# CHAPTER 1

# INTRODUCTION

## 1.1 Background and industry context

In the tropics, productivity of beef cattle enterprises depends not only on the inherent ability of animals to grow and reproduce, but also on the ability of animals to withstand the stressors of the environment. In northern Australia, these stressors include ecto-parasites (cattle tick, *Boophilus microplus*, and buffalo fly, *Haematobia irritans exigua*) and endo-parasites (gastro-intestinal helminths or worms, predominantly *Haemonchus, Cooperia* and *Oesophagostomum* species), heat stress resulting from high temperatures and humidity, poor nutrition during the dry season, and periodic exposure to endemic diseases caused by insect-borne viruses. Under extensive pastoral systems, it is usually not possible for beef producers to control or modify these stressors using management strategies alone, although in some cases, management practices such as vaccination against diseases, seasonal mating, early weaning and rigid culling of subfertile breeders have been effective in reducing their impact. Generally though, producers need to breed cattle that are productive in the presence of the stressors, without the need for managerial intervention.

In these areas, *Bos indicus* breeds and their derivatives predominate because of their high levels of adaptation to such stressors (Seifert, 1971*a,b*; Turner and Short, 1972; Frisch, 1973; Frisch and Vercoe, 1982, 1984; Turner, 1975, 1979, 1982, 1984). However, these cattle are also more temperamental than *Bos taurus* (Fordyce *et al.*, 1982; Hearnshaw and Morris, 1984) when reared under comparable conditions. A combination of temperamental animals and the infrequent mustering and handling that cattle in extensive pastoral areas experience has led beef producers in northern Australia to consider temperament as one of the most important factors to be considered in beef breeding programs (Hassall, 1974; Elder *et al.*, 1980*a,b*).

In spite of the importance placed on temperament by beef producers though, very little scientific research has been conducted on temperament of beef cattle, largely due to lack of

simple, meaningful measures of the trait.

## 1.2 Measurement of temperament

Recognising that cattle handling problems may result from poor behaviour in different situations such as in a paddock and a crush, Fordyce *et al.* (1982) developed a series of temperament tests. Two of these tests, the crush test and the flight distance test, were repeatable and accurately identified 'trouble-makers' in crush and paddock situations respectively. However, the flight distance test was difficult and time-consuming to implement, could not easily be incorporated into routine management procedures and was not acceptable to cattlemen because of risk of damage to yards and injury to both cattle and the observer.

Following an observation that some animals remain calm while being weighed, it was noted that others moved continuously during this activity, and subsequently vacated the weighing scale much more rapidly than their more docile contemporaries. A simple electronic system, known as a flight speed test (Burrow *et al.*, 1988), was devised to measure the time taken for an animal to cover a fixed distance after leaving a confined area. The system incorporates two light beams focused on infra-red reflectors with a trigger on/off mechanism as the light beams are broken. The time for an animal to cover the fixed distance after leaving a weighing scale is electronically recorded in hundredths of a second.

This test was shown to be favourably correlated with the flight distance test that was recommended by Fordyce *et al.* (1982). Subjective reports from experienced stockmen indicated that both the flight distance and flight speed tests accurately identified problem animals in the paddock situation, with the flight speed test having additional advantages of being able to distinguish good and excellent temperaments in cattle, and of being safe, objective, quick to record and simple to implement on-farm (Burrow *et al.*, 1988). The flight speed test has since been used as a scientific tool in the studies reported herein, to investigate genetic and environmental factors that affect temperament and to determine genetic and phenotypic relationships between temperament and other productive and adaptive traits in zebu-derived cattle grazed at pasture in the tropics.

## 1.3 Use of temperament tests as scientific tools

To effectively design breeding programs and to estimate breeding values for traits of relevance to beef producers, knowledge of the nature and magnitude of population parameters for economically important traits is needed. In tropical and subtropical areas, expression of productive traits such as growth, fertility and carcass and meat quality attributes are restricted by environmental stressors. Hence, cattle breeding programs in these areas must consider the full range of traits that economically impact on production. In northern Australia, these include growth between birth and maturity, feed efficiency, male and female fertility, carcass and meat quality attributes, resistance to endo- and ecto-parasites and heat stress, and temperament. Population parameters for these traits provide a useful guide to the likely effectiveness of breeding programs. Appropriately designed experiments that measure direct and correlated responses to selection provide additional evidence of the direction and magnitude of relationships between the different traits.

In 1982, selection experiments were established at the National Cattle Breeding Station, 'Belmont' in Central Queensland. Experimental cattle were from two stabilised genotypes, referred to as AX and AXBX. AX cattle consist of 25% Hereford, 25% Shorthorn and 50% Africander, whilst AXBX cattle consist of 25% of each of the Africander, Brahman, Hereford and Shorthorn breeds. The aim of the experiments was to define direct and correlated responses to selection for a productive and an adaptive trait. Two lines that differed marginally in their level of adaptation to environmental stressors (AX and AXBX -UPWT) were selected for high growth rate, measured by estimated breeding value (EBV) for growth to 600 days. A third line (AXBX – TEMP) was selected for heat resistance, measured by low EBV for repeated records of rectal temperature under conditions of heat stress. A control line (AXBX – CONT) was also established, with minimum selection differential for 600-day weight. The experiments continued for two generations.

In total, data from nine calf crops were available for analysis. They comprised data from about 2600 animals, the progeny of 38 AX sires (average of 20 progeny per sire) and 101 AXBX sires (average of 18 progeny per sire), measured on repeated occasions between birth

and slaughter or disposal from the breeding herd, with up to 73 different measurements recorded on each animal, including measurements of productive and adaptive traits and temperament. As well, a full pedigree history of these herds was available, back to base breeding animals in 1948.

Due to the effects of environmental stressors on productive traits, growth and production in the tropics have more sources of variation and covariation than growth in temperate environments. Hence it is possible that selection for these traits in tropical environments may produce different responses than selection for the same traits in temperate environments. Alternately, selection based on the same measurement in different environments may be selection for different traits. For example, selection for EBV for 600 day weight in the tropics may be selection for a combination of direct genes for growth plus genes for resistance to parasites; in temperate environments, selection for the EBV for 600 day weight is more likely to involve selection for direct genes for growth. Frisch (1981) reported that selection of British breed cattle for growth in a tropical environment increased adaptation to environmental stressors but did not increase the components associated with direct genes for growth or "growth potential", which he defined as growth in the absence of environmental stressors. Improvements in growth rate were achieved entirely through increases in resistance to environmental stressors that affected growth rate. On the basis of across-breed studies, Frisch and Vercoe (1984) reported that in tropical areas, "growth potential" and resistance to environmental stressors were negatively correlated. If these findings apply within breeds, it is possible that direct selection for resistance to environmental stressors may indirectly increase growth rate in tropical areas more rapidly than would direct selection for growth.

Another hypothesis to be investigated is that temperament may be a survival mechanism for animals reared in harsh environments, and hence it is possible that selection for growth or adaptation will favour animals that are more alert and less tractable when handled. Alternately, if temperament impacts on productive traits only through stress resulting from contact with humans, it is likely that relationships between temperament and productive traits are less pronounced in extensive than in intensive production systems.

Other issues that need to be considered in selection programs for tropical environments include the depression in performance that results from concentrating genes within family lines through inbreeding. Selection using EBVs tends to make coselection of relatives likely (Belonsky and Kennedy, 1988), because related animals have similar breeding values. In selecting among animals with differing levels of inbreeding, allowance may have to be made for any effect of inbreeding on production. In addition, any evaluation of different breeding programmes should consider the rate of inbreeding and any consequent effects on mean phenotypic performance. Genotype x environment interactions are another source of variation that need to be considered when designing breeding programs and estimating breeding values for relevant traits in these areas.

This thesis explores many aspects of these issues. Reviews of the literature investigate measures of temperament and their relationships with performance traits of beef cattle, the effects of inbreeding on performance traits and also the use of breeding objectives and selection indices to effectively combine economically important traits within a breeding program.

Initial experiments aim to determine both genetic and environmental factors that affect temperament of tropical beef cattle. In these experiments, subjective and objective measurements of temperament are compared to determine the most useful tests to evaluate relationships between temperament and other productive and adaptive traits. Other factors such as differences between breeds, sexes, ages of measurement and various management strategies that affect temperament are considered in these experiments. Preliminary estimates of genetic effects on measures of temperament are also obtained.

A complete genetic analysis of productive and adaptive traits and temperament is then undertaken to provide estimates of variances and covariances, heritabilities and correlations for, and between, each of twenty traits. Traits included in the analyses are live weights at birth, weaning (6 months), yearling and 18 months, and maturity in breeding cows; period weight gains between birth and 18 months; repeated tick, worm and buffalo fly counts and measures of rectal temperature (a measure of heat resistance) and flight speed (a measure of temperament); scrotal circumference at weaning, yearling and 18 months; and repeated

measures of pregnancy rate, days to calving and calving outcome.

Direct and correlated responses to selection for growth and heat resistance are examined for all the above traits, by comparisons of performance of animals within selection lines relative to the control line, and also through genetic trends analyses. Responses to selection for growth and heat resistance for feed conversion efficiency and carcass and meat quality attributes are examined by comparisons of performance of animals within selection lines relative to the control line.

A complete analysis of the effects of inbreeding of both the animal and dam on all productive and adaptive traits and temperament is undertaken using regression techniques. Rates of inbreeding are examined in two closed herds that were selected for high growth rate to 600 days, but with differing selection emphasis to control inbreeding. The study also examines whether selection for high growth rate can overcome any deleterious effects of inbreeding on live weights.

An additional experiment is conducted to investigate the possibility of using management strategies such as intensive training of weaners as a tool to modify temperament of zebu-derived cattle over both the short- and the longer-term. Another experiment examines relationships between temperament and traits that are important in a more intensive production environment, such as growth in a feedlot and commercial carcass traits. An additional experiment is conducted to determine relationships between temperament and weight loss during, and recovery following, long distance transport and also with haematological indicators of stress measured in these animals.

Methods for determining relative economic values of temperament in beef production systems are discussed and strategies for inclusion of temperament as a trait in formal breeding objectives for tropical areas are considered. Finally, new areas of research on this topic are suggested.

## 1.4 References


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