LIVESTOCK MANAGEMENT SYSTEMS IN EAST AFRICA: AN ALTERNATIVE TO UNCONTROLLED COMMUNAL GRAZING

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Livestock Management Systems in East Africa: An Alternative to Uncontrolled Communal Grazing

Cattle productivity in Africa's major livestock regions is extremely low, compared to livestock systems in Europe or the United States (Simpson and Farris). Most countries in Africa have a need, at the national level, to make rapid improvements in productivity of their livestock industries to avoid an even more serious protein gap. Crotty (p. 1) found that annual output per head of cattle is 14 lb of beef and 10 gal of milk in the countries with the poorest one third of the world's population while in the wealthiest nations output is 140 lb of beef and 140 gal of milk. Research points to the problem of uncontrolled communal grazing in underutilization of livestock/range resources, a situation which has led to the tragedy of the common grazing lands in Africa (Hopcraft).

A series of recent articles in the Journal have examined various alternatives for mitigating the problem of Africa's low cattle productivity (Doran, Low and Kemp, Jarvis; Low, Doran, and Kemp). A central theme has been the need for institutional changes to correct the problem of low productivity. Distribution of range resources now used as common property to private ownership, is regarded as a radical solution to the overgrazing problem due to inherent sociological difficulties (Schneider, 1979). At least one researcher feels that conversion of communal to private property in East Africa would constitute a second best solution (Runge).

An alternative solution in some African nations, especially East Africa, is cooperative grazing management providing they have a legal foundation for appropriate institutions. Improved management, based on the existing cattle system, need to be interfaced with traditional management practices and to be evaluated for their economic benefit (Simpson, 1971). This study evaluates a communal

grazing area in Tanzania where an excessive inventory of cattle has exacerberated range denudation. A government program to create village institutions has placed additional grazing pressure on a limited area of rangeland. Our thesis is that reduction of uncontrolled grazing must be based on tailoring improved management practices within the context of the existing livestock grazing systems. Improved management practices which conform to the livestock system are hypothesized to either maintain or increase output from the village herd. A major purpose of this paper is determining quantitatively the potential benefits from alternative village level grazing practices.

METHODOLOGY

A field survey was conducted in 1975-76 to describe the livestock production system in Tanzania. From the survey, a baseline village herd was estimated for several areas, two of which are the semi-arid production region of Sukumaland, south of Lake Victoria, and the drier production region of Gogoland in Central Tanzania. The livestock management systems in the two regions, which constitute our analysis, are similar for comparison of herd performance for a twelve month period; and they are typical of livestock systems in much of Africa.

The survey data was used to simulate four improved management practices based on research conducted on livestock systems in Botswana (ILCA). The improved management practices require cooperation by producers, with producers still owning cattle privately. Each management practice has a sufficiently low capital and technology requirement to be within the reach of virtually all cattle owners, and requires mainly cooperation in grazing and culling their herds.

The method used to evaluate the alternative management practices for the baseline herds in two production regions is a dynamic forage/cattle simulation

model. The model allows for herd level changes due to various mananagement practices with the feedback effect of stocking rate on forage quantity and quality. The quantity and value of the outputs from each management practice are measured to determine the best (in an economic sense) set of practices for each production zone for a ten year simulation period. Climatic conditions are varied over the ten year period to approximate producer risk. Climatic variables of rainfall, radiation and pan evaporation are estimated from historical data using a lognormal probability function. The baseline herd was simulated for twenty years to achieve an equilibrium level, and validated to assure that the baseline herd approximated the survey data.

TRADITIONAL VERSUS IMPROVED MANAGEMENT PRACTICES

Management practices from the field survey were identified for the representative village herd in both production zones. Existing management consists of a twelve month breeding season with no bull selection. Calves are weaned from ten to twelve months with no additional care given to them. The dry season in the semi-arid region (Sukumaland) lasts for five months compared with six months in the lower rainfall zone (Gogoland). There is no supplemental feeding of calves in either region. Commercial offtake from the herds is at 13 percent with the majority of all sales during the dry season. (This is in contrast to a 33 percent commercial offtake in the United States) (U. S. Department of Agriculture).

The four management strategies which are outlined almost appear to be naive in their simplicity and logical benefit. But, they are not practiced, and cannot be practiced in an uncontrolled communal grazing system since complete cooperation is required in order for any one producer to effectively carry out a practice. Thus, the key is village level cooperation. The first management practice evaluated is an adjustment in the breeding season by removing bulls for three

months to prevent calves from being born during the stress period of the dry season. Benefits from shifting the calving season are lower death losses and higher weaning weights.

The second management strategy tested is weaning calves at eight months of age rather than the normal ten months - a practice which allows cows to return to the breeding cycle sooner. The management practice is expected to yield healthier cows which will produce more calves over time, and also increase milk output for home consumption. The tradeoff is for lower weaning weights for calves because of being removed from the dams at an early age.

Another practice evaluated is a supplemental hay program for weaned calves during the dry season. The economics of a hay making operation was determined feasible in each region (Sullivan, et al.). With the dry season lasting between four to five months in each region, cattle lose weight because of having to walk longer distances for forage and water. Producing supplemental feed for weaned calves can help cattle maintain their weight during this stress period. More forage is available in situ for the remaining herd.

The fourth, and last, management policy evaluated is adjustment in herd size by a sales policy. This practice has potential for increasing producer benefits since cattle are normally sold during the middle and end of the dry season period, when forage is scarce and prices are seasonally lower. This strategy assumes that beginning four months before the start of the dry season, a third of the cows over 12 years of age, cycling and open, would be sold each month to capture higher prices. This management practice has the benefit of removing unproductive cows and allowing more forage for the remaining herd. The effect of each strategy, seperately and in conjunction with others, are compared to traditional practices for a representative village baseline herd in the two production regions.

THE VILLAGE HERD MODEL

An interactive forage/cattle model simulating the dynamic growth of the village herd over time is used to test the potential of cooperative management practices. The forage portion of the model, which was adapted from a model by Smith and Williams, simulates growth for the predominant forage specie in the two production regions. In the higher rainfall region of Sukumaland, the major forage specie is Themeda triandra and in the drier zone of Gogoland, Panicum maximum. The driving variables of the forage model are weather, forage quality and availability. Output of the forage model is composition of the forage, green and dry grass, and its crude protein and digestibility. Monthly forage availability and its quality are key variables in the herd production model. The cattle herd inventory portion of the model was developed by Sanders and Cartwright (1979 a,b). The animal growth functions are based on a cow's genetic potential for her breed type and milk production. The interfaced model was validated by using primary and secondary data (Sullivan, 1979, 1981; and Getz et al.;and Kyomo) and is illustrated in Figure 1.

Composition of the representative village herd is estimated for the two climatic production zones. (Sheep and goats are not included in the village herd model and are assumed as complementary enterprises consuming different species of forage). The available grazing area for the village herd is estimated as a radius of five miles from the village and assumes cattle are corralled at night in the village. This practice is consistent for sedentary pastoral systems in both production regions (Sullivan and Farris).

Inventory composition of the village herd in the initial year is based on the situation estimated from the survey. In each year the composition changes until the herd reaches an equilibrium which then becomes the baseline for

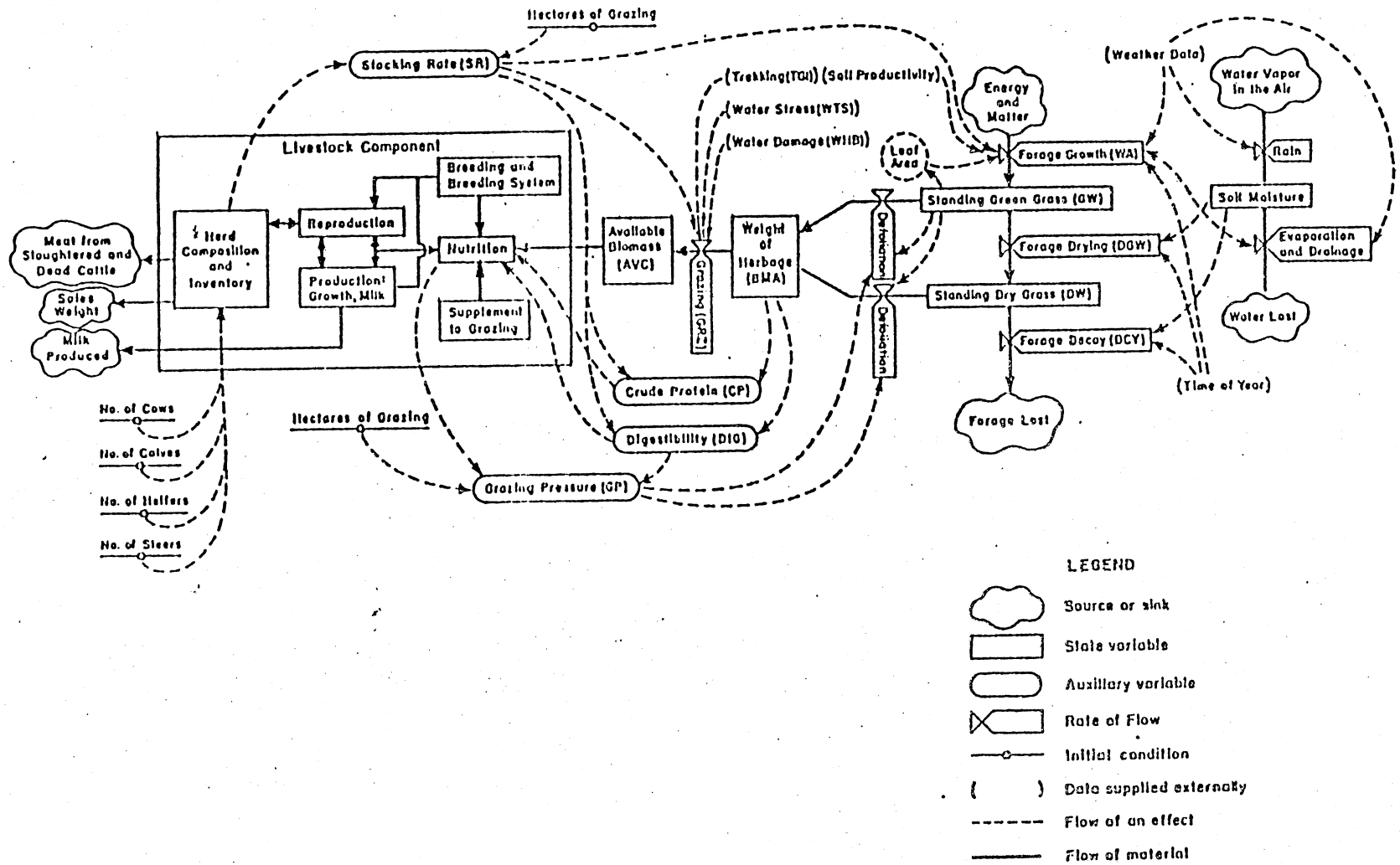

Figure 1. A flow diagram of a forage and cattle production simulation model.

Source: Sullivan, G. M., T. C. Cartwright, and D. E. Farris. "Simulation of Production Systems in East Africa by Use of Interfaced Forage and Cattle Models." Agric Systems 7 (1981) 245-265.

simulating traditional and alternative management practices for a ten year period. The ten year weather pattern is unique and estimated from a log-normal distribution based on twenty years of weather data (East African Community). All management practices are simulated with the same ten year weather pattern.

RESULTS

Higher Rainfall Zone

Simulation results are presented in Table 1 for the representative village herds in the two rainfall regions. In all cases the criterias for ranking the practices is weight of the herd, sale weight and milk production. Monetary benefits are given in Table 2. In the higher rainfall region of Sukumaland with a ten year average of 818 mm of rainfall per year, the weight of the baseline herd declines over the ten year period from 766 m.t. in the first year to 565 m.t. at the end of the tenth year because the weather pattern includes six years below the normal annual average. The only single management practice alternative which results in a larger herd weight than the baseline is supplemental feeding of weaner calves during the dry season, which increases the total herd weight 9 percent above the baseline. Without a supplemental hay program, total herd weight is either the same as the baseline or lower. Reducing herd numbers by selling cows, twelve years or older which are open and cycling, reduces herd weight to 84 percent of the baseline herd. Supplemental feeding allows more forage for the rest of the herd.

More important as an evaluative criterion than herd weight is sale weight. Of all practices the greatest effect on sale weight is a combination of a breeding program with supplemental feeding, a practice which provides a 9 percent increase over the baseline situation. The average weight per animal sold for the ten year period increases 10 kg per head with this combination of improved practices. Any combination using the weaning practices lowers the average weight

Table 1. A Comparison of Traditional and Improved Management Practices for a Ten Year Simulation of a Representative Village Livestock Herd in Sukumaland and Gogoland, Tanzania.

Management Practice	Sukumaland - 818 mm rainfall/yr.						Gogoland - 530 mm rainfall/yr.					
	Total Weight of herd		Sale Weight		Milk Production		Total Weight of herd		Sale Weight		Milk Production	
	m.t.	%	m.t.	%	m.t.	%	m.t.	%	m.t.	%	m.t.	%
Baseline	565	100	1167.	100	2618.	100	635	100	1340	100	3010	100
Breeding Season	519	92	1186.	102	2497.	95	610	96	1350	101	2900	96
Weaning Period	563	100	1170.	100	2630.	100	619	97	1360	101	2880	96
Supplemental Feed to Calves	618	109	1244.	107	2990.	114	945	149	1820	136	4940	164
Weaning + Breed	545	96	1164.	100	2552.	97	593	93	1360	101	2780	92
Weaning + Supplement	564	100	1169.	100	2638.	101	625	98	1360	101	2870	95
Breeding + Supplement	578	102	1275.	109	2858.	109	902	142	1810	135	4710	156
Breed + Wean + Suppl.	546	97	1165.	100	2559.	98	599	94	1360	101	2770	92
Sales Policy	474	84	1410.	121	2879.	110	485	76	1670	125	3442	114
Sales + Suppl. + Breed	458	81	1550.	133	3130.	120	---		----		----	
Sales + Supplemental	---		----		----		534	84	1680	125	3443	114

SOURCE: Sullivan, G. M. "Economics of Improved Management for Transforming the Forage/Livestock System in Tanzania - A Simulation Model." Unpublished Ph.D. dissertation, Texas A&M University, August 1979.

per head. For village milk production, the cooperative management practice of supplemental feeding increases milk production by 14 percent above the baseline for the ten year period. The breeding or weaning programs results in either a negligible increase or a slight decrease in milk production. Supplemental feeding plus the breeding program results in the second highest increase in milk production.

Another possible village policy is the sale of unproductive cows in periods when prices are higher. This practice results in total sale weight for the ten years increasing 21 percent above the baseline. Milk production increases ten percent above the baseline but not to the level of supplemental feeding. The mandatory culling of cows reduces total herd weight, but makes the remaining herd more productive per animal because of more available forage.

For the representative village herd in Sukumaland, the greatest economic impact is with a combination of a sales policy, supplemental feeding and a restricted breeding program. Herd size is the smallest but sale weight and milk production are the greatest for the ten year period. After the cost of hay production, the net value of meat and milk increases by 126 percent above the baseline value (Table 2). The conclusion is producers in this region would be much better off with a cooperative program than acting independently particularly given the uncertainty of weather as measured by 6 years of rainfall below the average. The productive efficiency of the herd increases with greater utilization of available forage.

Drier Rainfall Zone

The longer dry period found in Gogoland changes the effect of management practices on the village herd. The 10 year annual rainfall level used in the simulation study averaged 537 mm per year with four years below the long term

Table 2. Average Annual Net Value of Output of Meat and Milk from Livestock Herds for Ten Year Simulation Period for Sukumaland and Gogoland in Tanzania.

	Sukumaland		Gogoland	
	Annual Net Value[c]	Percent of Baseline	Annual Net Value[c]	Percent of Baseline
	'000 Tsh.	%	'000 Tsh.	%
Baseline	780	100	922	100
Breeding (B)	760	97	903	98
Weaning (W)	781	100	902	98
Supplement (S)	855	110	1400	152
W x B	764	98	883	96
W x S	759	97	844	92
B x S	835	107	1376	149
B x W x S	748	96	835	91
Sales	918	118	1205	131
Sales x Supplement x Breeding[b]	984	126	---	---
Sales x Supplement[a]	---	---	1172	127

SOURCE: Sullivan, G. M. "Economics of Improved Management for Transforming the Forage/Livestock System in Tanzania - A Simulation Model." Unpublished Ph.D. dissertation, Texas A&M University, August 1979.

[a]This combination of management practices was not examined for Sukumaland.

[b]Combination of management practices was not examined for Gogoland.

[c]Net value has cost of hay for supplementing weaner calves subtracted.

annual average for the region. Supplemental feeding of weaner calves increases the total weight of the village herd over the ten year period. Supplementing weaner calves with or without a breeding program allows more available forage to other cattle in the herd allowing cattle to maintain their weight during the dry season. Sale weight of cattle and milk production is greater than the baseline by 36 and 64 percent, respectively, with supplemental feeding. Implementing a weaning or breeding program only slightly increases sale weight but reduces milk production during the ten year period.

Instituting a sales policy of culling unproductive, old cows reduces total weight of the village herd but increases sale weight and milk production for the village herd by 125 and 114 percent, respectively, above the baseline. Reducing herd numbers does not have as great an impact as supplementing weaner calves. The amount of grazing is sufficient for herd size to increase, especially when supplemental feeding is available.

The sales policy combined with supplemental feeding slightly increases the total herd weight, but sales weight and milk production does not increase above those of a sales policy alone. Forage availability is the constraining factor in the drier zone so that reduction in herd numbers by a sales policy does not increase forage availability as much as supplemental feeding.

The net benefit from supplementation is an increase in the value of meat and milk output by 152 percent above the baseline herd (Table 2). A breeding program with supplementation produces a slightly lower increase in the value of the output. In the drier zone, supplementation of weaner calves during the longer dry season improves the replacement rate of the herd allowing more available forage for the rest of the livestock herd.

CONCLUSION

The purpose of this study is provision of quantitative data on the value of village level cooperative practices in East African communal grazing situations. This effort complements other studies which are more descriptive or theoretical in nature. The study's results show that cooperative management practices can increase the stream of outputs for a village herd compared to the use of traditional management practices. An important finding is that higher productivity can be obtained over a period of variable rainfall, a factor which can be an incentive for producers to adopt cooperative livestock management practices. In the two production regions, supplemental feeding of weaner calves with or without other practices significantly increases output over the baseline herd. A village sales policy of culling old, unproductive cows increases the value of meat and milk produced above that of the baseline herd.

Division of communal rangeland to private property or enforcing quotas on individual herd size may not be feasible. This study shows the potential benefits from management cooperation by producers, in many cases a more culturally acceptable solution than imposing more radical institutional change. An appropriate institution which can promote activities based on nonseparable decision-making and cooperative actions can be a pareto-superior use of resources compared to policies which can be incompatible within the cultural setting. Tanzania herdsmen already have the legal authority for cooperative control of grazing land. It is well known that until institutions are developed that facilitate effective management of grazing lands and livestock systems, there will be little progress in improving the productivity of livestock in much of Africa. This paper estimates the impact of one of those alternative institutions.

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