Research and development innovations for climate-smart beef production in subtropical countries

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CONTEXT

Climate change is a reality that will result in more extreme conditions (droughts, floods, higher temperature and more heat waves)

In the case of beef cattle this will lead to:

- **A decrease in production (growth and milk)**
- **Lower reproduction (both males and females)**

In tropical and sub-tropical countries Animal Production: Contribute to climate change and is affected by climate change

That is why- adaptation, mitigation and resilience strategies are all needed

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CLIMATE CHANGE ⇨ ADAPTATION + MITIGATION + RESILIENCE

ADAPTATION	MITIGATION	RESILIENCE
• Use of indigenous breeds • Early warning systems • Crossbreeding ➢ Maintain production under climate change	• Improved cow-calf efficiency • Selection for alternative measures of efficiency and lower emissions • Crossbreeding ➢ Lower carbon footprint	• Breeding for less plastic / more climate resilient genotypes ➢ recover quickly, bounce back, robustness

STRATEGIES TO BE DISCUSSED

1. Utilization of indigenous / adapted genotypes
2. Early warning systems
3. Improved efficiency of production
   - cow-calf efficiency
   - alternative measures of post-weaning efficiency
4. Effective crossbreeding
5. Breeding for less plastic / more resilient genotypes

Strategy 1: Indigenous breeds
⇨ Our heritage for food security



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ADVANTAGES OF INDIGENOUS / ADAPTED BREEDS

- Adapted to the local conditions and are able to survive and reproduce under harsh environments.

- Fertility and growth less affected by heat stress

- Meat quality of indigenous breeds (juiciness & tenderness) comparable to the best of the British and European breeds

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Strategy 2: Early warning systems

- **Short term (7 – 14 day) warning systems: Nutrition play an important role to mitigate heat stress:**
  - Supplements for cattle can be formulated for proper cation-anion balance to mitigate heat stress.
- **Seasonal warning systems (6 to 12 months):**
  - Farmers can be warned to reduce animal numbers in order to manage stocking rates in periods of draught
  - Heat stress compromise the fertility of bulls, warned in time of seasons that may have high temperatures --- use multi-sire breeding and/or bulls from tropical adapted genotypes
  - Vaccines can be produced in time to limit disease outbreaks associated warmer/wetter climates.

Strategy 3a: Improved cow- calf efficiency

- **<u>The three traits that influence cow efficiency are:</u>**
  1. **Weaning weight of the calf (WW)**
  2. **Feed requirements of cow (measured through Large Stock Unit)**
  3. **The frequency at which a calf is produced**

How to increase the weaning weight of calves in relation to a cow LSU (Large Stock Unit) in extensive beef production systems.

Cow-calf efficiency = WW the calf / Cow LSU (feed requirement) x Calving %

Kilogram calf weaned per hectare

(LSU – linked to the carrying capacity)

Strategy 3b. Selection for alternative measures of efficiency

Feed conversion ratio (FCR) - improved by better growth or lower intake or both (we don't know which one and in what proportion)

<u>Alternative efficiency traits</u>:

- **Residual feed intake (RFI) - improved by reducing feed intake without changing growth**
- **Residual daily gain (RDG) - improve growth without affecting feed intake**

Low RFI animals produces less methane and eats less than high RFI animals – more efficient cows

Proposed: Use an economic index that include both feed intake and growth

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Strategy 4. Effective Crossbreeding

- **Widely used mating system in commercial beef herds - Can result in up to 25% increase in weight of calf weaned per cow exposed to breeding as compared to straight breeding**

Increased cow productivity (without additional herd cost) through properly designed crossbreeding systems: Examples from Vaalharts (hot and dry area)

- **Brahman x Afrikaner = 12%**
- **Simmentaler x Afrikaner = 15%**
- **Angus x Nguni = 21%**
- **F1 Afrikaner cow: up to 49%**

Reduction in the carbon footprint per kg product

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Current Crossbreeding at Vaalharts (Northern Cape)

Afrikaner, Bonsmara and Nguni cows mated with Afrikaner, Bonsmara, Nguni, Angus and Simmentaler bulls in all possible combinations

Comparison of the weaning weights of Sanga sired calves and Angus/Simmentaler sired calves between the 2015/2016 (dry and hot) and 2016/2017 (wet and cool) seasons.

Season	Sanga sires			Taurus sires	
	Afrikaner	Bonsmara	Nguni	Angus	Simmental
2015/2016	179±26.6	**161±20.7**	172±31.0	176±43.3	166±14.8
Average	171			171	
2016/2017	176±34.0	186±27.6	186±26.5	204±36.9	215±15.9
Average	183			210	

Diff between Sanga & Taurus: 0 kg (15/16) 27 kg (16/17)

Diff within Sanga & Taurus: 12 kg 39 kg

Diff within Breeds: 3 kg 24 kg 14kg 28 kg 49 kg

2015/2016 – 12 heatwaves with 71 heatwave days

2016/2017 - Average 2 heatwaves with 7 heatwave days

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Strategy 5a: Breeding for less plastic / more climate resilient genotypes

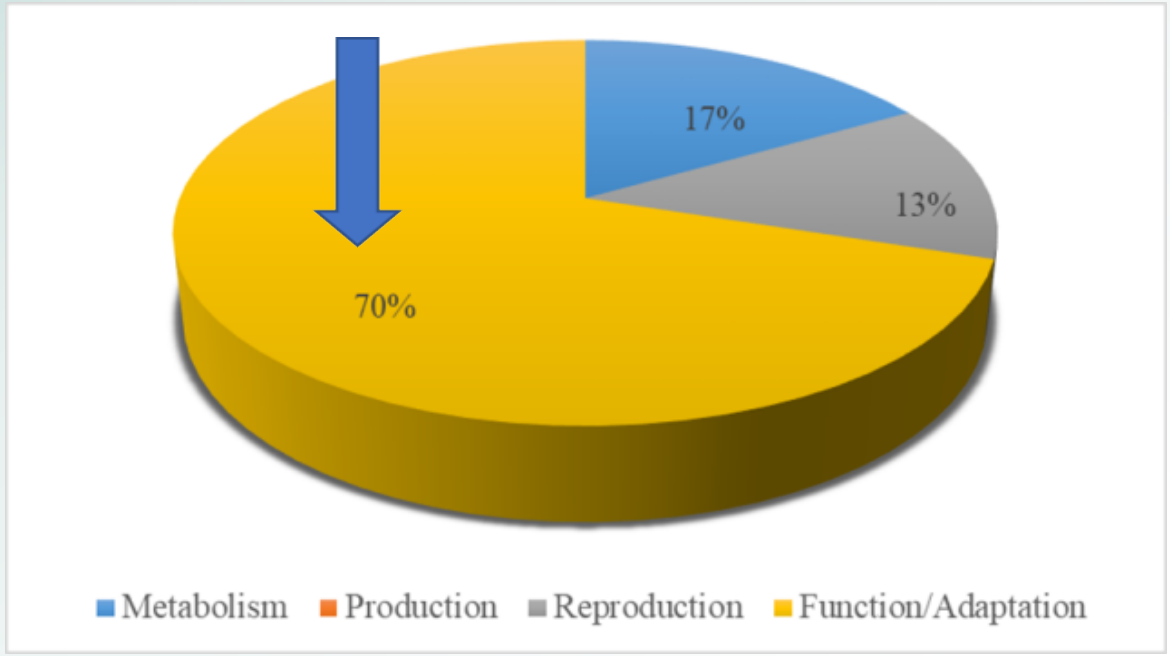
- Plasticity is higher when variation between years is high and lower when these interaction effects are smaller
- **Indigenous breeds – Plasticity** (Results from the crossbreeding project at Vaalharts (weaning weight of crossbred calves)

Sire breed	Afrikaner	Nguni	Bonsmara	Angus	Simm
Difference in Weaning Weight between years (kg)	15	22	24	31	49

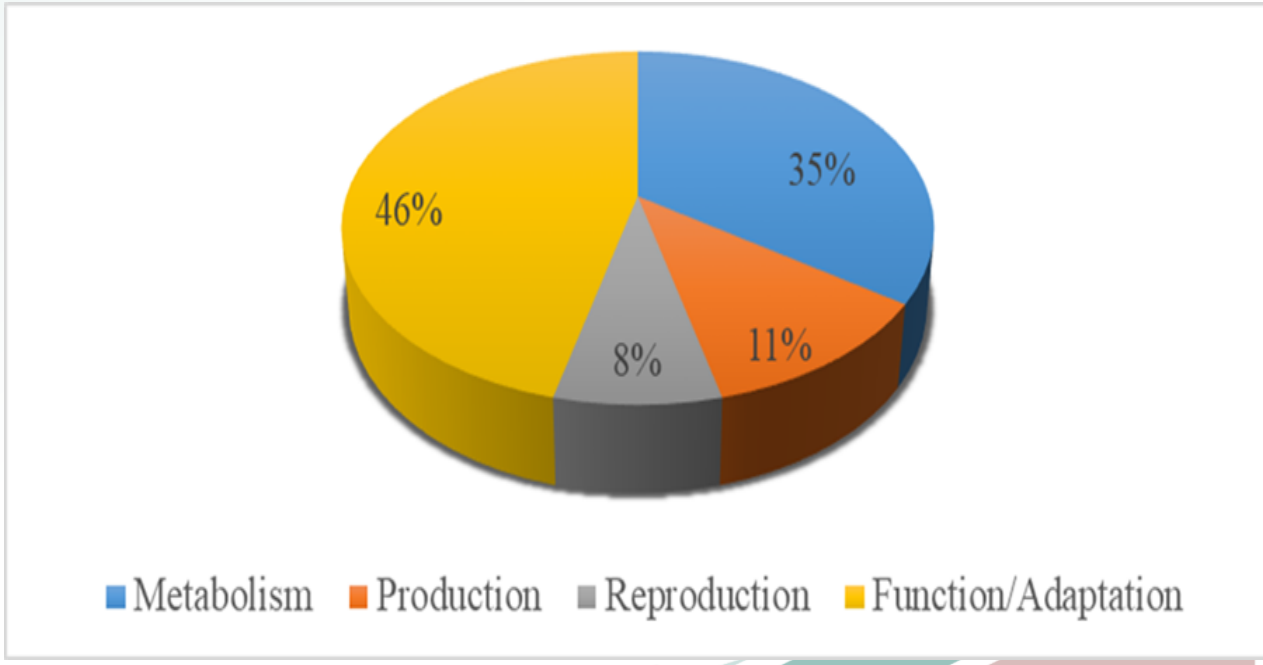
Strategy 5b: Breeding for less plastic / more climate resilient genotypes

Genomic signals of selection for adaptation emphasized the environmental adaptation of the Afrikaner and Brahman.

Afrikaner



Brahman




13 Cows and 10 calves

Strategy 5: Breeding for climate resilient genotypes

- It was surprising that there were no genes associated with production in the Afrikaner and only 11% in the Brahman

- Possible explanation: While breeders were selecting for growth, natural selection increased the frequency of genes for function/adaptation to survive and reproduce under the harsh South African environment.

- Frisch (1981) observed that selection for growth rate in a stressful environment was achieved through increases in resistance to environmental stress.

Adaptability or Robustness

"Response to selection for growth rate in stressful environments is largely a result of an increase in resistance to stress, rather than an inherent improvement to growth potential" Frisch 1981

Livestock that experienced selection pressure due to environmental conditions, such as drought, display a greater genetic diversity across habitats when compared with the "neutral" genome background (Hanotte *et al.*, 2010)

CONCLUSION

These strategies will safeguard food security through adaptation and reduce greenhouse gas emissions from beef cattle through mitigation, while resilience to climatic effects will be enhanced.

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