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Effects of Environment and Management on Yak Reproduction (Last Updated: 1-Dec-2000)

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Summary
Yaks live in a very harsh environment, including seasonal nutritional deficiencies, cold weather and air with low oxygen content. These conditions seriously reduce reproductive performance. This paper summarizes recent findings of environmental effects on reproductive performance in yaks.

Introduction
Yak production in Qinghai-Tibet Plateau is still characterized by year-round grazing without supplementation. However, the period of grass growth lasts only about 4.5 months and only during June does the grass adequately meet the nutritional needs of the yaks. Failure of the pasture to provide adequate nourishment during the majority of the year profoundly limits growth, production and reproduction.
Due to consumption and trampling, the amount of available grass declines rapidly during the non-growing season (approximately a 50% decline each month). Concurrently, the nutritional value of the grass also declines rapidly. Digestible protein content and overall digestibility are 11.5 and 75.4%, respectively, as the grass begins seed production but decline to 3.3 and 48.0% when seed production is complete and the plants are mature [1-2].
Reproductive performance of yaks is influenced by many factors, particularly nutrition. Although yaks are adapted to the cold weather, low oxygen content and rainfall in the Qinghai-Tibet Plateau, these environmental conditions seriously affect reproduction. The severity and duration of malnutrition is primarily related to dry matter intake, which is related to body condition at calving. The detrimental effects of malnutrition appear to be manifested as reduced fertility; the greater the loss of body condition, the greater the reduction in pregnancy rate. In general, parturition and breeding (for yaks and indeed most of the livestock in the Qinghai-Tibet Plateau) occur during the period of long days and maximal nutrient availability (summer).

Effect of Cold Weather on Reproduction
During cold weather, yaks must increase their metabolism to maintain body temperature. If the intake of natural forage does not meet their nutritional needs, they will use stored reserves, thereby decreasing weight and body condition. In that regard, bodyweight typically decreases 17 to 25% during the cold season. If postpartum females become pregnant again in the same year, their body condition and fetal development will be adversely affected due to the nutritional demands of calving, lactation and pregnancy. Consequently, some of these yaks will abort or die. Therefore, many yaks are anestrous after calving [3].
Young yaks that are born late or are weak and lack adequate body reserves at the start of their first cold season will have delayed puberty (normally 2 and 2.5 years for females and males, respectively) and delayed mating (normally 3 years and 2 years for females and males, respectively). The preferred temperature for well-nourished yaks is about 10ºC but increases to above 18ºC if they are malnourished. In cold weather, a 1ºC decrease in ambient temperature may result in a 2 - 5% increase in metabolic demands; yaks exposed to blizzard conditions without shelter may die from hypothermia and exposure [1,3]. In addition, pregnant yaks may abort during very cold weather. The effects of cold weather are exacerbated by other environmental factors such as wind speed and humidity. For example, a doubling of wind speed causes a four-fold increase in heat loss from the body surface. Furthermore, in cold weather, the heat conductivity of air with a humidity of 40% is 10-fold higher than that of dry air (0.00051 versus 0.00005 calories/cm.second.degree, respectively). Therefore, the humid conditions resulting from yaks crowded together in poorly ventilated sheds may increase heat loss.

Effect of Environment and Nutrition on Estrus

Seasonality of Estrus -

Estrus is not displayed year-round but is influenced by season and nutrition. In reports from Datong Yak Farm, Qinghai [1,4], yaks grazing year-round (at an altitude between 3000 and 4800 m) were most likely to display estrus between June and November (Table 1).

Table 1. Seasonality of Estrus in Yaks at Datong Yak Farm, Qinghai Province, China

Yaks		Month											
	Nº	June		July		August		September		October		November	
		Nº	%	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%
Dry	70	4	5.7	25	35.7	33	47.1	8	11.4	-	-	-	-
Milking	45	-	-	-	-	-	-	13	28.9	18	40	14	31.1

Dry cows were detected in estrus from June 25th to September, with the highest incidence (about 83%) in July and August. However, postpartum milking cows required a longer interval to regain body condition and they were detected in estrus from September 5th to November, with the highest incidence (about 40%) in October. Cows that calved late in the season usually failed to display estrus that year. After November, pasture quality declined and most yaks became anestrus until the following summer. However, normal spermatozoa were present in the testis and epididymis of yak bulls during the period when the females were anestrus, suggesting that the breeding season is determined largely by the reproductive seasonality of the female.

Diurnal Distribution of Estrus -

Lei studied the diurnal distribution of estrus in yaks and reported that estrus was most common in the cool morning or evening. Furthermore, many yaks were in estrus and bred during overcast days (in the breeding season) [5].

Table 2. Diurnal Distribution of Estrus in Yaks

Estrus		Time of Day			
		06:00 - 09:00	10:00 - 12:00	13:00 - 18:00	19:00 - 22:00
Number of Yak	75	35	6	14	20
%	100	46.7	8	18.6	26.7

Duration of Estrus -

The duration of estrus is difficult to quantify because signs of estrus may be weak or vague. In one report (from the Naqu district of Tibet), the average duration of estrus was 32.2 hours (range, 16 - 56). The duration of estrus was affected by ambient temperature (longer during cool weather compared to warm weather) and age (average 23.8 and 36.2 hours in young versus mature yaks, respectively). Liu et al. [6] reported that the duration of estrus in yaks in Shandan, Gansu was 1.6±0.8 days. In July, estrus lasted 1 or 2 days in 76.7% of yaks, while in August and September, it lasted 1 day in 91.7% and 2 days in 98.7%.

Effects of Environment and Nutrition on Conception and Pregnancy -

Yaks in Datong Yak Farm that grazed year-round (without supplementary feed) had a conception rate of 61.5% while those in Shandan (that also grazed but were supplemented during the cold season) had a conception rate of 81.9% [1]. It appears that conception rate was positively correlated with body condition and nutritional status of the females and that it was improved by supplementary feeding during the cold season. Yaks living at an altitude above 4500 m started to display estrus later in the

year and had a lower conception rate than those living at lower altitudes. Yaks in Qinghai-Tibet Plateau generally had a high conception rate if they were mated in the cool morning. However, during hot days, heart and respiratory rates were elevated, grass intake was decreased, and conception rates were low.

Cai et al. [2] reported that the first-service conception rate in yaks was 74.9%, but it decreased to 20.5% in those that failed to conceive and were bred a second time.

The gestation period was 250 to 260 days for female and male fetuses, respectively, with the fetus located in the left and right uterine horns in 64.7 and 35.3% of pregnancies, respectively [7]. Xue reported that milk progesterone concentrations increased during pregnancy and that a concentration >1.0 ng/ml between Days 16 and 24 was indicative of pregnancy (accuracy, 86.7% [8]).

The placenta is relatively heavy (compared to the fetus), facilitating the delivery of oxygen to the fetus. Furthermore, the relatively short gestation period and low birth weight decreases oxygen demands on both the dam and the fetus and facilitates a rapid and easy parturition. Although the low birth weight may be a disadvantage to the calf [3], they do have fetal hemoglobin (HbF2) during the neonatal period. The optimal time for calving is from April to May when the temperature is rising and the grass is beginning to grow.

Detailed observations by Ouyang et al. [9] on 20 yak calves (elevation, 3500 to 4100 m) showed that neonatal survival was related to the maintenance of body temperature. The decline in body temperature in the first hour after birth (average fall 0.38ºC) was inversely correlated (r = 0.69) with birth weight (the greater the weight, the less the temperature loss) but much less strongly correlated with ambient temperature. Therefore, body condition of dam during pregnancy affected calf survival (through its effect on birth weight). The body temperature of the calves returned to normal, on average, 3 hours after birth.

More detailed study of yak physiology and nutrition are needed to determine whether specific nutrients may be limiting factors and whether specific supplements at critical times would be cost-effective. There is a paucity of information on whether natural yak diets have deficiencies, excesses or imbalances of, for example, trace minerals [10,11].