Menu

Crossbreeding Afrikaner, Bonsmara and Nguni cows

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Crossbreeding effects with specialized sire lines in Afrikaner, Bonsmara and Nguni beef cattle herds

Industry Sector: Cattle And Small Stock

Research Focus Area: Livestock Production With Global Competitiveness: Breeding, Physiology And Management

Research Institute: Agriculture Research Institute – Animal Production Institute

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Year Of Completion : 2018

Aims Of The Project

- 1. To estimate the genetic and phenotypic trends in the dam lines

- 2. To evaluate crossbreeding systems and quantify the phenotypic progress made in economically important traits in crossbred cattle for beef production
- 3. To characterize the additive and non-additive genetic effects for production and health traits in progeny of terminal sires and dam line breeding cows
- 4. To validate an existing simulation model for the development of breeding objectives for specialized sire lines on Landrace breed cows for use in small scale and commercial farming that better meet commercial feedlot requirements
- 5. To make recommendations with regard to future selection and management of beef herds in warm arid areas
- 6. To evaluate alternative production systems in anticipation of global warming

Executive Summary

Climate has been changing and these changes are predicted to be highly dynamic. Increasing frequencies of heat stress, drought and flooding events are likely, and these will have adverse effects livestock production. It is therefore important that production systems utilizing local landrace and adapted breeds that are better adapted to warmer climates, be investigated.

In South Africa extensive cattle farming dominate primary cattle production systems, while more than 80% of all beef cattle slaughtered in the formal sector in South Africa originate from commercial feedlots. A total of 67% of feedlot animals are crossbreds, indicating that crossbreeding is playing a significant role in the commercial industry in South Africa. Well-structured crossbreeding systems allows producers to capture benefits from complementarity and heterosis.

The study is being conducted at Vaalharts Research Station. The aim is to use the Afrikaner, Bonsmara and Nguni as dam lines in crosses with specialized sire lines from British (represented by Angus) and European (represented by Simmentaler) breeds. In addition these dam lines were also mated with Afrikaner, Bonsmara and Nguni bulls in all combinations. This is producing 15 different genotypes.

It is anticipated that the information from five breeding seasons will be needed for the a more comprehensive study. Currently the information from three seasons are available and have been summarized. A protocol for Phase 2 of the study has been submitted.

The phenotypic trends in production traits of the three breeds over 25 years revealed an increase in cow productivity in all the breeds varying from 10% in the Bonsmara to 18.3% in the Afrikaner, where cow productivity was defined as kg calf weaned per Large Stock Unit mated. This also resulted in a decrease in the carbon footprint of up to 12%. The bottom line is that cow productivity can be improved if the weaning weight of the calf relative to the weight of the cow can be increased; and the inter-calving period reduced. Well-structured crossbreeding should have a much bigger effect on this and therefore the environmental impact, will be included in the final analyses of this study.

The simulation study indicated that breed, weaner and carcass price have an influence in the gross income from weaner and ox production systems. The simulation model in question can be used to quantify the benefits from the different crosses on completion of the study on condition that it is based on sound assumptions regarding weaner and carcass prices.

The information on 550 weaner calves and 125 feedlot bulls are currently available. The heaviest weaning weights are from Simmentaler sires on Afrikaner (220 kg) and Bonsmara (213 kg) dams, as well as Angus sires on Bonsmara (252 kg) dams. The lightest weaner calves were produced from purebred Ngunis (171 kg) and Angus sires on Nguni dams (173 kg). The severe draught and extreme heat of the 2015/2016 summer season had a big effect on the Angus and Simmentaler sired calves. The Sanga sired calves and Angus/Simmentaler sired calves had the same weaning weight (171 kg) in this season. In contrast, the 2016/2017 summer season was cooler and wetter, resulting in the weaning weight of the Angus/Simmentaler sired calves being 27 kg heavier than the Sanga sired calves (210 kg versus 183 kg). This demonstrates the importance of including the effect of climate on the pre- and post-weaning performance in Phase 2 of the experiment.

At the completion of the study all the information will be updated and this baseline information used to evaluate how effective the current crossbreeding systems in South Africa are and to quantify the direct and maternal heterotic effects, the possible/promising advantages of structured crossbreeding, as well as the effect of climate.

The very dry and hot 2015/2016 season also had an effect on the post weaning feed intake and growth. For example, the ADG of the Angus and Simmentaler types decreased by 17%, whereas that of the

Sanga and Sanga derived types (Afrikaner, Bonsmara, Nguni) decreased by 9%, as a result of the heat waves experienced.

It is foreseen that indigenous and adapted beef breeds may become more important in South Africa as a consequence of climate change that will result in more challenging environments. The use of specialized sire and dam lines offer an opportunity to increase output by taking advantage of heterosis and complementarity. The effects of weather patterns on beef production in South Africa should also be estimated and thereafter, mitigation strategies developed in the era of climate change to ensure optimal production efficiency.

With the information collect from the GrowSafe system, it will be possible to study feed and water intake patterns as well as behavior of individual animals and different genotypes. This may give valuable information on the effect of climate on animal performance and behavior.

This study produced one M.Sc. thesis, 8 peer reviewed scientific articles, chapters in books and conference proceedings, as well as 8 popular articles.

Popular Article

The Principles Behind Climate Smart Beef Cow Efficiency Through Utilization Of Structured Crossbreeding

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Background and deliberations

With the ever swelling costs of production, beef cattle producers in South Africa have a sure challenge for sustainability. This is aggravated by the vagaries of climate change. The country's most recent vulnerability was displayed during the 2015 drought, which was the warmest year ever recorded and was accompanied by extreme heat. The beef industry is one of the agricultural sectors that need to focus on both adaptation and mitigation strategies in response to greenhouse gas (GHG) emissions and global warming.

The utilization of more hardy breed resources in a changing production environment is one of the alternative strategies to be considered. The most fundamental factor in this strategy will be the emphasis on a high reproductive rate of the selected breeds in the particular environment to increase the overall efficiency of the beef cattle enterprise.

Another alternate is the use of sustainable crossbreeding systems that pool indigenous and exotic breeds, but with retention of the genetic resources, which have shown to be an effective means to reduces GHG, as it has been shown to increase reproduction and production levels in overseas and in local studies. In this regard, a newly developed more sophisticated Large Stock Unit (LSU) calculator by Neser (2012) and Mokolobate (2015) and the measurement of cow efficiency (to calculate kg calf weaned/kg LSU of the dam); initiated an evaluation tool for "cross-bred" selection and breeding to improve cow efficiency; as long as the nutritional needs of animals are fully met.

This expression of cow efficiency is an improved replacement for the biological definition of kg calf weaned/kg mature cow weight that not only has two variables of which anyone or both in the ratio can change to have the same answer, but does not express beef production in terms of an assigned nutrient intake. The advantage of the new biological expression of cow efficiency is that the method increases output and reduces input, which will then support and facilitate the implementation of climate smart production, adaptation and mitigation measures.

Initially Meissner *et al*. (1983) defined a LSU on the basis of the nutrient requirement of a unit. However, with differences in frame sizes there are differences in the voluntary feed intake between such animals although they have the same body weight. The LSU equivalents for beef cattle of different frame sizes also vary according to physiological phases, eg. heifers (over 12 months of age) and lactating cows. Table 1 shows examples of the refined estimations of LSU equivalents according to frame sizes of cows that was derived with the calculator.

Table 1: LSU equivalents for beef cattle of different frame sizes and physiological phases

Weight Kg	**Small Frame**		**Medium Frame**		**Large Frame**	
	Heifer (>12 months)	**Cow & Calf**	**Heifer (>12 months)**	**Cow & Calf**	**Heifer (>12 months)**	**Cow & Calf**
150	0.37	X	X	X	X	X
175	0.42	X	X	X	X	X
200	0.47	X	0.50	X	X	X
225	0.52	0.83	0.56	X	X	X
250	0.57	0.89	0.61	X	0.67	X
275	0.61	0.95	0.66	X	0.72	X
300	0.66	1.00	0.70	1.05	0.77	X
325	0.70	1.06	0.75	1.11	0.82	X
350	0.73	1.11	0.80	1.17	0.88	X
375	0.77	1.16	0.84	1.23	0.93	1.48
400	0.80	1.22	0.89	1.29	0.98	1.55
425	0.83	1.27	0.93	1.34	1.03	1.61
450	0.85	1.32	0.97	1.40	1.08	1.66
475	X	1.37	1.01	1.45	1.13	1.72
500	X	1.42	1.05	1.50	1.18	1.78
525	X	1.47	1.08	1.55	1.23	1.83
550	X	1.52	1.12	1.60	1.28	1.88
575	X	1.57	X	1.65	1.33	1.93
600	X	1.61	X	1.69	1.38	1.98
625	X	X	X	1.74	1.43	2.02
650	X	X	X	1.78	X	2.07
675	X	X	X	X	X	2.11
700	X	X	X	X	X	2.15

Crossbreeding has proved to increase cow efficiency when it is measured and calculated with the LSU caculator. Table 2 demonstrates the results of a study that was done at Vaalharts Research Station that used mature cows of different breeds. The cow efficiency, estimated by kg calf weaned / cow LSU (KgC/LSU), for the Afrikaner (A), Brahman (B), Charolais (C), Hereford (H) and Simmentaler (S) breed types were calculated according to their different frame sizes and expressed as percentage deviation from the Afrikaner breed in brackets.

Table 2 The estimated cow efficiency (KgC/LSU) for the 29 different breed types and percentage deviation from the Afrikaner breed in brackets

	Sire Breed				
Dam breed	**Afrikaner (A)**	**Brahman (B)**	**Charoloais (C)**	**Hereford (H)**	**Simmentaler (S)**
A	142.6 (0.0)	144.2 (1.1%)	145.7 (2.1%)	151.2 (6.0%)	143.7 (0.7%)
B		142.0 (-0.4%)			
C			124.9 (-12.4%)		
H				149.3 (4.6%)	
S					139.3 (-2.3%)
BA	148.9 (4.4%)	147.1 (3.1%)	155.6 (9.1%)	162.0 (13.6%)	160.1 (12.3%)
CA	152.3 (6.7%)	155.5 (9.0%)	154.5 (8.3%)	157.1 (10.1%)	158.4 (11.0%)
HA	155.7	170.1	175.1	161.2	176.8

	(9.2%)	(19.2%)	(22.7%)	(13.0%)	(23.9%)
SA	155.9 (9.3%)	156.6 (9.8%)	161.1 (12.9%)	163.8 (14.8%)	162.1 (13.6%)

Table 2 shows that with the exception of the Hereford, purebred dams were less efficient than purebred Afrikaner dams under the particular environmental conditions. The purebred Charolais (C) dam was the least efficient dam out of all the genotypes. Crossbreeding the Afrikaner (A) dam line with Brahman (B), Charolais (C), Hereford (H) and Simmentaler (S) as sire lines indicated small effects (between +0.7 to +6.0%) on KgC/LSU above that of the purebred Afrikaner (A). However, the efficiency in the F1 cow increased relative to that of the purebred exotic cows. For example, the cow efficiency of the CA cow, compared to pure C cow increased with +14.5% (from -12.4% to +2.1%).

In the case of F_I cows the HA was unsurpassed and increased cow efficiency on average by +17.6%, while the BA, CA and SA dam lines increased cow efficiency by +8.5, +9.0 and +12.1% respectively. Continental and Zebu sire lines mated to the most productive HA crossbred dam line in a three-breed system (S x HA, C x HA and B x HA) increased KgC/LSU on average by +22.7, +23.9 and +19.2% respectively, against that of the A x HA backcross with +9.2%.

The improvement demonstrated in the study concurs with that of Schoeman (2010), which indicated that crossbreeding improves calf/cow efficiency when measured as energy requirements or input costs per kg of equivalent steer weight. Although the effect of heterosis on individual traits is normally relatively small, the cumulative effect on composite traits, such as weight of calf weaned per cow exposed are immense which explains the superiority in kgC/LSU as a composite trait. Conversely, researchers cautioned on the attempt to extrapolate research results to all environments other than those similar to where the studies were conducted because of the presence of genotype x environment interactions.

While KgC/LSU as trait on its own can be used to rank productive cows in a contemporary group, it cannot be used to plan breeding strategies. Fertility, or the number of calves weaned in a cow group should certainly also be considered as a complementary factor that influences cow efficiency. In this study the net effect on weaning rate (WR) was that crossbred dams outperformed their purebred contemporaries by 8%.

Cow efficiency can then be estimated as follows: Y = WR x KgC/LSU

where Y = cow efficiency.

Since weaning rate has a low heritability and largely depends on the climatic and managerial (environmental) factors of a particular farm, this trait can contribute to large deviations in the estimated cow efficiencies that were obtained in Table 2. When weaning rate is included in the metioned Vaalharts study, it showed that when compared to the A, only purebred H and S cows have increased cow efficiency potential (+11.4 and 5.3% respectively). Two-breed progeny of the A dam line increased cow efficiency on average by +16.5%. All these increases are ascribed to the increased WR of the breeds compared to that of the A, B and C pure-breeds.

While A sire line backcrosses increased cow efficiency on average by +20.3%, three-breed progeny from B, C, H and S sire lines had average increases of +21.6, +24.4, +30.2 and 34.8% respectively. The S x HA showed the notable increase of 49.7%. Similarly, the BA, CA, HA and SA dam lines respectively had average increases of +24.1, +18.9. +36.6 and +25.2% on cow efficiency. All crossbred dam genotypes increased cow efficiency, the only exceptions being a trivial increase of +0.6% of the B x CA genotype. In this study the Pearson correlation between kgC/LSU (cow efficiency without WR included) and WR x kgC/LSU (cow efficiency with WR included) is 0.88%.

In the current Vaalharts crossbreeding project, the Bonsmara and Nguni are added to the Afrikaner as dam lines. These dam lines are mated to Angus and Simmentaler as specialized sire lines. In addition, the dam lines are also inter-mated in all possible combinations. The result is 15 different genotypes. The data will be analysed similar to that of the previous crossbreeding project.

Conclusions

A sophisticated Large Stock Unit (LSU) calculator can be used for the measurement of cow efficiency (to calculate kg calf weaned/kg LSU of the dam) of different frame sizes and without additional inputs. Cross-breeding has shown to increase cow efficiency; as long as cow frame sizes do not increase up to a point where the nutritional needs of animals are not fully being met. Increases in cow efficiency (weaning rate x kg calf/large stock unit) in two-breed and three-breed cattle was mainly derived from differences in frame size, fitness and relationships between calf weight and cow Large Stock Units.

The fact that there are large differences in cow efficiency in reproductive cows point to genetic differences and holds the potential for cow ranking and improvement through selection in contemporary groups. Optimum crossbreeding strategies may increase cow efficiency up to a notable 49.7%. This will support climate smart beef production, since it will reduce resource use and reduce the carbon footprint per unit of product produced.

Acknowledgement

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Please contact the Primary Researcher if you need a copy of the comprehensive report of this project – Michiel Scholtz on gscholtz@arc.agric.za

Breeding, Cattle and Small Stock, Livestock Production, physiology and management, with global competitiveness

2018, ARC, ARC-API, Paper, Scholtz

‹ Landscape genomics in South Africa

› Discovery of single nucleotide polymorphisms

DEADLINES for RESEARCHERS 2021

Proposals for 2021: TBC
Progress reports: 28 Jan 21
Final reports: 29 Jan 21 Final includes comprehensive report and popular article

COMMITEE MEETINGS for 2021

RMRDSA CSS Planning - TBC
Project Committee - TBC
Pork Planning - TBC

Calendar

< Apr 2021 >

Sun	Mon	Tue	Wed	Tur	Fri	Sat
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4	5	6	7	8	9	10
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25	26	27	28	29	30	

PORK Priority Areas

Cattle & Small Stock Programmes

1 Sustainable natural resource utilisation

2 Improvement of Livestock production and forage

3 Management of agricultural risk to create a resilient Red Meat sector

4 Sustainable health and welfare for the Red Meat sector

5 Enhancement of production and processing of Animal Products

6 Consumer and market development of the Red Meat sector

7 Commercialisation of the emerging sector