Estimating Cattle Gains from Consumption of Digestible Forage on Ponderosa Pine Range[1]

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Highlight

In vitro digestibility measurements reduce the variability in estimating cattle gains from forage intake measurements. The daily digestible forage intake requirements of range cattle appear similar to the requirements of cattle in feedlots.

La Estimacion de Ganancias del Ganado Bovino por el Consumo de Forraje Digestible

Resumen[3]

Se llevó a cabo el estudio en un pastizal tipo pino ponderosa cerca de Flagstaff, Arizona, E.U.A. Las ganancias del ganado bovino fueron relacionadas directamente con el consumo de forraje digestible y el consumo ordinario. El consumo de forraje digestible explica el 80% de las ganancias y el consumo ordinario explica el 75.3%. Se concluyó que la mejor evaluación de los pastizales es el consumo de forraje digestible.

Range nutritional value is usually measured in terms of forage production, utilization, and chemical analyses, and less frequently in terms of animal production. Although it is generally simpler and less expensive to measure forage than animals, some conversion of forage measurements into animal products is necessary to properly assess range value. The most meaningful conversion is based on forage intake and digestibility of that forage: digestible forage consumed. This conversion provides a better evaluation of different ranges regardless of species composition of the animal diet.

Forage requirements for animal maintenance and gain are also important in determining range value. The energy requirements for domestic livestock in feedlots have been investigated by several workers (Green et al., 1959; Garrett et al., 1959; Winchester and Hendricks, 1953), but little quantitative information is available on maintenance or gain requirements for grazing animals under range conditions. Kromann et al. (1961) found no difference in the maintenance requirements for digestible energy between steers fed in a drylot and those grazing irrigated pasture. They suggest that the extra activity involved in grazing does not materially increase the digestible energy requirements of cattle.

Relationships between digestible forage intake and yearling cattle gain on ponderosa pine (*Pinus ponderosa* Laws.) summer range are reported here. Included are (1) the beef gain-forage consumption per acre relationship, and (2) quantitative daily requirements of grazing cattle. In vitro dry matter digestibility has been applied directly to animal responses instead of being converted to in vivo digestibility prior to application.

Since digestible dry matter accurately describes digestible energy and total digestible nutrients (TDN), with appropriate transformations these terms can apparently be used interchangeably when considering nutrient requirements for livestock (Moir, 1961; Harris et al., 1959; McCullough, 1959).

Methods and Procedures

The ponderosa pine range studied, near Flagstaff, Arizona, is described in detail by Pearson and Jameson (1967); it includes seven pastures varying from 40 to 250 acres. The pine stands in four pastures were thinned to different densities of trees; two pastures were clearcut and one was left unthinned. These differing densities of overstory provided pastures with varying forage yields. Arizona fescue (*Festuca arizonica* Vasey), mountain muhly (*Muhlenbergia montana* (Nutt.) Hitchc.), bottlebrush squirreltail (*Sitanion hystrix* (Nutt.) J. G. Smith), and sedge (*Carex geophila* Mackenz.) comprised the major portion of the herbaceous vegetation.

Yearling Hereford heifer cattle grazed each pasture for a 4-month season, June through September, 1963–67. The average animal weight varied between 450 and 600 pounds. Forage utilization varied between 5 and 40%.

Water and salt were manipulated to provide uniform grazing in each pasture. Trap gates at the water facilities were used to catch animals for weighings. Animals were held off water 12 to 16 hrs prior to weighings. Animal gain was determined by difference between initial animal weight in June and ending weight in September.

Forty-five pairs of 9.6-ft^2 plots (one caged, one uncaged) were located in each of the seven pastures to measure utilization production, and forage digestibility. The caged plots were clipped at 6-week intervals during the season to resemble cattle grazing on the uncaged plots. Digestibility of the clipped forage, which duplicated cattle intake or consumption ranged from 52.1 to 60.3% and was determined by the two-stage in vitro technique (Tilley and Terry, 1963). The remaining forage on the caged plots was clipped to near ground level at the end of the growing season. Total production was obtained by adding all clippings.

Least squares regression analyses

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were used to determine simple prediction formulas based on pasture mean values. The independent variables (seasonal forage intake and seasonal digestibility) were subject to large sampling error, however.

Animal weight gains and forage intake varied according to stocking rate, grazing intensity, and forage production. From these relationships a regression equation was calculated to describe the maintenance and gain requirements of grazing cattle. The maintenance and gain requirements are determined by use of the equation $f = aw^b (1 + kg)$ described by Winchester and Hendricks (1953), where f is the daily energy intake, w is the mean body weight, b is the basal metabolism factor, and g is the mean daily weight; a is the intercept constant determined from the linear relationship between energy intake and weight gain while k is a constant determined by dividing the regression coefficient from the linear relationship by the intercept constant.

Results and Discussion

Beef Gain-Forage Consumption per Acre

Beef gain per acre was directly related to in vitro digestible forage consumption per acre (Fig. 1) and ordinary forage consumption. The regression equation expression of beef gain per acre to digestible forage consumption was:

$$G = 0.257\ DC - 1.013$$

where G is the seasonal yearling beef gain in lb./acre and DC is the mean product of in vitro digestible dry matter consumption in lb./acre. Digestible forage consumed explains 80% of the variation in gains. The equation for ordinary forage consumption per acre was:

$$G = 0.141\ C - 0.643$$

where C is dry matter consumption in lb./acre. Consumption alone explains 75.3% of the variation in gains. Relative precision of the equations is computed as the ratio of the coefficients of determination

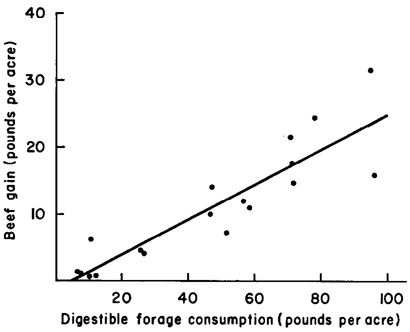

FIG. 1. Relationship between digestible forage consumed and beef gain per acre.

$(1 - r^2)$. The relative gain in precision by inclusion of digestibility was 25%, which is significant at the 0.01 probability level (Williams, 1959).

Since forages can differ in nutritive value from year to year on various ranges, the digestibility measurements enhance forage evaluations. Forage from different ranges can be compared, regardless of species composition.

These relationships are most useful for predicting beef production from studies in which forage can be measured but beef gains cannot. The in vitro digestibility measurements are especially useful in range evaluations. Only small forage samples are necessary for determinations and an acceptable level of precision can be prescribed. The specific relationships described here apply only to beef yields per acre for yearling heifers grazing pine summer range in the southwestern United States, however.

Daily Nutrient Requirement

The equation used to describe daily intake requirements was:

$$DDM = 0.033\ w^{3/4} (1 + 0.479g)$$

where DDM represents the mean daily in vitro digestible dry matter intake in pounds, w is the mean body weight in pounds during the grazing season, and g is the mean daily weight gain in pounds. The constants a (0.033) and k (0.479) were calculated from the data, while the constant b (¾) was assumed (Garrett et al., 1959). A scatter diagram between digestible forage consumed and weight gain per animal shows that this equation has little predictive value.

Although the constants from these data were somewhat different, this equation was similar to the equation by Garrett et al. (1959) for estimating TDN requirements for maintenance and gain ($TDN = 0.0312w^{3/4} (1 + 0.633g)$. Since no transformations were calculated for converting DDM to TDN, the values must be assumed equal for comparing regressions. Within limits, however, daily maintenance and gain requirement data obtained from the feedlot studies can apparently be applied to range evaluations. These data are also in general agreement with Kromann et al. (1961), who converted TDN measurements to digestible energy by the conversion factor of 2,000 kcal/lb. of digestible feed. Applying this conversion factor to these in vitro digestibility measurements would yield an equation similar to Garrett's for daily digestible energy requirements.

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