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Research Article

Developing an Elite Strain of Performance Angus Cattle Containing Major Effect Genes for Adaption to the Tropics

Craig Mckimmie[1]* and Christopher J O'Neill[2]

[1]*Global Genetic Solutions New Zealand Limited, New Zealand*

[2]*Precision Livestock Management Group, CQUniversity, School of Medical and Applied Sciences, Rockhampton, QLD, Australia*

***Corresponding author:** Craig Mckimmie, Global Genetic Solutions New Zealand Limited, New Zealand.

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Abstract

The Angus breed (*Bos taurus*) has established itself as the premier breed for beef production globally, with significant selection on meat quality and production traits. Currently it would have to be considered as one of the most profitable breeds for beef production in temperate climates with premiums paid globally for Angus content cattle.

This paper aims to outline the use of marker assisted selection to infuse genes from tropically adapted breeds of cattle into a strain of high carcase merit. Whilst maintaining selection for carcass yield, marbling, tenderness, and fertility the Angus requires an optimum balance for mature cow size and growth. Utilising estimated breeding values (EBVs) and phenotypic selection to select the Angus genetics will also optimise profit for beef production in the tropics.

After a thorough analysis of the literature, it is feasible to integrate tropical adaption genes into Angus Genetics recorded on the Australian Angus Associations MBR and APR registers. Elite carcase genetics, proven through the sire benchmarking program, could be infused into a tropically adapted strain of Angus that could improve access to premium markets for cattle bred and finished in the tropical and arid regions of northern Australia.

Angus has clearly become the breed of choice with consumers and producers alike – this paper outlines a list of tools to adapt them to the tropical regions of the world.

Introduction

Global beef demand is expected to increase from 60 million to 130 million tons by 2050 to be able to feed an ever-expanding world population, 70% of the production increase to be seen in subtropical and tropical environments. Bos indicus-derived cattle dominate in this kind of environment due to their adaptive advantages [1]. Hence, a fundamental step to for fill the expanding global demand for beef is to develop a tropically adapted Taurine (Angus). The Angus breed (Bos taurus) has established itself as the premier breed for beef production globally, with significant selection on meat quality and production traits. currently it would have to be considered as one of the most profitable breeds for beef production in temperate climates with premiums paid globally for Angus Branded cattle and Beef.

Presently tropical beef production in northern Australia relies heavily on Brahman Bos indicus cattle and Brahman crossbreds. They have been shown to exhibit superior heat tolerance and cattle tick resistance to B. taurus cattle leading to increased survival under the harsh conditions of tropical northern Australia.

B. indicus cattle have not been shown to achieve the same level of eating quality as B. taurus; with British taurine breeds like Angus, Shorthorn and Hereford achieving higher scores for tenderness and marbling; with the majority of B. indicus infused beef tending not to grade at a level that is able to achieve market premiums.

This paper aims to outline the use of marker assisted selection to infuse genes from tropically adapted breeds of cattle into a strain of high carcase merit. This strain includes marbling, tenderness and yield Angus with the optimum balance of growth to mature cow weight fertility and function. This is done by utilising estimated breeding values and phenotypical selection to optimise profit for beef production in the tropics.

Marker Assisted Selection

With the development of marker assisted selection, highly polymorphic DNA-based markers have been developed where genes exhibiting simple Mendelian inheritance are often easily and quickly detected. A considerable number of significant effect markers are present in beef cattle populations, the most famous being the Myostatin Blocker gene. This gene causes double carriers of the mutation to exhibit a phenotype of extreme muscling referred to as double muscling found in Belgium Blue and Piedmontite cattle. These markers allow the gene to be transferred into other populations increasing the predictability of hybrid performance, the use of myostatin NT 821 gene in Angus cattle has been explored and it was found that double muscled Angus sired progeny from dairy dams had the potential to meet premium brand specifications (Mckimmie "et al.; 2024). These molecular markers can be of use in indirect selection processes, ensuring further propagation of individuals carrying the desired genes.

These major gene markers that are responsible for economically important characteristics, can transfer the effect to unrelated populations with completely different phenotypes and production parameters, rather than direct selection of the target Phenotype. Utilization of the marker loci linked to major genes for selection which can sometimes be more efficient than direct selection for the target phenotype as sometimes a series of more complex genes that are less heritable and subject to dilution may be responsible for the selected phenotype. This can lead to a situation where the for a high percentage of the parent breed to maintain the desired phenotype as seen in B. indicus cattle percentage cattle with regards to both heat tolerance and tick resistance.

Slick gene (Senepol)

One of the most significant to the development of tropically adapted taurine cattle is the slick gene isolated in the Senepol a tropically adapted taurine breed developed early in the 20th century on the Caribbean Island of St. Croix. The Senepol breeds heat tolerance attributed to a single isolated gene marker the SLICK1 bovine mutation PRLR (c.1382del; rs517047387) is a deletion mutation resulting in a protein with a truncated intracellular domain. Cattle carrying one or more copies of the allele are characterized by a short hair coat (slick phenotype) [2] with increased heat stress resistance. In recent years, studies of cattle populations around the world have isolated several major effect gene markers. This is an important major effect gene which has been proven to give heat resistance equivalent to B. indicus cattle. Cattle carrying this gene, exhibit short slick coats and heat resistance along with a larger number of sweat glands giving them the ability to dissipate heat.

Figure 1: Hazeldean Senengus bulls running at Duringa feedlot in central Queensland exhibiting the slick phenotype.

The Slick gene has become of major significance to tropical beef production and has been infused into many breeds to assist in tropical adaption. Although merging is a significant tool to tropical beef production, the slick gene applies a solution to only half of the problem as these cattle do not have the same level of tick resistance as Brahman cattle.

Tick resistance gene (Adaptaur)

Work done at the CSIRO's Belmont research centre starting 1980 and finishing in 2008, established that tick resistance greater than Brahman could be achieved using pure B. taurus cattle Evolutionary Applications [3] found a major effect gene was potentially in existence in the strain of Hereford Shorthorn that had been running on the Belmont research station since the 1952 Evolutionary Applications [3].The strain had been selected for growth and high tick resistance, and since 1980 focusing on a single family. Adaptaur maintained reproductive rates and meat quality traits equivalent to taurine herds kept in temperate climates.

Figure 2: Adaptaur Bull from Vineree, Kalapa, Central Queensland-From an Artificial Infestation Of 10,000 Tick Larvae Yielded a Tick Resistance Rating of 99%. (Christopher J. O'neill).

In a trial conducted on Belmont Research Station in 2007, 2-year-old heifers of straightbred Brahman, and Adaptaur and F1 Murray Grey X Adaptaur and F1 Senepol X Adaptaur were artificially infested with tick larvae there were four Adaptaur and 3 F1's with zero tick counts but none of the straight Brahman were completely resistant [4]. In the mid-1980s Adaptaur cattle had demonstrated a huge potential for advancement of beef production in the tropics the breed was named the Adaptaur (Adapted Taurus).

Figure 3: F1 Adaptaur X Senepol This Female Showed 100% Natural Resistance And 100% Resistance When Infected With 10,000 Tick Larvae She Carries Both The Slick Gene And The Adaptaur Tick Resistance Gene (O'neill, Swain, & Kadarmideen, 2010).

Coat colour (Silver)

There is a common misconception among northern Australian producers that the preferred colour is red or dark red with the understanding that black cattle are more susceptible to heat stress, while this is true to some degree the surface temperature of a red animal is only one degree cooler than a black, were as the surface temperature of a white animal is up to seven degrees cooler. As referred to in the paper Relationships of Coat Colour, Body Surface Temperature and Respiration Rate in Feedlot Steers [5] on days of full sun, animals without shade show surface temperature of a black animal at midday is 5 degrees Celsius hotter than that of a white animal and six degrees Celsius by 1.30 pm. It can then be assumed that under these conditions black animals are under a considerable amount more heat stress than white.

The effect of coat color on performance recorded by Evolutionary Applications [3] showing measurements taken over 36 days in full sun of three white and three red shorthorn steers. Exposing each steer to the sun for 30 minutes six times over 6 hours between 08.00am and 1.00 pm, and six times between 11.00. am and 4.pm. across different days. The difference between colors had significant effects on growth. White steers gained zero·13 kg more per day than dark red ones. The effect of color seen in grazing behavior; light steers spend more time in the sun and grazing than dark ones. Coat type also affected growth and grazing behavior with short sleek coats having a positive effect. The effect of coat type on growth and behavior was less significant in light-colored steers. This would suggest that light-colored slick coated cattle would have an advantage under heat stress in overall performance. Coat color could play a significant role in fertility Trials done at university of Florida show that conception rates decline once rectal temperature exceeds 102.2 F. [6].

Figure 4: Ona White Angus Developed at The Range Cattle Research and Education Centre by the university of Florida.

Figure 5: Murray Grey (Silver Angus) Dominated the Australian Feedlot Industry in the 90's Coat Colour Reducing Heat Stress Under Open Lot Conditions.

Figure 6: Brahman Cows Exhibiting Light Colour and Slick Coats.

Angus in the Tropics

Research conducted by the University of Florida from 2006-2011 on adaption of Angus to subtropical environments [7] compared a tropically adapted line of Angus (Florida) against a high-performance line from outside the tropics (Kansas). Progeny from the performance selected stock performed better across all the key performance traits except fertility and mature cow weight.

This research found that the cows from the tropically adapted line remained in the herd while the outside line numbers got fewer each year. While the adapted line was smaller, fatter and had sleeker coats than the outside line.

The outside line cows that remained in the herd were those of slicker coats and more moderate milk production in comparison to those cows that had left the herd, the remaining cattle from the outside line outperformed or matched the adapted line in all economic parameters apart from their larger mature weight requiring a higher level of energy for maintenance.

Why Angus

Fifteen of the top twenty steaks in the World Championships were Angus influenced including dual World Championship winning Wagyu. Angus have dominated most taste test competitions world-wide including grand champion taste test carcase Sydney Royal 2016 and winning and filling most of the places in the top twenty at the prestigious New Zealand Steak of Origin competition.

The Australian Angus society in conjunction with MLA and CRC run one of the most comprehensive sire Benchmarking programs in the world. It is the largest database of any breed in Australia allowing for accurate measurement of real population data.

There are indications from a study of New Zealand beef and lamb [8] that it may be possible for elite Angus cattle to produce world class marbled tender Angus beef of similar quality to Wagyu beef in much faster timeframes – possibly achieving those grades at only half of the age of taken to reach these grades' currently with Wagyu genetics.

Angus Society of Australia APR Register

The Australian Angus Association provides a register for Angus Cattle not registered in the Society herd book in the Angus Performance Register (APR). APR animals can have their pedigrees recorded and performance compared against the same base as herd book recorded animals using estimated breeding values (EBV's). To be registered on the APR, animals must be graded up to a minimum of 87.5% Angus Genetics. Under the current rules of the Association, animals must be of a colour recognised by the association. To be eligible for entry in the HBR or APR animals must be black or red in colour and shall not have white skin above the underline, or on or in front of the navel scar, or on a leg or foot (unless it is a birthmark). Currently the association only recognises black and red animals as Angus. https://www.angusaustralia.com.au/content/uploads/2023/07/Regulations-1-September-2021-New-Branding.pdf [9].

Angus Society of Australia MBR Register

The Multi-breed Register (MBR) is provided for the registration of Angus influenced animals not eligible for recording in the HBR or APR by the Australian Angus Association allows for the comparison of Angus composites against the Angus base the largest recorded base in Australia, Using this register, we can record the pedigrees and performance of all Tropical Angus composites against the Angus base.

https://www.angusaustralia.com.au/content/

uploads/2023/07/Regulations-1-September-2021-New-Branding.pdf [9, 10].

Conclusion

In considering a beef herd for semi-arid and tropical Australia, it should be considered that not including all elements required to deal with heat stress (poor heat dissipation), will have major long-term disadvantages on overall production and survival. An advantage of using marker assisted selection and major effect gene markers for adaption, is that they can be infused into populations of cattle bred for carcase growth and fertility without the need for a high percentage of the parent breed. Another advantage would include continually adding more of the performance genetics without the dilution effect on the adaptive traits that is currently seen in B. indicus hybrids as B. indicus content decreases. A further advantage when crossbreeding also optimizes heterosis in a two or three way cross while maintaining the same major effect adaption genes in all populations. To achieve a strain of Angus with similar adaption to Brahman cattle, the strain would have to be homozygous for the following four major effect genes.

1: Slick gene (Senepol)

2: tick resistance gene (Adaptaur)

3: Silver Gene (Murray Grey)

4: Poll (all Breeds)

It is then possible to use phenotypic selection and EBV's to select for carcase quality along with moderate mature cow size, good calving ease, moderate milk production, optimise fat cover, increase fertility and maximise growth within those parameters.

To breed tropically adapted taurine cattle, developing a strain with close to a hundred percent tick resistance as seen in the Adaptaur and combining this with the slick gene from Senepol cattle along with the white colour silver gene from the Murray Grey could be considered essential. All indications suggest that combining these traits could show that B. taurus cattle outperform B. indicus under heat and tick stress in tropical environments. Due to its position in the market globally, the Angus breed is the obvious choice as a host breed for these genes. This is due to its vast gene pool and dataset with information on carcase quality coming through the CRC sire benchmarking program [8]. Indications show that elite selected Angus cattle might be able to produce world class marbled tender beef of similar quality to Wagyu beef in much faster time frames.

From the research conducted from the University of Florida [7] it could then be deducted that a program infusing high performance Angus genetics with moderate milk production and mature weight into a slick gene carrying Angus could then give the optimum overall result of increased production in the tropics.

Summarizing and analysing this information indicates that establishing a program aiming to integrate tropical adaption genes into Angus Genetics recorded on the Australian Angus Associations MBR and APR registers, would allow the use of elite carcase genetics proven through the sire benchmarking program to be infused into a tropically adapted strain that could improve access to premium markets for cattle bred and finished in the tropical and arid regions of northern Australia.

This program is written with Angus as the host breed but could be duplicated in a variety of host breeds and composites other posable candidates include Charolais, Simmental, Shorthorn and any other British or European breed or its composites.

Acknowledgement

None.

Conflict of Interest

None.

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