THE LAND-VARIABILITY FACTOR IN CATTLE-GRAZING EXPERIMENTS

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IN MANY TYPES of agricultural experiments the factor of land variability is controlled to a satisfactory degree by using plots of suitable size and shape, by adequate replication, or by other elements of design. In cattle-grazing experiments land variability is not easily overcome. The cost of setting up pastures that often cover 100 acres or more usually makes it impracticable to use more than two or three replications of a given treatment. Furthermore, these experiments are conducted on ranges that typically are highly variable. Even where special care is taken in selecting the experimental site to ensure uniformity, land variability is not satisfactorily eliminated, and experimental results therefore are often difficult to analyze.

A cattle-grazing experiment that is being carried on by this Station illustrates the point. Close study of this experiment has pointed to the possibility of measuring range variations in pastures and using the information in interpreting the results of treatments. Highly important practical results have been obtained from the experiment to date. By the application of suitable statistical methods probably still more information can be extracted from it. The basic problem involved is presented here briefly for consideration by statisticians.

The purpose of the experiment is to determine the effect of three intensities of grazing on the yield and composition of forage and on livestock production in terms of pounds of meat produced. The experiment was set up to run over a period of years, since forage variations and their effect on livestock occur gradually.

Three paired pastures were used—two 160 acres, two 240 acres, and two 320 acres. They were rectangular, roughly twice as long as wide, and were arranged in a block so that no two pastures of the same size lay side by side. Each pasture was stocked with 15 cows and their calves so that the whole experiment provided three intensities of grazing—light, moderate, and heavy. The cattle were grazed in the pastures from January to August, a season that includes most of the green-forage period and about a month and a half of the dry period. The cattle were weighed individually at the beginning and at the end of the grazing season and at three other times in between. Vegetation changes were measured in terms of density and composition, and the degree of grazing was judged by the amount of forage left on the ground at the end of the grazing season.

The first four years of data showed that intensity of grazing and weight gains of the livestock were not consistently correlated with size of pastures. For example, each year about twice as much forage was left in one of the 160-acre

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pastures as in the other of the same size, and only a little more was left in one of the 240-acre pastures than in the most lightly grazed of the 160-acre pastures. Similarly, there were large differences between the weight gains of cattle grazed in pastures of the same size, sometimes greater than those between pastures of different sizes.

Further study was made of the pastures to account for the differences observed. The actual acreage of forage-producing ground in each pasture was obtained by subtracting from the pasture total the acreage covered by rocks, brush, trees, roads, and other areas inaccessible to livestock. Furthermore, it

COMPARISON OF SIX PASTURES USED IN INTENSITY-OF-GRAZING EXPERIMENT FOR A GIVEN SEASON

	Pasture number					
	1	3	2	5	4	6
Pasture size (acres)	160	160	240	240	320	320
Total grazeable acres	136	106	185	163	206	259
Forage-producing sites (acres)						
Swale	19	12	23	7	8	18
Rolling slopes	116	77	145	57	113	203
Steep slopes	1	17	17	99	85	38
Animal units*	17.3	18.9	18.1	19.2	19.6	18.4
Grazeable acres per animal unit	7.9	5.6	10.2	8.4	10.5	14.1
Forage on ground end of season (pounds per acre)	300	150	700	400	600	700
Cattle weight gains for season						
Per animal unit	291	279	360	362	342	366
Per grazeable acre	37.1	49.8	35.3	42.8	32.6	26.0

* One cow is one animal unit; one calf is one-half animal unit.

was found that the pastures contained three recognizable forage-producing sites—swales, rolling slopes, and steep slopes—that differed in yield, quality of forage, time of growth, or a combination of these. These and other differences between pastures are shown in the table above.

The problem now is to determine the effect of forage-producing site on intensity of grazing, cattle weights, and forage changes. If this problem can be solved, the experiment would yield much more information of value in range management than could be obtained from simpler replicated tests. The effect of different forage-producing sites on the weight gains of cattle and on intensity of grazing could then be calculated quantitatively. The combination of site and degree of grazing yielding maximum meat production could be computed and the results extended to similar ranges. Furthermore, a new approach to pasture experimentation would be possible: the highly variable pastures found in field work could be used instead of the more uniform ones demanded by replicated pasture designs.

A tentative approach to the problem could be based on the following assumptions: (1) that the weight gains of the cattle are determined primarily by the amount and kind (quality) of forage they eat; (2) that the amount and kind of forage eaten is determined by the acreage of each forage-producing site, by the yield, nutritive value, and time of growth of forage in each site, and by the time and period of grazing in each site; (3) that the closeness of grazing and resulting changes in the forage are determined by the number of cattle and the acreage of each site in each pasture. All the variables mentioned can probably be measured or reasonably estimated. The most difficult to get at perhaps would be the nutritive value of the forage.

This problem has received some statistical attention but no concrete results have been obtained. Professor Jerzy Neyman, of the Statistical Laboratory, University of California, Berkeley, has suggested a method of analysis. However, difficulties were encountered in both the mathematical and the biological phases of the work.

The statistical study was interrupted by the start of the war and has not been resumed since. It is hoped that range and animal-husbandry technicians and statisticians working together will be able to develop a method of analysis that will broaden the values and application of results.