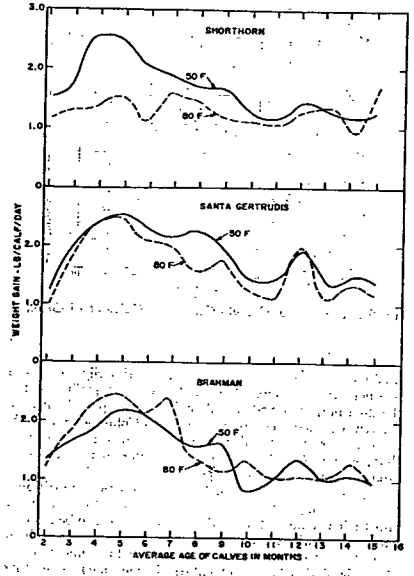

Fig. 6 .... Daily Weight Gain of Beef Calves[1]

the rate of wool growth. It appears that wool growth aids in limiting radiant heating loads[16] which is significant because of their normal posture.[17]

Reproduction

Sheep will mate only during certain periods of the year, but may sometimes be induced to mate outside the normal season if the natural environment is modified. Ewes may sometimes be bred if exposed to air temperatures of 45 F before mating.

A number of studies have been made into the effects of high temperatures on reproduction of sheep. Over 30 years ago it was reported that air temperature affected the rate of spermatogenesis. Rams kept at an environmental temperature of 90 F showed a reduced rate of spermatogenesis, although a period of 3 weeks at 70 F was sufficient to effect recovery to the normal rate.[12,13] Later reports further suggest that high air temperatures may cause lowered fertility for other reasons.[18] Subjecting ewes to temperatures of 100 F just before mating will cause a fertilization failure.[21] Generally, there will be some form of degeneration of the structures of the ovum.

Under practical conditions, the greatest loss in potential offspring conceived in a high temperature environment appears to be due to very early embryonic death.[21,22] The degree of susceptibility to adversely high temperatures is greatest near the time of mating, but this susceptibility generally decreases as the length of time after mating increases. A temperature of 90 F and relative humidity of 65 percent at time of mating will cause most of the embryos to die at an early age.[21] The same conditions applied later in the gestation period will not cause death but will result in the birth of small, weak lambs.[24] The longer the period of high temperatures, especially during the last third of the gestation, the greater will be the number of small, weak lambs born.[24] It now appears that all reproductive processes are more adversely affected by high air temperature when accompanied by a high relative humidity.

Table 1 .... Heat Production of Sheep as Related to Fleece Length[26,27]

Fleece Length, Inches	At 46 F		At 68 F		At 90 F	
	Total[a]	Latent[b]	Total[a]	Latent[b]	Total[a]	Latent[b]
Shorn	3.15	8%	2.08	14%	1.54	38%
0.5	2.15		1.76		1.54	
1.0	1.73	16%	1.54	26%	1.54	62%
1.5	1.54		1.54		1.54	

[a] Btu per (hr) (lb of body weight).
[b] Percent of total heat.

Heat Production

Only a few tests of heat production have been conducted mostly for correlation with other physiological data. No studies to determine design load calculations, similar to those performed with other farm animals, have been conducted with sheep. The ability of lambs to generate heat is of considerable practical importance, because they are normally born during the most severe climatic season. One study indicated that new born lambs were limited in heat production to 30 Btu per (hr) (lb), which was five times the basal level.[25] The conditions of the tests were from 14 F to 32 F with a 12 mph wind, but lambs are capable of withstanding temperatures as low as −40 F. They tend to orient to the wind direction to minimize convective heat loss.

Table 1 shows an example of the relationship between fleece length and heat production.[26,27]

SWINE

Feed conversion and daily rate of weight gain of growing swine are affected by the level of ambient air temperature.[23] Fig. 7 shows that ambient temperatures between 60 and 70 F produce maximum rates of gain. Fig. 8 shows the effect of ambient temperature on feed conversion, and shows that this declines (more feed consumed per pound of gain) as temperatures fall below 60 F. As temperatures increase above 70 F, daily feed consumption declines and rate of gain is reduced.

If the daily air temperature cycles more than 10 F deg on either side of 70 F, the daily gain by pigs will be lowered and

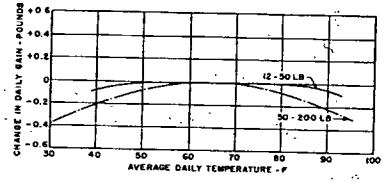

Fig. 7 .... Deviation of Average Daily Swine Gains with Temperature[23]

their feed requirements per pound of gain will be increased.[23] Reasonably constant air temperatures are desirable.

The level of the air temperature in which swine are grown affect deposition and retention of protein (carcass quality). Formation of lean meat is reportedly highest in pigs raised at temperatures between 60 and 70 F.[20] The ratio of protein to fat becomes less at air temperatures above and below 59 F.[21] There is evidence that sows are benefited by some type of cooling in hot weather.[23]

Swine gains and feed conversion rates are not increased by high air velocities, and in many cases are adversely affected.[23] Fig. 9 shows a comparison of feed utilization and gain at low (35 fpm) and high (300 fpm) air velocities.

Heat and Moisture

Heat and moisture that must be accounted for in the ventilation or air conditioning of swine housing are shown in Figs. 10 and 11.[24] These figures are for swine weighing between 50 and 400 lb, housed at temperatures ranging from 50 to 90 F. These data are the sensible and latent heats measured in a room containing hogs. Thus, a portion of the sensible heat was used to evaporate the moisture of urine, etc., and ultimately appears as latent heat. For design purposes, the data reflect actual conditions better than metabolic heat production from an individual hog.

It has been found[23] that these same data can be applied even where building temperatures are cycling, if the average air temperature during the cycle is used for design. The total animal heat load and the latent load which the ventilation system must remove are greater than the values shown in Figs. 10 and 11, if the air velocity around the animals is more than about 50 fpm.[23]

POULTRY

The adverse effects of high thermal environments (above 85 F) on egg production are: fewer eggs, reduced egg weight, and thinner shells.[25,26,27] Hens older than one year are more adversely affected by high thermal environment than younger hens. Larger hens, such as Rhode Island Reds, are more adversely affected than smaller hens, such as White Leghorns. Hatchability also declines as temperatures increase. Although the fertility rate is good at 70 F, it declines at 86 F. Feed requirements increase markedly below 45 F, and activity and productivity decline below 32 F. The suggested ideal environment is between 55 and 75 F.

Poultry do not have sweat glands that are comparable to man's and latent heat dissipation is primarily through the respiratory system. Increasing the relative humidity above 70 percent, at 85 F dry-bulb temperature, produces increased

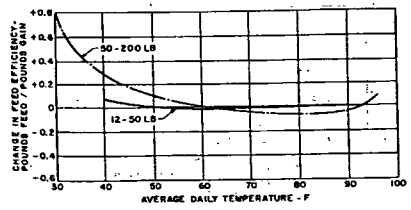

Fig. 8 .... Deviation of Pounds Feed Required per Pound Gain for Swine[23]

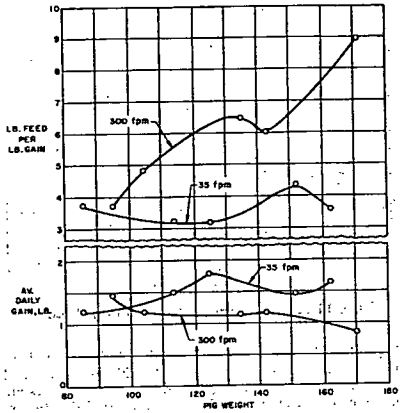

Fig. 9 .... Feed Utilization Efficiency and Rate of Gain for Pigs Exposed at Optimum Air Temperatures to Air Velocities of Either 35 or 300 fpm

respiration rate and drooping wings. However, after 7 to 10 days, respiration rates may decrease. The control of dust is a problem that may contribute to disease. A relative humidity of 70 to 75 percent is generally recommended.

In terms of rate of gain and efficiency, broiler chickens have undergone tremendous genetic improvement during the past ten years. Older data on the subject must be used with caution. Table 2 indicates feed consumption and growth of a modern strain of broilers.

Supplemental heat is generally needed for newly hatched chicks. Modern strains of broilers respond well to brooder temperatures of 92 F under the hovers. Thereafter, air temperatures may be decreased at a rate of 7 F deg per week. Relative humidities of 65 to 70 percent promote good feather-

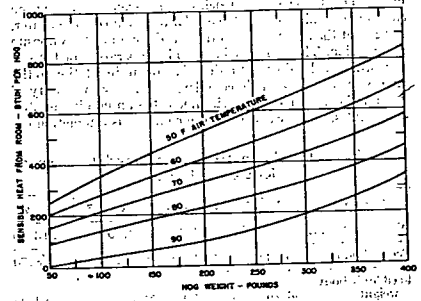

Fig. 10 .... Room Sensible Heat in a Hog House[24]