WATER INTAKE RATES OF CATTLE

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IN areas of limited water supply, quantitative information on water intake rates of farm animals is comparable in importance to information on the animals' other nutrient requirements. Published data on water intake rates of various species of farm animals have been reviewed by various workers but apparently tables of water intake of cattle under a variety of conditions of ambient temperature, body size, and level of feed intake have not been compiled. The prediction of the water intake of a single animal or of a few head of cattle is not possible due to the wide difference that exist between the intake levels of individuals, or even between the levels ingested by a given animal on consecutive days, under apparently like conditions. On the other hand, the probable intake of a large number of animals under a given set of conditions can be estimated with a fair degree of confidence. We began this study in response to requests by livestockmen, engineers and others for information for practical use on water consumption of herds of cattle. Because of the urgency of the need for information and the fact that many persons have asked us to make available without delay any facts pertinent to the water requirements of cattle, our estimates have been based upon such data as are presently available rather than upon extensive original data compiled over a period of years. Some terms describing the amounts of water ingested that must be defined before a discussion of the water needs of farm animals can be undertaken are the following: 1. "Water consumption" represents the "free water" drank by an animal. 2."Total water intake" includes both the water drank and that contained by the feed. 3. "Water requirement" is the equivalent of the water from all sources, including that of metabolism, necessary to maintain the water balance.

Sources of Information

Ritzman and Benedict (1924) observed that rate of water intake is a function of dry matter consumption and on the basis of this observa-

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Indian cattle *(Bos indicus)*. These data plus a small amount of hitherto unpublished information on feed and water consumption of some cattle used in nutrition studies at Beltsville, Maryland, comprise the basic data used in making our estimates. The last mentioned group of animals consisted of 3 pairs of monozygotic twins including one pair each of steer and heifer Milking Shorthorns and a pair of Hereford × Guernsey heifers.

Analytical Methods and Results

To determine whether or not the ambient temperature-dry matter consumption-water intake relationship can be used to estimate water intake of cattle, the ratios of water intake per unit of dry matter ingested at various ambient temperatures were calculated on the basis of the data we have described. These calculations made apparent the existence of 2 distinct curves representing water intake rates respectively of European and Indian cattle.

Estimation of Water Intake Rates

The rate of water intake per unit of dry matter ingested remains relatively constant from around 10° to 40° F. and then increases with ambient temperature at an accelating rate. In figure 1 are given mean values of total water intake in gallons per pound of dry matter ingested at 40° to 100° F. together with the standard deviations of the means as indices of the distribution of the datum points in relation to the mean values. With a single exception, the data used in the calculations consisted of mean intake rates of *individuals* over a period roughly of one or two weeks. The exception was the information on beef cattle at 90° F. which was recorded originally as group data. In every case means were weighted regarding the numbers of individuals involved, but in calculating the standard error at 90° it was necessary to treat each of the 4 numbers representing seasonal means of groups of 4 to 10 beef animals as though they represented merely the intake of individuals. Perhaps the standard error would have been somewhat *larger* than that given for 90° in figure 1 if information on individuals instead of groups had been used.

In addition to any other value they may have, the standard deviations serve as a basis of judgment as to whether or not the data constitute two distinct curves or one.

The curves shown in figure 1 were obtained by fitting orthogonal polynomials (Fisher and Yates, 1948). This method is based on the

assumption that the values of the dependent variable, Y, are of equal weight, *i.e.*, that the number of animals on which calculations are based is the same at each temperature. This was not true of the data used in calculating the polynomial equation for European cattle; these data were

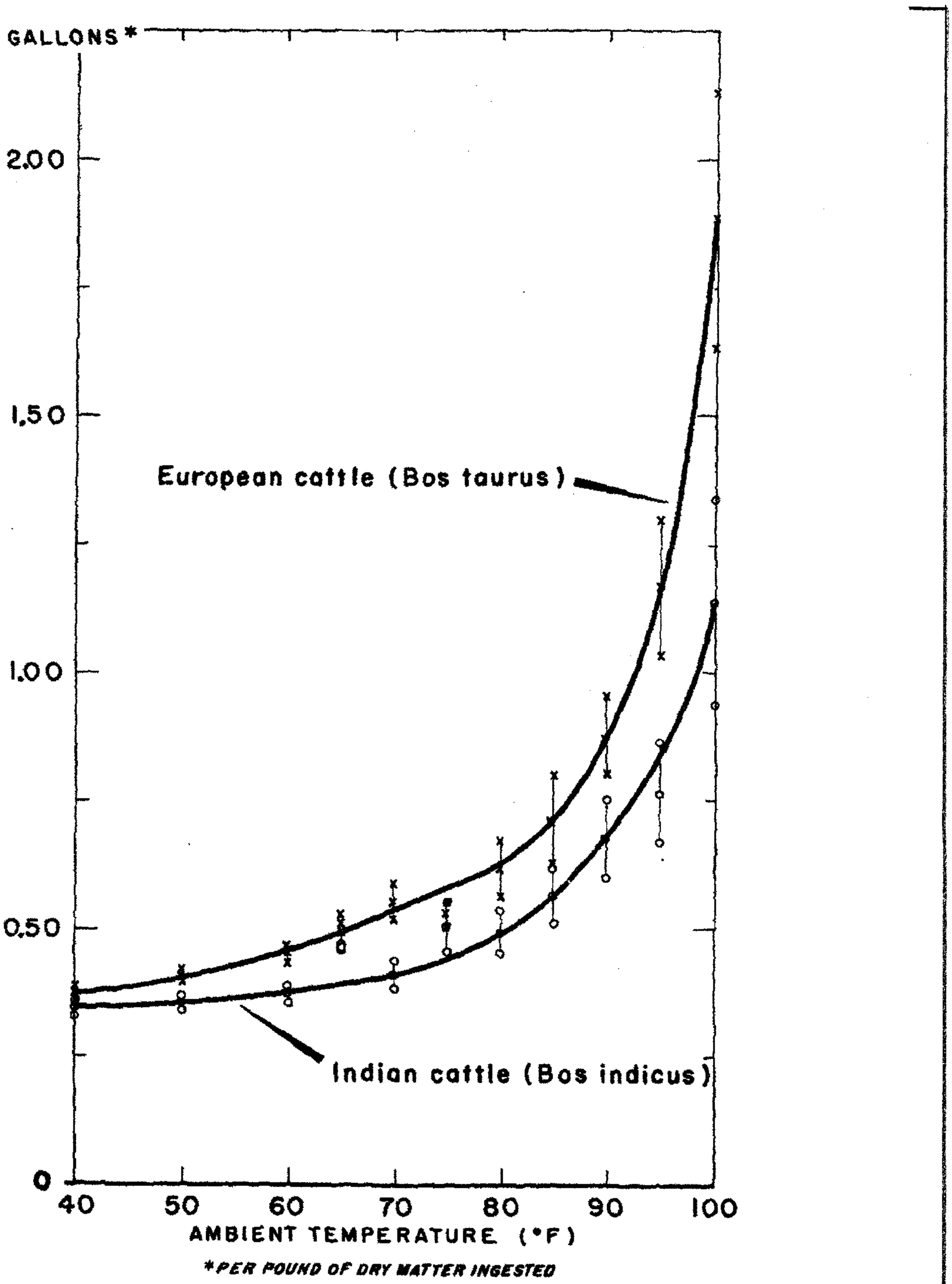

Figure 1. Water intake expressed as a function of dry matter consumption and ambient temperature.

The information presented in figure 1 and table 1 is given in terms of *total water intake* which includes both the water drank and the water contained in the feed. The amount of *free water* that cattle can be expected to drink can be calculated from the information given in table 1 as follows:

$$\text{Free water consumption (gal.)} = \text{total water (gal.)} - \frac{\frac{\%\text{water in feed}}{\%\text{dry matter in feed}} \times \text{daily dry matter intake in pounds}}{\text{weight of water in pounds per gallon}}$$

When the ration consists of hay, grain and similar "dry" feeds that are about 10% moisture, cattle ordinarily obtain only a third of a gallon or less of water a day from the rations. Because this amount is small, in practical situations the difference between *total water intake* and *free water consumption* often can be ignored and the water intake rates given by table 1 used to represent free water consumption. The amount of water a 1,000 lb. animal may be expected to drink compared with estimated total water intake at 70° when growth is normal may be used as an example. Under the section: "Heifers and steers", table 1, part 2, dry matter intake is estimated to be 18.9 lb. and total water intake 10.2 gallons per day. Assuming that the feed is 10% water, we may estimate water consumption (free water drank) as follows:

$$\text{Free water consumption} = 10.2 - \frac{1/9\ (18.9)}{8.345} \text{ or 10 gallons per day.}$$

In contrast with the small amount of water ingested in hay and grain, the water included in the feed when cattle are on pasture or consuming silage or other succulent feeds may amount to a large part of the animals' water requirement. In order to estimate the animals' need for drinking water while on succulent feeds, the moisture in the feed must be subtracted from the estimated total water intake. An example that illustrates this point is the following: How much water will be drunk by a herd of 100 dairy type heifers of 600 lb. mean body weight allowed 1,000 lb. of alfalfa plus 1,500 lb. of corn silage daily during a month when the mean temperature is 70° F.? If the hay is 10% and the silage 73% moisture (Guilbert *et al.*, 1950), the water in the feed amounts to 1,195 lb. or 143 gallons. The difference between 730 gallons, the estimated intake level given by table 1, and the 143 gallons of water contained by the feed is 587 gallons, the amount that the herd can be expected to drink daily under the conditions described.

40 to 60% in water consumption (table 3). This table also brings out the interesting fact that while water intake by California Herefords per unit of dry matter was greater when the water was uncooled than when it was cooled so long as ordinary rations were used, when highly salted rations were fed no more water was consumed in relation to dry matter when the water was uncooled than when it was cooled.

Water intake and urine excretion rates are functions of protein intake. Steers on high protein allowances consumed 26% more water than did similar animals on low protein rations (Ritzman and Benedict, 1924). The fact that water intake is related to the protein level of the feed should be kept in mind when protein is supplied in liberal amounts. Whether or not the ratio of water intake to dry matter ingested varies with the ratio between energy and dry matter in a ration apparently is not known. The quality of the rations fed the animals on which our study is based did not influence water intake so far as we can determine. Therefore, even though differences of considerable magnitude existed between rations consumed by the different groups of animals upon which this study is based, in the absence of any reason for not doing so we have "pooled" the data.

The effect of relative humidity on feed and water consumption of cattle was studied by Ragsdale *et al.* (1953). At temperatures below 75° F. the effect of humidity was found to be negligible. The frequency of drinking was greater above than below 75° and at temperatures above 75° water consumption was somewhat less at high than at low levels of relative humidity. This appears to have been a reflection, in part, of lower intake of feed and, in part, of decreased moisture vaporization at high levels of humidity. Some individuals wasted considerable amounts of water at high ambient temperatures when the level of humidity was also high.

Wind up to 9 miles per hour did not influence water intake of dairy animals (Brody *et al.*, 1954). Unfortunately, no information on the effects of wind at velocities above 9 miles per hour on water intake of cattle have come to light.

Water Consumption Patterns

Until the ambient temperature exceeds 80° F., cattle tend to do most of their drinking in the forenoon and late afternoon and evening while very little water is consumed during the night or in the early morning and early afternoon hours. At 90° F., the periods during which no water is consumed tend to be shortened and it appears that the animals then