Quantifying the impact of weather environment across three timescales on lamb performance

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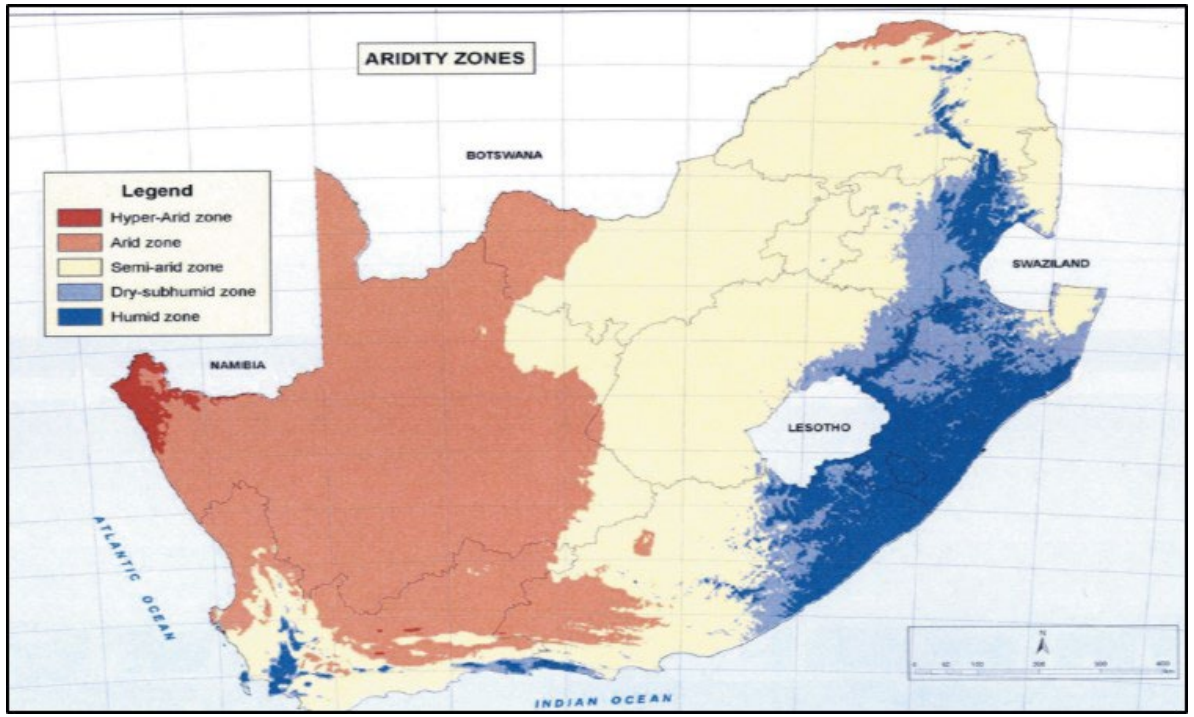
Introduction

Introduction

- More than 80% of agricultural land area in South Africa is non-arable
- Livestock farming is the only viable agricultural practice in these areas
- Global climate change poses a threat to the future sustainability of livestock farming
- Details regarding the relationship between weather conditions and production performance are lacking
- This lack of information hampers producers
  - Magnitude and nature of climate effects?
  - Duration of these effects?
  - Can they be mitigated?
  - Is mitigation necessary?



AIM

Explore the effect of weather conditions at various periods prior to lambing on the birth weight, weaning weight and survival of Dormer lambs

Methodology

Methodology

Location and environment

- Elsenburg Research Farm, Western Cape, South Africa (33° 51' S, 18° 30' E)
- Mediterranean climate
  - Mean yearly temperature of 23,75˚C
  - Winter rainfall (May-August)
  - 560 mm per annum
- Irrigated pastures for grazing
  - Kikuyu in summer
  - Mixed lucerne, kikuyu, clover medics and oats in winter
- Limited supplementary feeding as required

Western Cape Government

Methodology

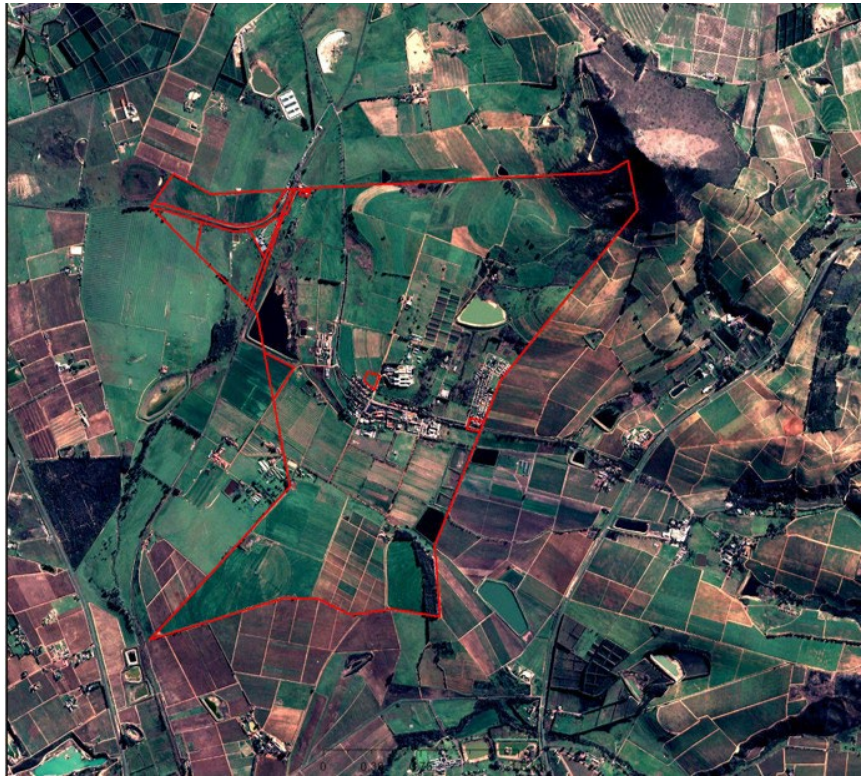
Animals

- Elsenburg Dormer stud
  - Founded in 1941
- Ewes mated in late spring (October-November)
- Individual lamb records between 1972 and 2021
  - Birthweight
  - Weaning weight
  - Survival until weaning
- Condensed to flock averages

Methodology

Weather data

- Weather station kept on farm by ARC
- Daily measurements
  - Temperature (*Tmax* and *Tmin)*
  - Relative humidity (*RHmax* and *RHmin*)
  - Rainfall (*Rain)*
- THI calculated (*THImax* and *THImin*)
  - $THI = Temp - (0.31 - 0.31 \times Relative\ Humidity) \times (Temp - 14.4)$
- Mean weather conditions across three different time periods
  - Year prior to mating (October year *y* to September year *y+1*)
  - Mating period (October-November)
  - Lambing period (March-April)



Methodology

Data analysis

- Statistica 14
- Principal component analysis was performed on weather data
  - Identified components with eigenvalues >1
- Factor loadings were then generated for each significant principal component
  - Varimax normalised data rotation
  - Loadings indicated correlation between components and weather variables
- Factor scores were analysed using GLM to determine significance of weather environment to lamb performance
- Significant principal components were included in regression models

Results

Results

Year before mating

Table 1 Significance level of the effect of yearly environmental weather conditions, separately and in combination, on lamb traits of the Elsenburg Dormer flock

	Environmental conditions			
Lamb trait	Cold rainy days	Cool nights	More humid	Total effect
Birthweight	0.112	**<0.001**	0.677	**<0.001**
Weaning weight	0.944	0.058	0.195	0.154
Survival	0.441	**0.009**	**0.026**	**0.008**

Table 2 Regression equations for modelling the impact of environmental conditions on lamb traits of the Elsenburg Dormer flock

Lamb trait	Equation	P-value	R^2
Birthweight	$4.048 + 0.209(Cool\ nights)$	<0.001	0.433
Survival	$80.889 + 3.838(Cool\ nights) + 3.233(More\ humid)$	0.004	0.194

Results

Mating period

Table 3 Significance level of the effect of mating period environmental weather conditions, separately and in combination, on lamb traits of the Elsenburg Dormer flock

	Environmental conditions		
Lamb trait	Hot dry days	Warm nights	Total effect
Birthweight	0.202	**0.003**	**0.005**
Weaning weight	0.890	0.708	0.923
Survival	0.837	0.258	0.513

Table 4 Regression equation for modelling the impact of mating period environmental weather conditions on survival in the Elsenburg Dormer flock

Lamb trait	Equation	P-value	R^2
Birthweight	$4.034 - 0.130(Warm\ nights)$	0.003	0.163

Results

Lambing period

Table 5 Significance level of the effect of lambing period environmental weather conditions, separately and in combination, on lamb traits of the Elsenburg Dormer flock

	Environmental conditions			
Lamb trait	Cold rainy days	Warm nights	More humid	Total effect
Birthweight	0.169	**0.001**	0.923	**0.006**
Weaning weight	0.764	**0.006**	0.446	**0.042**
Survival	**0.004**	**0.022**	0.545	**0.004**

Table 6 Regression equation for modelling the impact of mating period environmental weather conditions on survival in the Elsenburg Dormer flock

Lamb trait	Equation	P-value	R^2
Birthweight	$4.040 - 0.136(Warm\ nights)$	0.002	0.180
Weaning weight	$23.069 - 1.735(Warm\ nights)$	0.004	0.155
Survival	$80.898 - 4.105(Cold\ rainy\ days) - 3.299(Warm\ nights)$	0.001	0.228

Discussion

Discussion

Year before mating

- Birthweight was positively related to "Cool nights"
  - Potentially related to heat stress recovery
- Survival was affected by both "Cool nights" and "More humid"
  - Partially affected by correlation between birthweight and survival
  - No complete explanation for influence of humidity
- Around 43,3% of variation in birthweight related to environmental effects
  - Increased night-time temperatures could impact significantly on trait
- Weather effects can have long-term impacts on sheep production

Discussion

Mating period

- Birthweight was inversely related to "Warm nights"
  - Mean minimum temperature (10,6 °C) below thermoneutral zone
  - Again, potentially pointing to heat stress recovery
- Further points to climate change impacts disrupting performance in the trait

Discussion

Lambing period

- "Warm nights" inversely related to all three traits
  - Clearly significant effect but relationship is unclear
  - Further research required
- "Cold rainy days" significantly affected survival
  - Mortalities increase as a result of cold stress
- Increased temperatures again linked to production decline

Conclusions

Conclusions

- Environmental weather conditions significantly impacted on lamb performance in this flock
  - Birthweight and survival most susceptible traits
- Lamb performance affected by environmental conditions experienced by their dams prior to conception
  - Implications for managing open ewes
- Projected changes in climate clearly linked to decreasing animal performance
- Principal component and factor analysis are suitable methodologies for analysing weather data

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Thank you

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