GENETIC AND BIOLOGICAL ASPECTS OF ZEBU ADAPTABILITY¹,²

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Summary

The utility and documentation of traits and characteristics of Zebu, *Bos indicus*, cattle in beef production in the United States are discussed with reference to adaptation. Zebu cattle are uniquely suited to hot climates due to coat, hide, skin and hematological attributes. Form, growth and physiological aspects are unique genetic attributes which are different from those of *Bos taurus* cattle. Compared with *Bos taurus* cattle, Zebu cattle are lower in reproduction, later maturing, slower growing and lower in beef quality. Zebu cattle are valuable in crossbreeding, with adaptive aspects transmitted and large amounts of heterosis in growth, maternal effects and reproductive traits. (Key Words: Beef cattle, Adaptation, Zebu, *Bos indicus*, Production.)

Introduction

Adaptation is a broad term used to describe the ability of animals to adjust to environmental conditions or to infer genetic modifications that make animals more suitable for existence under specific environmental conditions. Zebu, *Bos indicus*, cattle are widely recognized as adaptable to tropical and subtropical environments that are restrictive to *Bos taurus* cattle. However, objective measurements of traits and characteristics that directly affect adaption are limited. Most work documents the effects of environmental factors on production variables or the broad effects of breed comparisons under specified environments.

Discussion

Research into adaptation can be viewed from two classical perspectives:

1. The direct measure of performance under measured environmental stress is the approach utilized by response scientists. The application is to control the environmental stresses reducing performance or to predict the ability of the animal to adjust to environmental stresses (Dowling, 1974; McDowell, 1974).

2. The classical genetic approach of fitness details a selective value for adapted animals to effect a population change in harmony with existing environmental conditions (Falconer, 1960).

Rohles (1974) presented an interesting concept for environmental research as the ecosystem complex. The ecosystem complex included: (1) physical factors defining the environment; (2) organismic factors, which are factors describing the animal, and (3) adaptive factors, those factors that interact with the physical factors and organism to allow for adaptation. While adaptation is a complex subject, the application of knowledge concerning Zebu cattle is important to beef production in several environments. This paper will present pertinent research that documents the adaptive aspects of Zebu cattle and their utility as a genetic entity.

Bonsma (1973) presented a comprehensive review of adaptation and beef cattle breeding. Zebu, *Bos indicus*, cattle evolved in the Southern hemisphere and adapted to muggy and scorching environments. These include environments defined by mean monthly temperatures of 18 °C or higher and relative humidity of 55% or higher. It was noted that humidity was of little importance compared to temperature. Therefore, particular emphasis was placed on temperature effects in the discussion of Zebu cattle. Because Zebu cattle are smooth-coated, have primary hair follicles, have better developed sweat and sebaceous glands than *Bos taurus* cattle and can lose more moisture by evaporation, they are cited as adaptable to hot climates. In addition, the ability to maintain thermal equilibrium is a necessary factor for...
normal function and performance. Bonsma (1973) expanded Zebu attributes to include coat color, pigmentation, conformation, genetic adaptation to the source of nutrition (forages) and resistance to pests and disease. The implications are that Zebu cattle are adaptable to poorer quality forages and soils of low pH and are resistant to ectoparasites and diseases transmitted by ectoparasites. Frisch and Vercoe (1978) studied 15-month weights of Bos indicus, Bos taurus and crosses and listed Brahman as resistant to ticks, worms, pinkeye, heat and nutritional fluctuations. Brahman (Bos indicus) were also cited as having lower inherent voluntary feed intake and lower relative maintenance requirements.

Howes (1963) reported that hematological comparisons of Brahman and Hereford cattle in Florida were related to respiration and adaptation. Brahman cattle were observed to have higher red blood cell counts, total cell volume and hemoglobin values. Venous blood of Brahman cattle had less carbon dioxide than did that of Herefords. These results imply that Brahman cattle are capable of maintaining lower respiration rates during periods of high ambient temperatures. Evans (1963) confirmed these hematological advantages for Zebu cattle as well as the effect of the advantages on adaptation to temperature stress.

Allen (1962) compared Brahman and Jersey cattle skin temperatures and respiration rates at air temperatures from 24 C to 35 C. Zebu cattle had lower respiration rates at all levels of skin temperature, and skin temperature of Zebus closely followed air temperature. Zebu cattle had the lower skin temperature below 24 C and the higher mean temperature above 35 C. It should be noted that Jersey cattle are generally accepted as adapted to warm climates.

Cartwright (1955) documented advantages in heat tolerance of Brahman and F-1 crosses over Hereford cattle. Superior summer gains were cited as important measures of adaptive merit of Brahmans and the Brahman × Hereford crosses.

Johnson (1963) cited the major factor favoring Brahman cattle as heat tolerance or the ability to respond to increasing heat loads.

Tugwell et al. (1969) studied levels of Brahman breeding and color as factors affecting horn fly, Haematobia irritans (L.), attractiveness and(or) repellency. As Brahman breeding (percentage of blood) increased, actual fly counts decreased, regardless of color. Subsequent investigation of ambient temperature, humidity and sunlight in association with horn fly counts and respiration rate, surface temperature and moisture of the animal did not define attractiveness and(or) repellency. Brahman breeding was cited as the important variable. Brown et al. (1977) found lighter coat color to be important in reducing fly counts in Arkansas. Breed differences were important during periods of high fly populations. No specific reference to the Brahman breed was made, yet purebred cattle were studied. Rick (1962) established Bos indicus breeding as a factor promoting resistance to the cattle tick, Boophilus microplus. Bos indicus × Bos taurus crosses were more resistant than were Bos taurus cattle. A portion of the resistance was termed innate. Strother et al. (1974) documented the resistance of Brahman cattle to the Lone Star tick, Amblyomma americanum. Both Brahman and Brahman × Hereford crosses were more resistant than Herefords.

Steelman et al. (1973) and Steelman et al. (1976) documented the efficacy of Brahman characteristics in reducing weight loss due to mosquito attack. Brahman steers were found to be more tolerant to mosquito attack than were Herefords on the basis of weight gains. Dowling (1974) dismissed the notion that heat tolerance limits Bos taurus cattle in Australia. He cited the resistance of Bos indicus cattle to ticks and parasites and calving ease as the important adaptive attributes and suggested that crossbreeding with Bos taurus cattle is necessary to improve production efficiency.

The environmental effects of nutritional status and breed × environment interaction on Zebu cattle are difficult to document. Zebu cattle are universally accepted as adapted to poor quality forages. Stated differently, they can survive and produce in restrictive environments. Most attribute this quality of Zebu cattle to a genetic ability to utilize forages more efficiently. Rogerson et al. (1968) compared Boran (Zebu) steers with grade Herefords (Bos taurus) on high energy diets and concluded that Zebu steers have lower dry matter intakes but do not use feedstuffs more efficiently. Zebu cattle had lower metabolic rates, and water intake was similar. Efficiency was measured as growth relative to feed intake. Lofgreen et al. (1975) reported that Brahman × British steers utilized energy more efficiently than British steers under a heat stress of warm drinking water (32.2 C) compared to cooled drinking water.
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(18.3 °C). Moore et al. (1975) reported a significant breed x diet (energy level) interaction in diet digestibilities. They observed that Brahman bull calves were more efficient on low energy (high roughage) diets than were Herefords, yet Herefords were superior to Brahmans on a high energy (low roughage) diet. The implication was that Brahman cattle utilize low energy diets more effectively than high energy diets. Related observations made by Bonsma (1973) verify that Zebu cattle founder readily under intensive feedlot conditions with moderate to high energy diets. Feed intake, nutritional requirements for growth and maintenance requirements for Zebu cattle may be different from those for Bos taurus cattle (Frisch and Vercoe, 1978). Evidence at least suggests advantages for Zebu cattle on roughage diets. Zebu cattle do not adapt to high energy feeding as readily as Bos taurus.

The unique qualities of Zebu cattle in comparison to Bos taurus breeds are important considerations for the breeding decisions made by many cattlemen. Because Zebu cattle are humped and atypical in conformation, and appear by observation to be shallow and narrow in the heart girth and narrow in the crops, they may not be considered as acceptable beef animals. Zebu cattle grunt or bellow more than low, and their disposition is truly different. Zebu cattle are docile and quiet yet possess the ability to become aroused more quickly than do Bos taurus cattle. Zebu cattle are difficult to handle under forced or stress working conditions. Some will fight, jump or exhibit extremely nervous behavior. Others sulk and refuse to be moved when they tire or face unfamiliar surroundings. It is safe to say that more research into animal behavior is needed and that learning and understanding the Zebu psyche will be an interesting research area. Some Zebu cattle are extremely docile while others are totally unruly. Disposition is believed to be heritable, and it is the most important reason why Zebu cattle are not used more in crossbreeding.

Zebu cattle are poorer in reproductive efficiency than Bos taurus cattle under subtropical conditions in the United States (Warnick, 1963; Reynolds, 1973; Wythe, 1970; Bazer, 1973). Howes (1963) stated that Brahman cows had lower ovulation rates than did Hereford cows. Also, lower levels of thyroid, adrenal and ovarian activity were cited as factors contributing to the Brahman's greater heat tolerance but lower reproductive efficiency. Howes (1963) and Hentges and Howes (1963) indicated that Brahman cows milked more than Herefords and used feedstuffs and nutrients from body stores to lactate at the expense of reproduction. Delayed estrus and subsequent lower reproductive rates were obvious effects. Kincaid (1963) documented a lactation status x breed interaction in fertility (calving rate). Dry Brahman cows were 13% more fertile than wet Brahman cows, while wet Hereford cows bred better (10%) than dry Hereford cows.

The Brahman breed of the United States has other unique reproductive qualities. Perinatal calving losses are normally greater in purebred Brahman herds (Reynolds, 1973). Franke et al. (1975) documented the incidence and characterized the weak calf syndrome in Brahman cattle. Purebred Brahman calves are often lacking in vigor at birth and are adversely affected by cool, moist conditions. Puberty occurs later in Zebu cattle than in Bos taurus breeds (Plasse et al., 1968b; Bazer, 1973). Late sexual maturity is a well-known characteristic of Zebu cattle. Brahman cattle have a gestation period of 292 days (Plasse et al., 1968c), and calving intervals average 410 days (Plasse et al., 1968a). Plasse et al. (1968b) observed a seasonal estrus activity in Brahman heifers, with spring and summer activity greatest. Zebu cattle are recognized as having excellent longevity and little dystocia (Wythe, 1970).

Brahman cattle have been characterized as slow-growing feedlot cattle that are lower grading and produce less tender beef (Turner, 1973). Slower growth performance for purebred Brahman steers was also reported by Crockett (1973) and Peacock et al. (1973). Carpenter (1973) reported that compared to straightbred Brahman, British x Brahman crosses produced carcasses with increased weight, grade, palatability and fat content with lower percentage lean and bone. Zebu purebreds are not recognized as efficient beef cattle but are desirable in restrictive environments.

The genetic utility of Zebu cattle has been well documented in beef production systems. Zebu crosses, Bos indicus x Bos taurus, including reciprocal crosses, exhibit heterosis in several economically important traits. The greatest and most important hybrid effects are found in reproductive performance (Turner et al., 1968; Bazer, 1973). Maternal heterosis is large for weaning weight (McDonald and Turner,
1972). Preweaning and postweaning growth traits exhibit heterosis of economic significance and are well documented. Carpenter (1973) stated that heterosis for carcass traits was limited almost entirely to traits associated with carcass weight.

The ultimate utility of Zebu cattle has been in well-defined crossbreeding programs. Achieving adaptation to hot climates and poor forage areas with Zebu crossbreeds via additive inheritance and utilizing heterotic advantages in reproductive, maternal and growth-related traits is the manner in which breeders use Zebu cattle. As atypical cattle, they excel in crossbreeding systems utilizing the additive inheritance of Bos taurus breeds. Crossbreeds are intermediates that adapt in much the same way as Zebu parental stock yet perform better than the Bos taurus parent breed. The success of such crossbreeding has led to the establishment of several new breeds based upon percentage of blood and selection. The common factor in most is that Zebu inheritance has been utilized for adaptation to produce in hot climates. It is important to note that the South and Southwest are regions of relatively high temperatures in which a sizable portion of the United States beef cattle population is located. Zebu crossbred cattle can and do move into more temperate zones, but the advantages of Zebu breeding apparently decline as Bos taurus cattle become better adapted and perform more favorably. Adaptation to cold weather quickly becomes the more important consideration.

Purebred Zebu cattle are found in greatest numbers in Texas, Florida and Louisiana. However, interest has allowed for expansion of Zebu cattle into other states in the South and Southwest. Additionally, Zebu breeders have advanced interest in developing and recording different types of Zebu cattle. The American Brahman Breeders Association currently maintains a single herdbook, while the Pan American Zebu Association has separate herdbooks for Zebu Tejano, Indu-Brazil and Gyr cattle.

Zebu cattle in the United States occupy a unique position. Purebreds are normally not used in commercial production, and many cattlemen are uninformed about the merit of Zebu breeding. There is no questioning the effective use of Zebu cattle for crossbreeding. Probably no other types or breeds have such a well-defined and accepted role in commercial beef production.

Literature Cited


