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-DRAFT FINAL
REPORT

IMPROVED AFRICAN LIVESTOCK PRODUCTION

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March 1990

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LABAT-ANDERSON, INCORPORATED

PART I

IMPROVED LIVESTOCK PRODUCTION

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When considering production on rangelands it is important to remember that the vegetation is the crop and grazing animals are used to harvest that crop. Harvesting rangelands with animals properly is one of the most difficult forms of agriculture. In arable agriculture the crop is protected and everything possible is done to favor growth until the desired growth is reached and the crop is harvested. When rangelands are harvested with animals many of the plants are harvested at the same time they are trying to make growth.

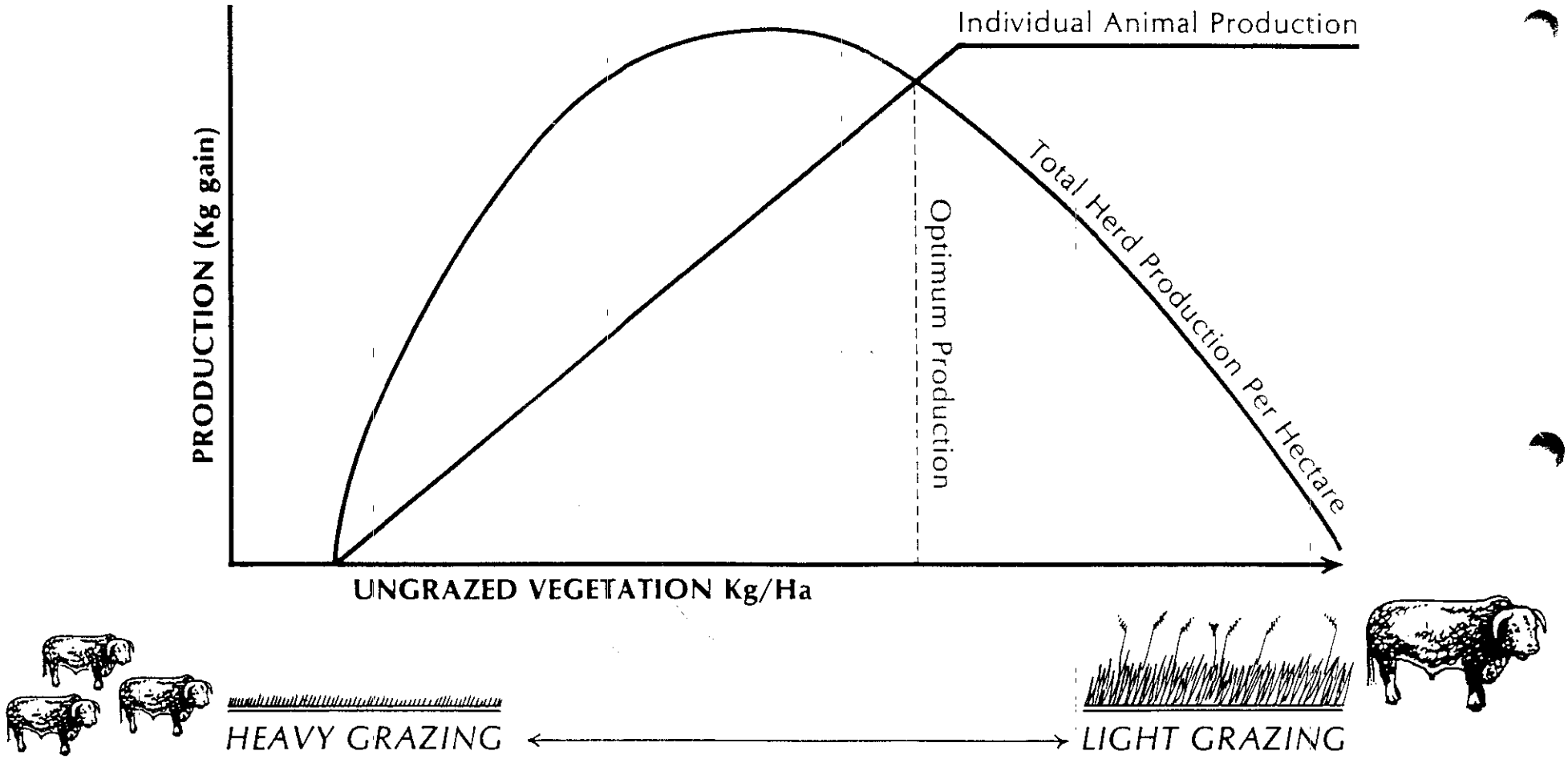
The balance of animal numbers with available vegetation is a delicate one especially in arid areas where the opportunities for plant growth are restricted. When rainfall presents an opportunity for plant growth, it is important that enough leaf material be left ungrazed for the plant to make the most rapid growth possible while moisture is available. When animal numbers are adjusted to maintain the needed amount of leaf material, the animals are in balance with the vegetation.

Production optimization and sustainability can only be accomplished when the range operators understand the animal-vegetation relationship for each important vegetation type. To understand this relationship one must know how a given species of animal responds to the quantity and quality of available vegetation and how that vegetation responds to the time and intensity of grazing it receives.

Grazing land managers are limited in what they can do to manipulate grazing. For a given area the manager can select the species of grazing animals, set the time of grazing and adjust the intensity of grazing. To manage a vegetation type effectively the manager must be able to answer four basic questions properly. These are: 1. When should the animals go on the area? 2. How many should go on? 3. When should they come out? 4. Where should they go? Understanding the animal-vegetation relationship makes it possible to answer the four basic questions logically and know the amount of leaf material to be left ungrazed in order to have animal numbers in balance with the vegetation.

The animal-vegetation relationship can best be understood by developing for each important vegetation type, a set of animal production graphs relating animal production to the quantity of vegetation available for grazing. Animal production graphs plotted on Figure 1 show how average individual animal and total herd production per hectare change as the amount of vegetation available to the animals changes. These production optimization graphs show how much vegetation should be left ungrazed for optimum animal

Figure 1. Livestock production graphs to optimize production on range lands.



production and vegetation sustainability.

The quantity of vegetation upon which management should be based is found at the point where the individual animal production line crosses the total herd production per hectare line. In order to correctly locate the intersection the graph must be prepared so the maximum individual animal production and the maximum herd production per hectare are plotted at the same level. The intersection is the balance point which shows how much vegetation must be left ungrazed to get optimum animal and optimuim vegetation production.

Production optimization graphs at the Central Plains Experimental Range in Colorado USA were first developed in 1963 using 19 years of heifer weight gains and vegetation biomass data from stocking rate trials. The average individual heifer gain was plotted over the quantity of vegetation left ungrazed at the end of each six month summer grazing season. This original graph was used as a management guide for public lands leased to the Crow Valley Grazing Association where the cattle owners paid a per head per month grazing fee. With the cost of grazing paid on an individual animal, the operation was most profitable when maximum animal gains were made. In this case it was best to leave ungrazed the amount of vegetation at the point where the individual animal gain flattened.

The Crow Valley Grazing Grazing Association ranchers who operated under this system on the public lands then wanted to know if the system was also best for privately owned lands. With privately owned lands it was thought that management should be based on beef production per acre. Total herd production per acre was then plotted over the quantity of ungrazed vegetation left at the end of the grazing season. It was found that maximum gain per acre occurred where approximately 100 pounds per acre less vegetation was left ungrazed.

Three years later it was seen that the heavier grazing required to get maximum gain per acre was too heavy and forage production was lowered by grazing at this level. It was then decided to look at cattle sale data taken at the annual sale held at the Experimental Range and plot dollar return per acre over the quantity of vegetation left ungrazed.

The sale data showed that the highest dollar return per acre came between the points where maximum herd gain per acre and maximum gain per individual animal were reached. With maximum individual animal gain and maximum herd gain per acre plotted at the same level, this optimum point occurred at the intersection of the two lines.

The original stocking rate guide produced from these data showed the point of highest dollar return to be where 300

pounds per acre of vegetation were left ungrazed and that the average stocking rate for those 19 years to leave 300 pounds per acre was 2.6 acres per animal month. Because of the extreme variation in precipitation amounts and the resulting fluctuation in the quantity of vegetation produced per acre,it was learned that stocking rate is a poor basis for range management. The average annual precipitation at the Experimental Range was 300 mm. During a ten year period following development of the graphs, a low of 107 mm and a high of 550 mm of annual precipitation were received. Only 124 lb/ac of vegetation were produced in the 107 mm year and 1130 lb/ac were produced in the 550 mm year. The graphs show that for effective management the area should not be grazed at all with only 124 lb/ac of vegetation produced. In the year when 1130 lb/ac of vegetation were produced, the graphs show that 830 lb/ac of vegetation could be grazed. Stocking rates are ineffective as management tools because animals do not eat acres nor hectares. They eat the vegetation that grows on those units of area and management decisions must be based on the amount of vegetation available for grazing not on the size of the area.

Since 1973 production optimization graphs have been developed on nine major vegetation types in Iceland where 2250 mm of annual precipitation are received and 24 hours of daylight occur per day during the growing season. One vegetation type located on heavy soils at sea level produces optimum livestock production and sustains the vegetation when a mixture of sheep and cattle graze the area always leaving 1100 kg/ha of vegetation ungrazed. Another Iceland vegetation type at high elevation on very sandy soils produces best when grazed by sheep and managed to leave 300 kg/ha of vegetation ungrazed.

In Niger, West Africa, on sandy soils with 100 to 175 mm of precipitation optimum livestock production is made on annual grasses when 180 kg/ha of vegetation are left ungrazed. A mixture of annuals and perennials with similar soils and precipitation produces best when 320 kg/ha of vegetation are left ungrazed.

The above examples demonstrate the need for developing production optimization graphs for the different important vegetation types. There is no need to determine the entire animal-vegetation relationship with expensive long term grazing trials as was done at Central Plains Experimental Range. The shape of the diagram is similar for all vegetation types. It is only necessary to establish the correct quantities of vegetation to fit the vegetation type to be managed. Establishing as few as three points with three intensities of grazing is often enough to develop the graphs and understand the animal-vegetation relationship.

To develop the production optmization graphs where there are no data available it is first necessary to identify the

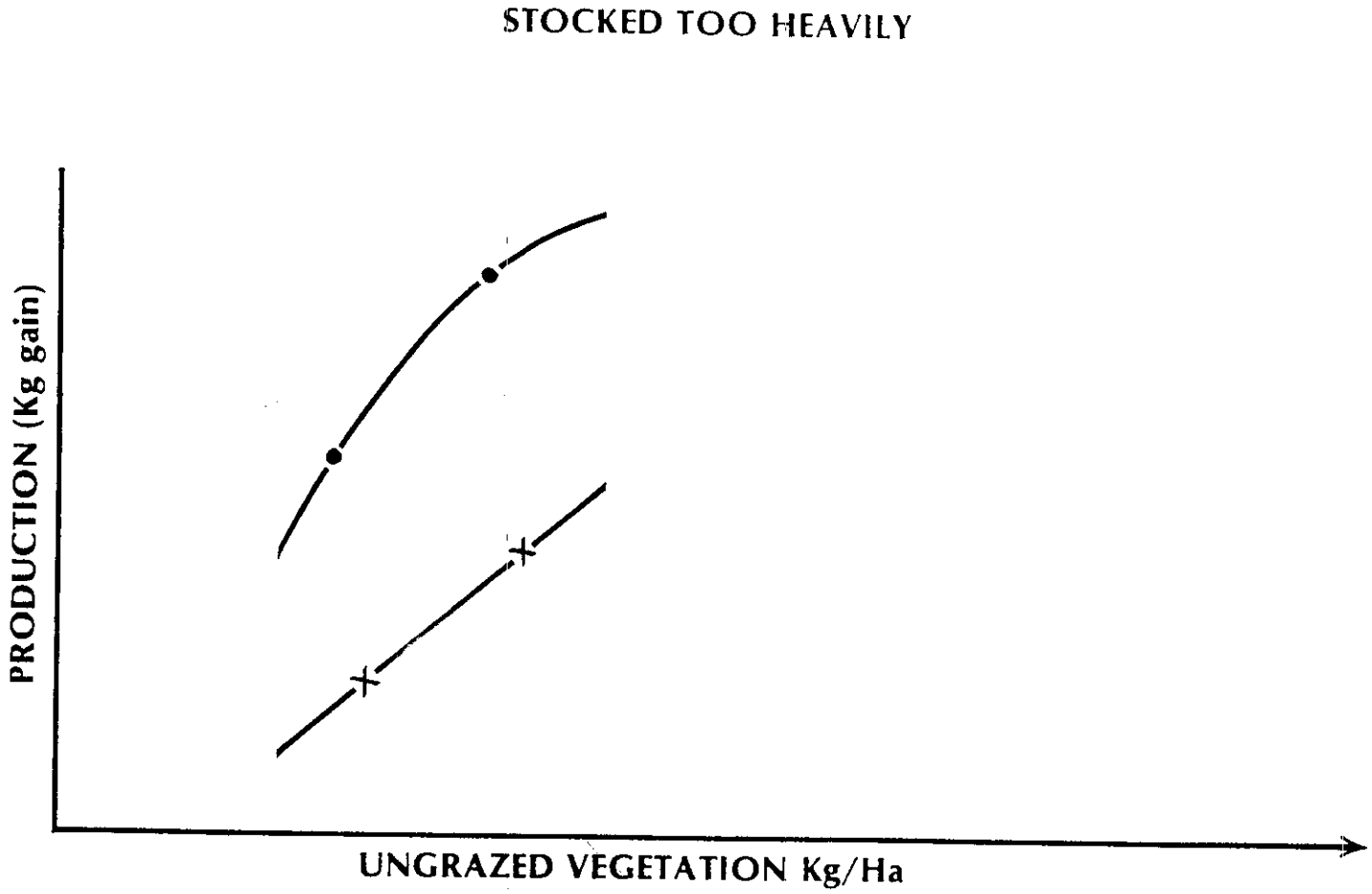
important vegetation types and define the plant community. This is best done using plant frequency taken along permanently marked transects using a quadrat of a size that will give a frequency of approximately 80% for the most abundant plant species. Once the important vegetation is identified and defined, the appropriate animal species should be determined and three areas selected for stocking at three distinctly different levels of grazing intensity. The quantity of vegetation is measured on each of the three areas at the beginning and end of each grazing period. Individual animal weights are also taken at the beginning and end of each grazing period. Average individual animal gain and total herd gain per hectare are then calculated and plotted over the quantity of vegetation left ungrazed at the end of the period. Each of the three grazing intensities will give one point on the individual animal gain line and one point on the total herd gain per hectare line.

Examination of the plotted points will show quickly if and how animal numbers need to be changed to include the intersection on the animal-vegetation graph. Figure 2 shows an example where the grazing intensities are too heavy. Animal numbers should be reduced to locate the intersection of the two lines. In Figure 3 the areas have been stocked too lightly to include the intersection and when grazing is repeated with similar amounts of vegetation, animal numbers should be increased to include the intersection. Figure 4 is an example of a case where the three grazing intensities have included the intersection. In this case the grazing trials should be continued to monitor the effects of time and intensity of grazing on vegetation production and changes that may occur in plant composition.

Plant species composition should be measured at least once a year. In cases where plant composition changes as a result of the grazing pressure it receives, those changes need to be defined. Grazing trials conducted to develop the production optimization graphs provide a demonstration of what happens to vegetation and animals under different times and intensities of grazing. When local livestock owners take part in the conduct of the trials, they often see for the first time an actual comparison of what different management techniques can produce.

In Niger, grazing trials conducted with cows and using milk as the measure of production showed that pastures protected from grazing during the growing season provided sufficient nutrients to extend milk production into the dry season. The local herders believed that milk production was possible for just a short time into the dry season until they saw that pastures protected from grazing during the growing season and grazed first during the dry season made it possible to extend milk production far into the dry season. These grazing trials showed that a deferred rotation system was far superior to continuous light grazing for this

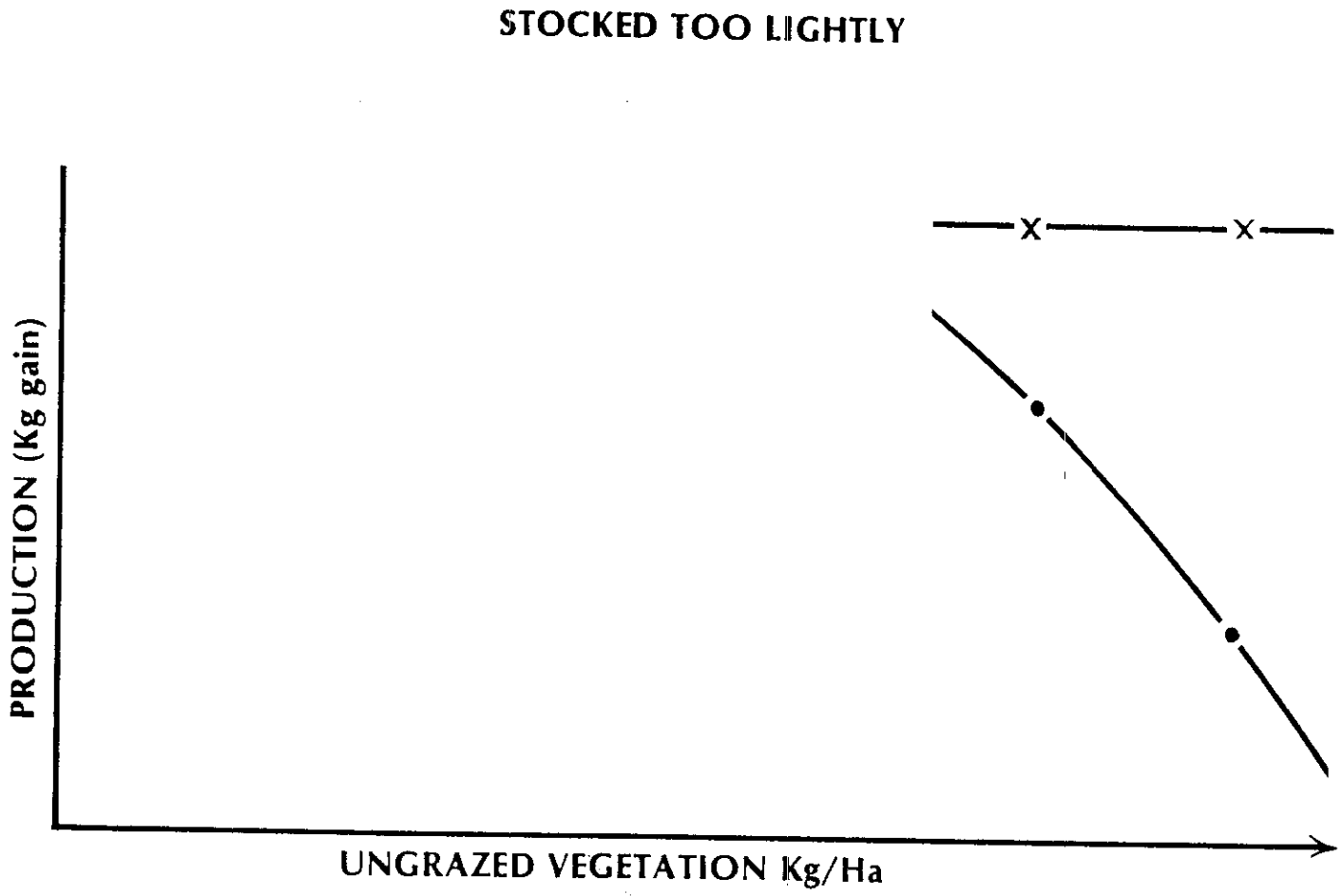
Figure 2. Development of livestock production graphs



X = Individual Animal Gain

• = Total Herd Gain Per Hectare

Figure 3. Development of livestock production graphs

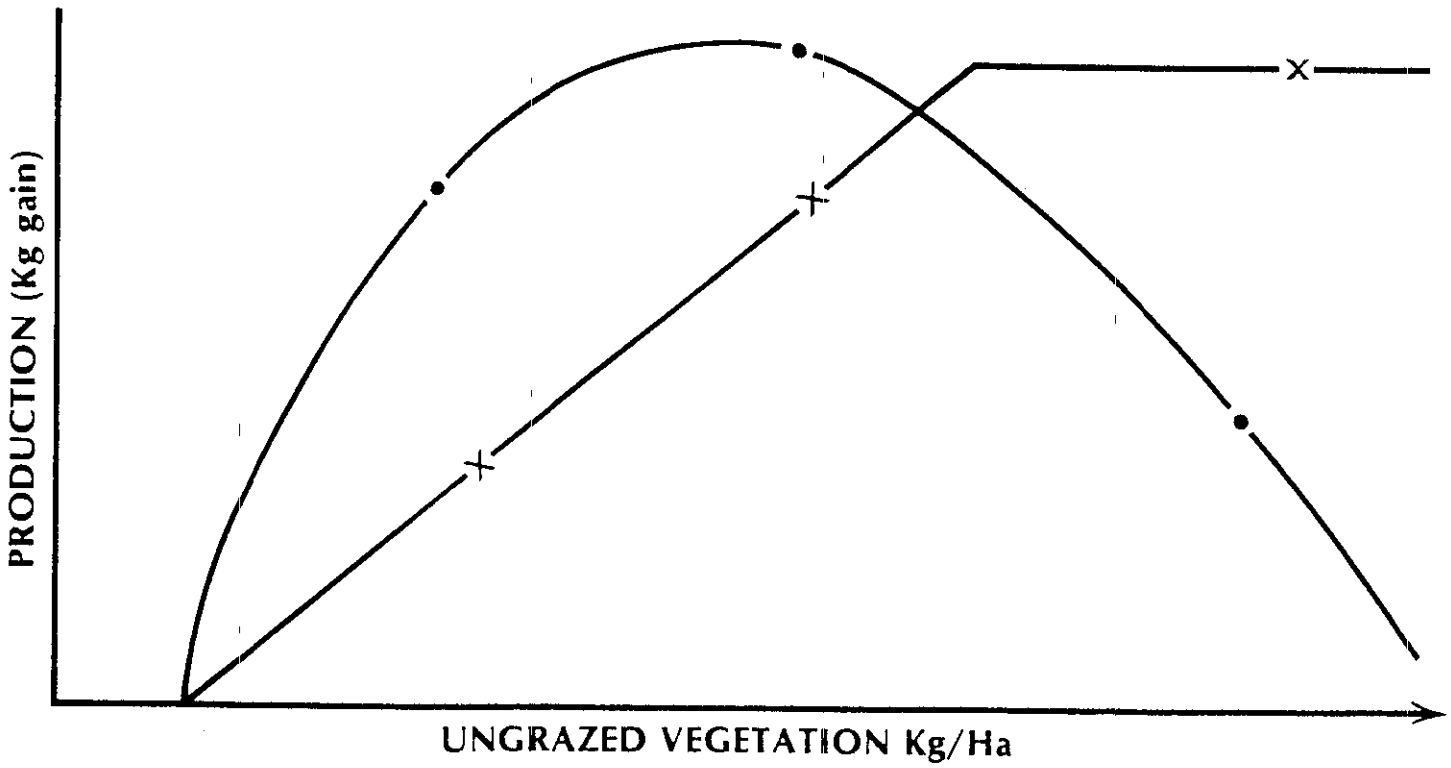


× = Individual Animal Gain

• = Total Herd Gain Per Hectare

Figure 4. Development of livestock production graphs

STOCKED TO INCLUDE THE INTERSECTION



X = Individual Animal Gain

• = Total Herd Gain Per Hectare

vegetation type used during the dry season.

Often times grazing systems are applied to a given vegetation type without understanding the animal-vegetation relationship. It is like stumbling in the dark. We should start as early as possible to take the simple livestock and vegetation data required to understand the relationship. When we understand the animal-vegetation relationship we will know what the grazing system must do to make a given range produce most effectively. Politicians, policy makers, planners, and especially livestock owners and managers need to know these relationships in order to determine proper sizes, locations and wise management for range units. Every one involved in range management needs these production optimization graphs to define over grazing and proper grazing for the major vegetation types. Development of these graphs will make it possible to focus on production intensification and range resource sustainability which means a continuous supply of high quality meat.

PART II

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I. Commercial Livestock Operations

Assessments of commercial livestock operations in Kenya and Botswana are based on visits to nine ranches in Kenya and four ranches in Botswana in 1990, visits to three ranches in Botswana in 1988 and work I did on the Lualenyi Ranch during two trips to Kenya in 1977.

A. Rangeland Capacity

The quantity and quality of vegetation on a given rangeland determine its capaciity for livestock production. In order to assess rangeland capacity it is essential to know how the vegetation responds to the time and intensity of grazing it receives and how the animals respond to the quantity and quality of vegetation available to them. This livestock vegetation relationship can be plotted as production optimization graphs as described in the Improved Livestock Production report by Bement, March 1990.

On this trip I saw ranch operations that ranged from extremely low production on the heavily grazed side of the graph to high individual animal production on the lightly grazed side of the graph. Somewhere between is the level of grazing that will result in optimum production. The graphs must be developed to locate this point for the important vegetation types.

B. Fodder Management

There are several opportunities for fodder management. In Botswana some ranchers are growing forage sorghum as a feed source for livestock. It is grazed in the field, fed as green chop and cured for hay. The possibility of preserving sorghum as silage in plastic bags would be extremely helpful in filling out a forage availability calendar in many areas.

The sisal estates in Kenya also can fill a niche in forage availability calendars. On some sandy soils I saw that it is possible to graze the areas between the sisal rows without damaging sisal production. Ordinarily the grass growing between the sisal rows is removed by hoeing as it is believed that trampling by grazing animals is detrimental to sisal production. Some estates with no grazing had as much as a ton per acre of forage grasses growing between the rows waiting to be cultivated. This means that fifty percent of the area in sisal could also provide forage for cattle. Grazing on soils with more clay may be detrimental

to sisal production but this could be readily determined in small grazing trials by weighing animals and measuring sisal leaf growth.

The waste from the sisal decordating process may also provide a source of food for livestock. This needs to be investigated as well as the possibility of making a Mexican tequila type drink from the sisal juice.

C. Feed Lotting

I visited one feedlot in Botswana where sorghum was grown and fed as green chop along with grain. In this case the cattle were marketed through the owner's butchery. A reliable source of grain was a problem.

D. Current Herd Production

The herd production ranges from outstanding, with calf crops of 85 to 90%, to very poor with calf crops of less than 20%. The herd production is closely related to the nutrition level available to the animals. Most animals exist on the heavy or the left side of the production optimization graph where the nutrition level is very low. An adequate level of nutrition is a basic requirement if an acceptable calf crop percentage is to be realized. On most ranges the level of nutrition is so low that it takes four or five years for a heifer to grow big enough to begin to cycle and take a bull. My heifers raised on grass and pastured to just reach the maximum individual animal gain on the graph, cycle and are bred at 14 months of age. One ranch in Botswana had similar results.

The same relationship exists with the steers. When the nutrition level is so low that it takes five years for a steer to reach 350 kg, the meat is tough. Young equals tender. The time it takes for a steer to reach marketable size can be reduced by increasing the level of nutrition and at the same time result in better quality meat. In most cases this means moving from the left side of the production optimization graph to the right side by simply reducing animal numbers.

E. Current Management Systems

In order to have an effective management system it is necessary to balance animal numbers with the vegetation. This means the manager must control both the land and the animals. On most range areas I saw on this assignment, there was no control and the result was heavily overgrazed ranges with poor livestock. The most successful operations were fenced and not heavily grazed. Of those that were not fenced, the most successful ones had a limited supply of water which in turn limited the number of livestock that could graze in the area.

The management levels on the fenced areas varied from an operation that had 400 head die during the 1987-88 drought to one that carried 3000 head nicely through the same drought. The one that survived the drought grazed lightly while the one that didn't survive grazed very heavily. To manage effectively the manager must know how much vegetation to leave ungrazed. The production optimization graphs will identify the proper amount.

II. Existing Levels of Management

A. Technology

Production optimization graphs are not available in either country for any vegetation type. In both countries I saw levels of management that ranged from one end of the graphs to the other. The most important thing that can be done at this time is to develop the graphs for the important vegetation types in each country. This technology will make it possible to optmize meat production and sustain the range resource.

B. Marketing

Marketing by the operators contacted included sales to National Meat Commissions, sales through rancher owned butchery and sales to livestock order buyers. One such buyer had leased a livestock carrying ship. He originally was a hay dealer and provided hay to the ship owner who transported dairy cattle. When the dairy cattle trade slackened the hay dealer leased the ship and began shipping beef cattle, sheep and goats out of Kenya. He would welcome a reliable source of reputable animals and could take from 150,000 to 180,000 head of good male sheep and goats per year. He would also like a reliable source of castrated, dehorned cattle in good shape and weighing over 350 kg for sale in near eastern countries. It looks as if there is a demand for good quality butcher cattle.

Two ranch operators, one in each country, sell wildlife carcasses from their fenced operations. The Kenyan harvests the wild game one night per week and sells the meat to a restaurant in Nairobi. The rancher has his own butchery and the meat is government inspected. The trim not taken by the restaurant is made into smoked jerky, packaged in small plastic sacks on the ranch and sold in stores and bars.

The operator in Botswana has his wildlife harvested by professional hunters equipped with hunting, dressing and meat cutting teams. They have refrigerated trucks and harvest once a year on a big scale. The meat is transported to West Germany for sale.

C. Requirements for Assistance and Personnel

In order to develop a total management and production plan, it is first necessary to have the production optimization graphs for the important vegetation types. Animal data for cattle, sheep and goats are already available on two government ranches in Botswana. Two ranchers in Botswana began taking cattle data in February 1990. One Botswana rancher has wildlife weights from 1989 and will collect data in 1990. Two cattle ranchers in Kenya will take livestock data to develop the graphs but at the time do not have scales. One rancher that also harvests wildife on a weekly basis has wildlife carcass weights.

The essential elements missing to develop the production optimization graphs are the vegetation data. The vegetation type must be defined showing the relative abundance of the different plant species making up the plant community. The kilograms per hectare of available vegetation left ungrazed at three different levels of grazing intensity are needed to plot the production graphs.

It is recommended that two vegetation teams be trained and equipped to operate one each in Kenya and Botswana. These teams would need to be highly mobile and very efficient. Each team should have a team leader and four members.

The first priority for the vegetation teams will be to identify the important vegetation types on the areas that can be managed. Once the important vegetation types are identified and arrangements for livestock data to be taken have been made, the following things will be done: The team leader will select and mark the permanent transects along which the vegetation data will be taken. He will also make rancher contacts and be sure the team takes the vegetation quantity data at the proper times to relate vegetation quantity to animal performance.

The team leader must know how to identify the plants and teach his team members how it is done.

The team must be highly mobile with four wheel drive vehicles and have one passenger vehicle that can carry the entire team. Two pickups are needed to haul equipment including camping facilities. The four team members will work in pairs and each pair will need a pickup.

Each team needs four long range radios, one for the team leader, one for each pair and a spare.

Camping equipment will be required as the team will stay on a given site until the data is taken. The vegetation quantity data must be taken as closely as possible to the same time on the three pastures providing the three data points. A list of equipment needed for each team is attatched as Appendix A.

Only one rancher had a scale suitable for taking animal data. It is recommended that the use of portable livestock scales be made available to ranchers interested in developing the production optimization graphs for their vegetation types. Electronic portable scales that operate from a car battery are available. Specifications are included in Appendix A.

III. Management and Production Plans

Once the production optimization graphs are developed, the management and production plans can be initiated. For each commercial unit a forage availability calendar will be prepared showing when what feed is available. Using the production graphs an animal production calendar will be prepared showing how the animals respond to the feeds available. From these data we will develop a herd adaptation program where the animals that best use the feed regime for a given operation are selected and developed. This will give us a group of animals that fit the vegetation that supports them.

From what I saw on this assignment, I am sure that on many heavily grazed areas an early response can be expected by simply reducing animal numbers. Ranches operating on the heavily grazed side of the production graphs can increase both individual animal gain and total herd gain per hectare by reducing animal numbers. This makes more feed available to the remaining animals. Ranchers operating on the far right of the lightly grazed side of the graph will be able to increase total herd gain per hectare by adding animals and still maintain high individual animal performance.

Development of the production optimization graphs will make it possible to put in place management systems that will focus on production intensification and range resource sustainability. This means a continuous supply of high quality meat.

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APPENDIX A. Equipment Requirements and U.S.A. Costs

Description	$ Price	Quantity	USA Cost
Passenger vehicle, 4-dr, 4x4, 6 passenger.	25,000	1 ea	25,000
Pickup truck w/shell, 4x4 heavy duty w/hitch to pull portable lvstk scale.	20,000	2 ea	40,000
VEHICLES			$65,000
Radios, long range, hand held.	600	4 ea	$2400
Scales, hand held			
300gx2g	40	4 ea	160
500gx5g	40	4 ea	160
1kgx10g	40	4 ea	160
Plant press	10	10 ea	100
Clip boards w/cover, 8.5x12"	20	10 ea	200
Grass shears	10	10 ea	100
Pocket magnifier lens	10	5 ea	50
Compass	15	3 ea	45
Field utility box	10	5 ea	50
Distance measure wheel w/case metric counter, disc wheel	150	2 ea	300
Vinyl flagging	1	35 rl	35
Plastic soil sample bags 10"x18", 100 bag pkg	9	10 pkg	90
Paper bags, 500 bdl			
12 lb	20	4 bdl	80
25 lb	30	4 bdl	120
Steel post driver	60	3 ea	180
Steel posts	3	250 ea	750
Rain guage, plastic - 27.9cm x 2mm	30	10 ea	300
SAMPLING EQUIPMENT			$2,880
First aid kit w/ case 24 unit	50	3 ea	150
Tent w/ fly, 12'x12'	400	2 ea	800
Screen tent, 10'x14'	350	2 ea	700
Cot w/case, 30"x72"x10"	45	6 ea	270
Center fold table, 30"x62"	60	2 ea	120
Chairs folding director type	30	8 ea	240
Cookware camp set, 6 person	50	2 ea	100
Propane stove, 2 burner	55	2 ea	110
Propane lantern w/case	50	4 ea	200

Water cans plastic	15	8 ea	120
Gas jerry cans plastic	15	6 ea	90
CAMPING EQUIPMENT			$2,900
Livestock scales,portable, electronic readout by auto battery,16"wheels	$5,000	3 ea	$15,000

SUMMARY:

Vehicles	$65,000	
Radios	2,400	
Sampling	2,880	
Camping	2,900	
	$73,180	to equip one vegetation team.
Livestock scales	$15,000	

Total equipment cost $88,180 per country. These costs were taken from current catalog prices and will need to be adjusted for transportation and import expenses.