Southern Rangelands Drought Resilience Situational Analysis

Cover to come

Australian Government
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Future Drought Fund

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South-West WA Drought Resilience Adoption and Innovation Hub

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Southern Rangelands

Figure 1. Map showing location of the Southern Rangelands

Key messages

- Climate change is projected to increase average temperatures and evapotranspiration across the Southern Rangelands, increasing heat stress of livestock.
- Forage production could decline by up to 10%.
- To meet future climate change challenges, pastoralists need to adopt technologies and management practices that optimise forage and livestock production while reducing costs of production.
- Best Practice production systems and labour/cost-saving technology exist but these need to be extended and demonstrated across the rangelands.
- A coordinated approach to RD&E activities in the Southern Rangelands is urgently required.

Location and size

The Southern Rangelands is located mostly south of the Pilbara region and between the South West agricultural region and the arid interior. The region covers an area of about 1.5 million square kilometres (about 150 million hectares) and comprises four sub-regions: the Gascoyne, the Murchison, the Goldfields and the Nullarbor (Figure 1).

Pastoral stations have operated across the Southern Rangelands for more than 150 years with the total area of pastoral leases across the four sub-regions currently just over 50 million hectares (Table 1). Vegetation across the region is characterised by shrublands – a mix of semi-arid mulga, spinifex and saltbush/bluebush vegetation communities. Of the 434 registered pastoral stations in WA (2020) about 66% (286) are in the Southern Rangelands (Table 1).

Table 1: Number of pastoral stations and livestock in the Southern Rangelands (2020)

	Gascoyne	Murchison	Goldfields	Nullarbor	Total
Number of stations	76	125	65	20	286
Number of leases	82	133	80	20	315
Cattle	116,295	91,427	45,485	18,687	271,894
Sheep	48,639	17,375	3,399	59,705	129,118
Goats – managed	25,887	3,186	84	0	29,073

Source: Nicholas Breadsell Pastoral Lands Board and Department of Planning, Lands and Heritage

Recent climate

The climate of the Southern Rangelands is semi-arid with an annual average rainfall of 200–300mm.

Over the past 30 years (1991–2021) winter rainfall across the entire Southern Rangelands has fallen by about a fifth compared to the previous few decades (1961–1990). However, over the same period, average annual rainfall has either increased slightly (2–5% in the Gascoyne, Murchison and Goldfields) or stayed the same (Nullabor) due to a 30% increase in summer rainfall (Table 2).

Annual rainfall across the region is highly variable. For example, over the past 30 years (1991–2001) the average annual rainfall for Cue in the Murchison was 253mm with a range from 72mm through to 518mm. Nine of the last 30 years have been wet (20–100% above average) while 13 years have been dry (>50% below average). Over the same period, a similar rainfall pattern has occurred right across the Southern Rangelands (Table 3).

Annual rainfall over the five years 2016–2020 was about 40% below the long-term average across the Gascoyne (Gascoyne Junction) and Murchison (Cue) regions and 10% below the long-term average for the Goldfields (Kalgoorlie) (Figure 2). In 2021, the dry spell 'broke' – with Gascoyne Junction receiving more than double the long-term average (550mm).

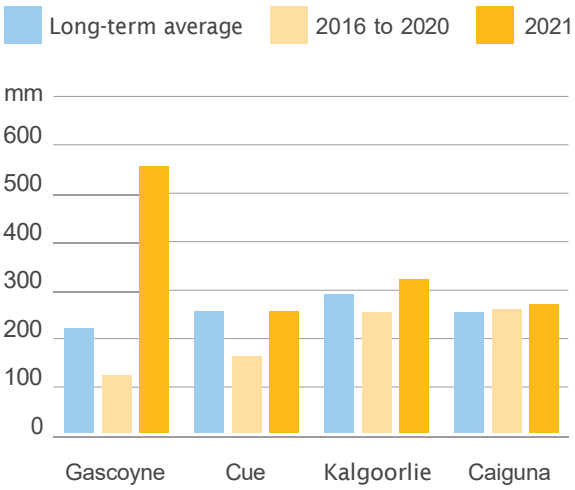


Figure 2: Five-year (2016–2020) average annual rainfall (mm) across the Southern Rangelands compared with the long-term average and the 2021 annual rainfall. Source: Bureau of Meteorology

Average maximum temperatures across the Southern Rangelands have risen by 0.5–1.0°C over the past 30 years (1991-2021) compared to the previous few decades (1960-1990). As a result, the number of days above 40°C have also risen (except for Caiguna in the Nullarbor) (Table 4).

Table 2: Change (%) in average annual rainfall (mm) across the Southern Rangelands between 1961–1990 and 1991–2021

Years	Rainfall	Gascoyne Jcn (Gascoyne)	Cue (Murchison)	Kalgoorlie (Goldfields)	Caiguna (Nullarbor)
1961-1990	Annual average	211	241	274	259
	May-Oct	113	120	143	150
	Nov-April	98	121	131	109
1991-2021	Annual average	220	253	280	258
	May-Oct	87 (-23%)	93 (-22%)	111 (-22%)	118 (-21%)
	Nov-April	133 (+36%)	160 (+32%)	169 (+29%)	140 (+28%)

*Data in brackets indicates change in rainfall over the past 30 years. Source: BOM data via Dr Meredith Guthrie DPIRD

Table 3: Range in average annual rainfall (mm) and number of dry vs wet years across the Southern Rangelands over the past 30 years (1991–2021)

	Annual (mm)	Range (mm)	Wet years	Dry years
Gascoyne Junction – Gascoyne	220	77–550	8	15
Cue – Murchison	253	72–518	9	13
Kalgoorlie – Goldfields	280	147–511	7	12
Caiguna – Nullarbor	250	120–528	6	9

Source: Bureau of Meteorology

Table 4: Difference in number of days above 40°C across the Southern Rangelands

	1960-1990	1991-2021	Difference
Gascoyne Junction - Gascoyne	41	52	+11
Cue - Murchison	25	32	+8
Kalgoorlie - Goldfields	8	11	+3
Caiguna - Nullarbor	4.8	4.4	-0.4

Source: Bureau of Meteorology

Between 1989 and 2018 Meekatharra experienced an average of 11 days per year above 42°C, compared to an average of six days per year above 42°C between 1959 and 1988 (Figure 3). Since 1989, temperatures of 46°C have been recorded for Meekatharra four times, twice in 2013, and once each in 2015 and 2018. A temperature of 46°C had not been recorded at Meekatharra before 2013.

Severe to extreme heat stress days for livestock are also increasing across the Southern Rangelands. Between 1989 and 2018, Wiluna experienced an average of eight days per year with a THI (temperature humidity index) of 90 or above, compared to an average of less than one day per year between 1959 and 1988 (Figure 4).

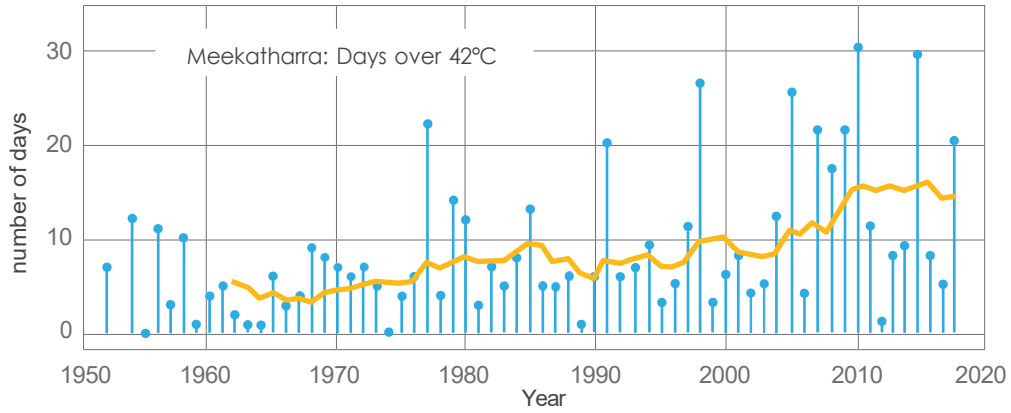


Figure 3: Annual number of days above 42°C (blue bars), with a 10-year running average (solid yellow line) for Meekatharra. Source: Bureau of Meteorology and CSIRO[1]

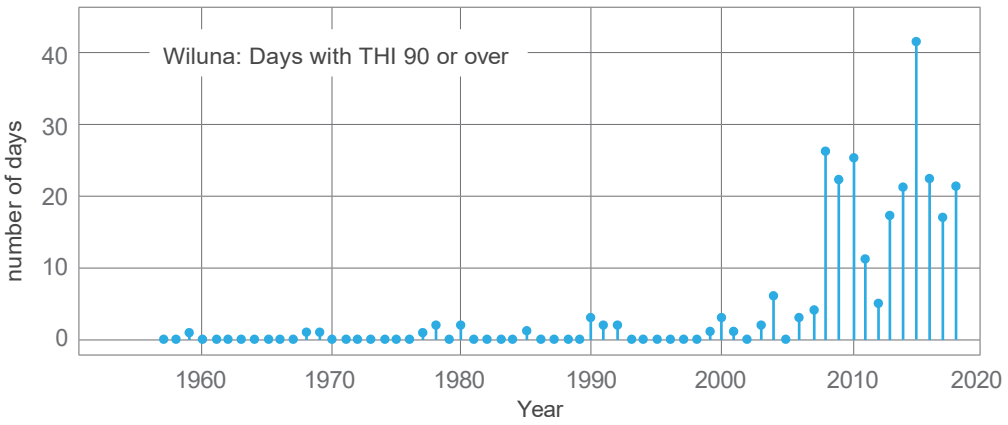


Figure 4: Annual number of severe heat stress days at Wiluna between 1959 and 2018
Source: Bureau of Meteorology and CSIRO[1]

Note: The temperature–humidity index (THI) is calculated using temperature and humidity readings and is a measure of the degree of discomfort experienced by an individual in warm weather. *Bos taurus* cattle can start to experience severe stress at THIs above 79 whereas *Bos indicus* cattle become severely stressed at THIs over 90.

Recent climate summary

Annual average rainfall has risen slightly (2–5%) across much of the Southern Rangelands over the past 30 years compared to the previous few decades (1960–1990) – due to a significant increase (30%) in summer rainfall. However, seasonal rainfall is highly variable with 10– 50% of the last 30 years below the average depending on location. Over the same period, average maximum temperatures have risen by 0.5 to 1.0°C across the region – resulting in more severe heat stress days for livestock.

Industry

In the early 1990s, the Southern Rangelands was a major wool-producing area with more than 1.5 million reported sheep but numbers, especially of Merino sheep, have greatly declined with just 130,000 reported in 2020 (Table 1). Cattle now dominate the Southern Rangelands with 270,000 reported in 2020 (Table 1 and Figure 5).

Wild dog predation has exacerbated the decline in sheep numbers and decimated the feral goat population. Some pastoral stations (particularly on the Nullarbor – see Figure 6) continue to run Merino sheep principally because they have dog-proof fences.

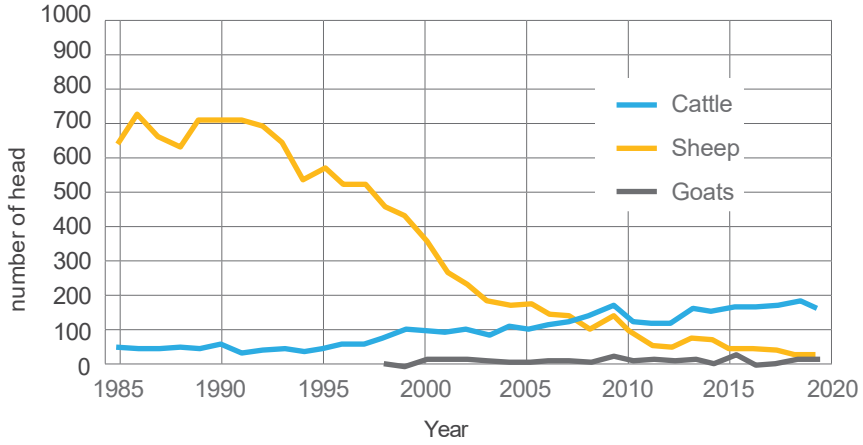


Figure 5a: Reported livestock numbers in the upper Southern Rangelands, 1985–2019

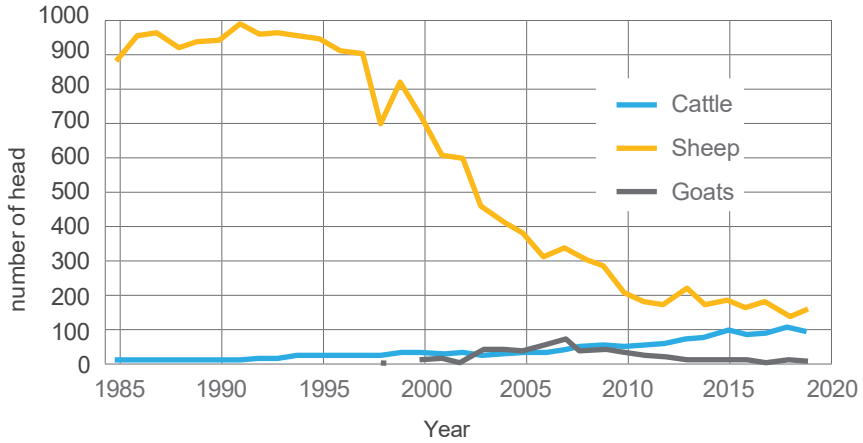


Figure 5b: Reported livestock numbers in the lower Southern Rangelands, 1985–2019 Source: DPIRD (2020) Status of the Western Australian pastoral rangelands 2020: condition, trend and risk.

Note: Of the 1.17 million head of cattle across all WA pastoral stations in 2019 about 25% (290,000) were in the Southern Rangelands, 20% in the Pilbara and about 55% in the Kimberley.[2]

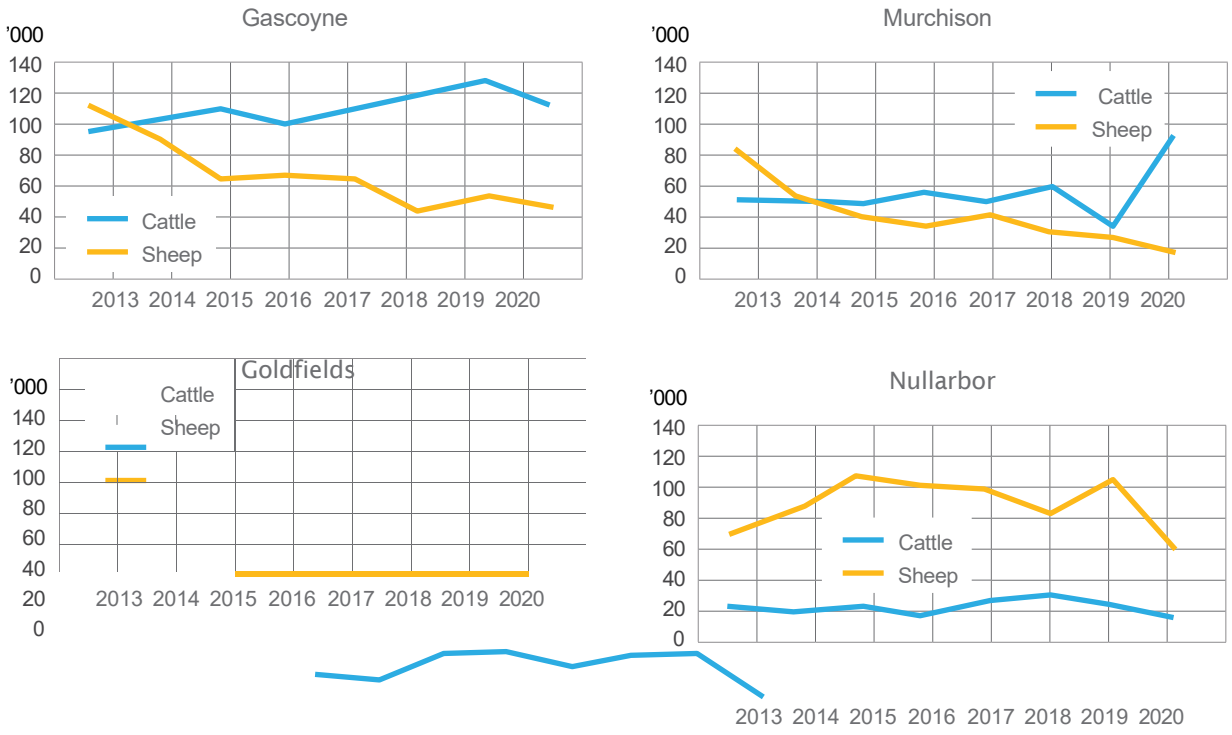


Figure 6: Change in cattle and sheep numbers across the Southern Rangelands 2013—2020.
Source: Nicholas Breadsell Pastoral Lands Board and Department of Planning, Lands and Heritage

Note: In 2020, about 90% of pastoralists in the Murchison and Goldfields-Nullarbor regions of the southern rangelands rated wild dogs as the most important factor influencing the economic state of the pastoral industry.[2]

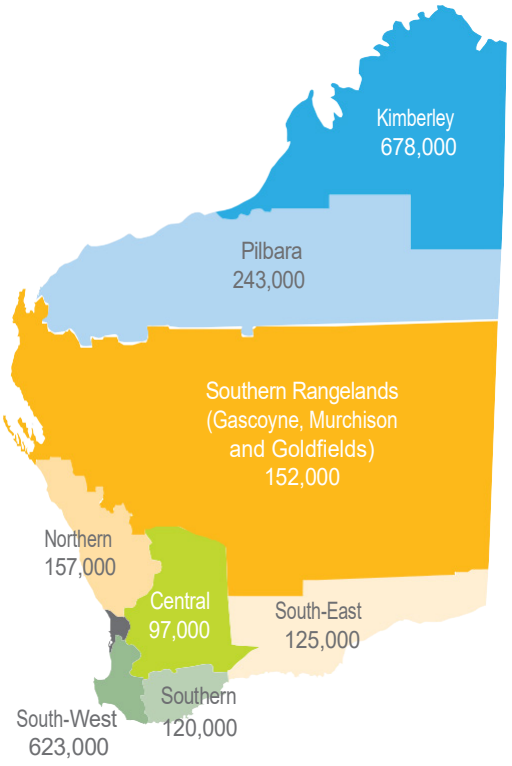
WA Beef cattle industry

Western Australia has about 10% of the nation's cattle herd at about 2.3 million head of beef cattle. Just over half the state's herd are breeding cows and heifers and the remainder bulls, steers and calves.

The WA beef cattle herd is almost evenly distributed 50:50 between the rangelands and agricultural regions.

About 6% of the state's beef cattle are in the southern rangelands, 10% in the Pilbara and 30% in the Kimberley.

The total value of the WA beef industry is about A$860m, which includes the live export industry, domestic consumption and boxed beef exports (both chilled and frozen). The industry's value has increased by about 30% over the past decade. In 2019–2020 total turn-off (slaughter + live export) from the WA cattle industry reached 792 000 – the highest on record over the past decade and an 11% increase year on year. Of this, domestic slaughter accounted for 58% of turn-off while live export accounted for 42% (approx. 333,000 head).[3]



Source: ABS 2011 and PLB 2013

WA live cattle exports

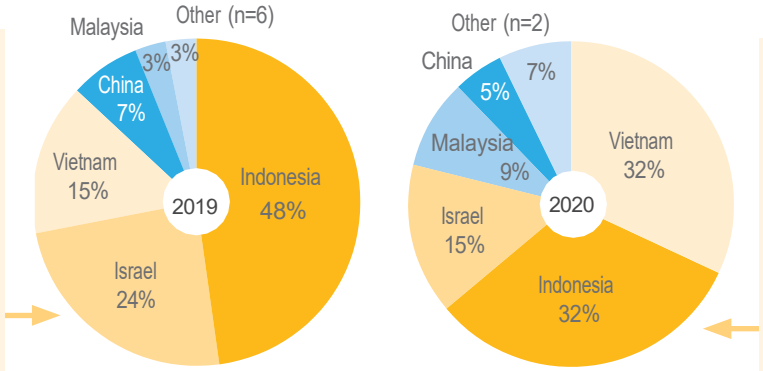
Unfortunately, no disaggregated data is available to determine the number and destination of cattle turned-off annually from the Southern Rangelands. However, most cattle in the Southern Rangelands are based on those preferred in Southeast Asian live export markets: *Bos indicus* (Brahman) and the *Bos indicus*-infused breeds Droughtmaster and Santa Gertrudis. About 60% of sales in the Pilbara-Southern Rangelands pastoral zone are reported as live export transactions.[4]

The value of live cattle exported from WA reached $334.2 million in 2020.

Indonesia, Vietnam and Israel are the major live export markets of WA cattle.

In 2019, Indonesia dominated the live cattle exports from WA with a total of 145,000 head shipped but in 2020 Vietnam accounted for about a third of cattle exported (83,000 head), an increase of 92% year on year (Figure 7).

Israel is a highly price-sensitive market. In 2020, the high price of Australian cattle combined with increased shipping costs stimulated Israeli importers to seek cattle closer to home from Rumania, Bulgaria, Spain, Portugal and Ireland.



2020 saw a large reduction in live cattle exports to Indonesia due to the combined effects of COVID-19 on the Indonesian economy, the high price of Australian cattle and competition from Indian buffalo and Brazilian beef.

Based on ABS data, DPIRD analysis

Figure 7: Proportion of total WA live-export cattle sent to various markets in 2019 and 2020

Climate change

By 2050, average temperatures across the Southern Rangelands are projected to rise by 0.8–1.5°C under a medium emissions scenario and by 1.2–2.3°C under a high emissions scenario compared to 1991–2020. On average, annual rainfall and summer rainfall (Dec–Jan) are expected to decline across the region but the confidence of the models for rainfall is not as high as those for temperature – meaning there is a large range in projections from below the long-term average to above the long-term average (Table 5).

Year to year variability in rainfall is expected to increase and under all emissions scenarios there is high confidence that the intensity of heavy rainfall events will increase.

Potential evapotranspiration is expected to increase in all seasons.

It is anticipated that projected climate change in the Southern Rangelands will:

- reduce forage production by 10% and increase seasonal variability of production[5]
- increase the proportion of less nutritious tropical C4 grasses (stimulated by a rise in CO_2 concentration)
- cause more intense rainfall events, which may advantage woody plants over grasses
- increase the likelihood of soil erosion from intense rainfall events
- increase heat stress of livestock, which in turn could reduce growth and reproductive rates and increase mortality rates
- increase the water requirements of livestock
- increase livestock susceptibility to new parasites and diseases
- increase the intensity and likelihood of wildfire.

Table 5: Projected rainfall and maximum temperatures in the Southern Rangelands by 2050 under medium and high emissions scenarios compared with recent climate (1991-2020)

	Annual rainfall (mm)		Summer rainfall (mm)		Maximum temperature °C	
Emissions scenario	**Medium**	**High**	**Medium**	**High**	**Medium**	**High**
Gascoyne Jcn - Gascoyne	214 (+0.9%)	187 (-12%)	66 (-20%)	60 (-26%)	33.8 (+1.4)	34.6 (+2.2)
Cue - Murchison	251 (+0.8%)	229 (-8%)	84 (-8%)	78 (-14%)	30.5 (+1.5)	31.3 (+2.3)
Kalgoorlie - Goldfields	276 (-5.0%)	252 (-13%)	86 (-13%)	79 (-20%)	27.1 (+1.4)	27.7 (+2.0)
Caiguna - Nullarbor	249 (-0.8%)	238 (-5%)	64 (-16%)	60 (-21%)	25.1 (+0.8)	25.5 (+1.2)

Southern Rangelands: market drivers

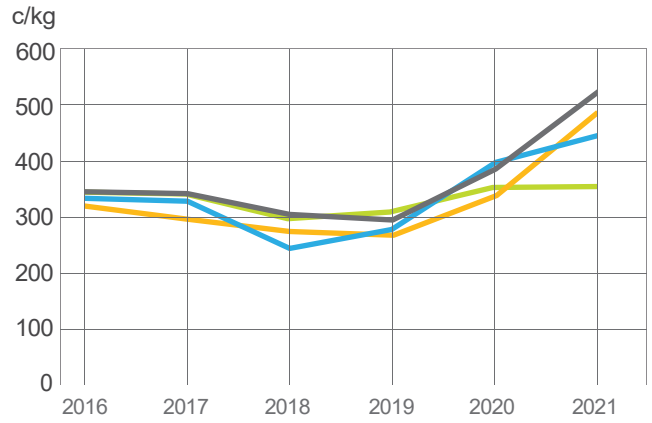
The cattle industry in the Southern Rangelands is relatively new with the region's sheep pastoralists converting to cattle over the past 10 to 15 years due to the decimation of the pastoral sheep industry by wild dogs. Many pastoralists are still learning which cattle breeds are best suited to their country and which markets will provide the best returns. Most pastoralists run *Bos indicus* and *Bos indicus*-infused cattle suited to the Indonesian live export industry, which developed in the 1990s. However, before this, *Bos taurus* breeds dominated the industry — Shorthorn and to a lesser extent Hereford and Devon.

In recent years, prices for domestic cattle have increased relative to live export prices and in 2021 prices of WA domestic market steers were 25–48% higher than live export steers (Figure 8).

In response to the price increase, some Southern Rangelands pastoralists have reportedly introduced *Bos taurus* (Charolais, Poll Shorthorn, Red Angus, Angus and Murray Grey) breeds into their *Bos indicus* (Brahman) or *Bos indicus*-infused (Droughtmaster, Santa Gertrudis) herds to meet the local market preference for *Bos taurus* rather than *Bos indicus*-infused breed.

For example, Darren Cousens, chairman of the Bullseye Group and manager of Hillview Station southeast of Meekatharra, is converting his production system from live export steers based on Droughtmaster cattle to heavy steer production based on Santa Gertrudis. The move is based partly on research at Old Man Plains Research Station out of Alice Springs, which showed judicious grazing management of buffel grass-based pastures could turn-off heavy steers (300kg clean weight) for the domestic market under a range of seasonal conditions.[6] Subsequent modelling work by the Department of Primary Industries and Regional Development showed that heavy steer production was more economic than live export steer production.[7]

Darren believes running fewer breeding females and more steers provides him with more flexibility in a dry year and changing from Droughtmaster to Santa Gertrudis allows him to better target the domestic market while retaining some *Bos indicus* genetics for environmental resilience.



Until 2019, live export prices were competitive with local WA saleyard prices but by 2021 there was a significant divergence, with domestic steers attracting 25–50% more per kilogram of liveweight than live export steers.

Re-stocker steer
Feeder steer
Vealer steer
Live export steer*

Figure 8: Price comparison (cents/kg liveweight) of Darwin live export steers* vs WA domestic market steers between 2016 and 2021

*as WA live export prices unavailable, Darwin prices have been used as a proxy

Drought adaptation – past successes and RD&E gaps

Periods of drought occur frequently across the Southern Rangelands, which pastoralists generally manage by:

- preserving the breeding herd
- protecting rangeland condition
- maintaining financial viability.

In the short-term, pastoralists cope with drought tactically by reducing livestock numbers to a level that sustains rangeland condition.

In the long-term, pastoralists manage drought by strategically setting an appropriate long-term stocking rate and targeting a specific market, which in turn shapes their production system.

While Southern Rangelands pastoralists have responded both tactically and strategically to past climate change, the rate of climate change going forward may be more rapid and might require a faster response.

Climate change resilience in the Southern Rangelands must accommodate both environmental, social and economic resilience.

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With more extreme seasonal conditions likely under climate change, pastoralists in the Southern Rangelands may need to consider operating at lower long-term stocking rates. In the short-term, while cattle prices are high, this is feasible. But in the longer term, when prices revert to trend, pastoralists will need to adopt technologies and management practices to ensure they can lower their costs of production while maintaining or increasing production rates.

Table 6 outlines the drought/climate change adaptation levers that Southern Rangeland pastoralists currently have at their disposal and outlines how pulling each of these levers has worked to date and the RD&E needed to better equip rangeland production systems under projected future climate change.

Table 6: Summary of drought mitigation levers available to rangeland pastoralists and the RD&E gaps needing attention to better equip the Southern Rangelands under projected future climate change

Drought mitigation lever	What's worked?	What's needed?
Better use of rainfall How can increases in summer rainfall be captured and used more efficiently to compensate for lower winter rainfall or drought years?	Pastoralists are interested in both rehydration and ponded pastures. Rehydration uses earthen barriers to slow and spread water run-off after a rainfall event. Ponded pastures use earthen banks along contours over a large area to hold back run-off after a rainfall event.	Pastoralists need help in formulating rehydration plans. Research on ponded pastures has mostly been done in higher rainfall regions: need to determine benefits for the SR. The Southern Rangelands Pastoral Alliance will deliver a workshop in 2022 in which pastoralists can learn how to carry out their own rehydration assessment.
Better use of groundwater – irrigation Many SR pastoral stations have significant but under-used groundwater resources, which could be used to irrigate fodder crops or diversify pastoral businesses.	Irrigated pasture production for beef cattle in the Pilbara generated projected returns from -3.3% to 22.8%. Providing high-quality feed to early weaned calves was the most profitable and increased breeder herd reproductive rate while decreasing mortality rate.[8]	Few irrigation projects have been undertaken in the SR due to uncertain economics and potential difficulties in gaining regulatory approval. For small-scale irrigation projects to help the SR cope with climate change, the current regulatory framework concerning irrigation projects needs to change. Irrigated crops for cattle feed could be feasible. With a 50ha centre pivot it could be possible to produce 15t/ha of summer maize and 10t/ha of winter wheat to generate 1250t of grain annually. With added protein this would be sufficient to grain finish 1250 yearling cattle over 100 days.

Drought mitigation lever	What's worked?	What's needed?
Forage use efficiency Grazing management decisions currently rely on a visual assessment of forage availability, which can be imprecise – leading to sub-optimal use of the forage resource.	'Self-herding'[9] and 'walk-over'[10] weighing systems can improve forage use efficiency and grazing management in the SR. Walk-over weighing systems coupled with satellite imagery could be used to monitor forage availability and quality and underpin grazing, sale and mating decisions.	Demonstration/extension of 'self-herding' and 'walk-over' benefits needed.
	GPS tags and virtual fencing collars enable cattle to be monitored in real time. GPS tags currently being trialled at Hillview Station southeast of Meekatharra. A 'proof of concept' virtual fencing trial using 20 cows in a 5ha paddock is underway on Rio Tinto's Hamersley station in the Pilbara as part of the UWA Beeflinks Project.	Virtual fencing trials need to be done in the SR. Virtual fencing potentially the 'holy grail' of pastoral management but setup currently expensive.
	Some stations successfully using long-term stocking rates well below their recommended carrying capacity[11] to ensure feed reserve no matter what the season.[12]	More research is needed on the environmental and economic impacts of long-term stocking rate strategies.
Costs of production	Remote sensing of water points, trap yards at water points and laneways have been adopted by some pastoralists but most in the SR are not yet using this cost-saving technology. A combination of self-herding, remote sensing, trap yards and laneways could substantially reduce the cost of mustering via savings in labour, fuel, repairs and maintenance of vehicles and aerial mustering costs. A study at Cunyu station, north of Wiluna, demonstrated that a team of two people could muster, without aerial assistance, between 2000 and 3000 cattle with the aid of strategically placed trap yards.[13]	The benefits of remote sensing for water points, trap yards and laneways need to be extended. Demonstration sites for remote water monitoring system, trap yards and laneways are needed. DPIRD's 'Rangeland Revitalisation' program and the 'Bullseye 2 Livestock Productivity' project, could assist in promoting adoption.

Drought mitigation lever	What's worked?	What's needed?
Best practice livestock management	Surveys indicate reproductive rates are low (50 to 65%) across WA pastoral regions. This is partly due to the introduction of *Bos indicus* and *Bos indicus*-infused breeds, which are less fertile than *Bos taurus* breeds	SR pastoral businesses would benefit greatly if reproductive rates could be increased. Best Practice extension work is needed in: 1. Animal health – vaccination against vibriosis; vaccination against botulism. 2. Animal nutrition – use of 'haystack' paddocks to provide heifers and first calvers with a rising plane of nutrition; controlling mating to ensure females calve when rainfall is most likely – generally January to March; protein supplements in the dry and phosphorus supplements in the wet. 3. Animal reproduction – ensuring a secure 'bull proof' paddock for weaner heifers to reduce exposure until they reach an appropriate mating weight – 300kg for most *Bos taurus* breed types and 330kg for most *Bos indicus* and *Bos indicus*-infused types.
Cattle breeds	A Northern Territory trial with a tropically adapted *Bos taurus* bull breed over *Bos indicus* females demonstrated both reproductive and growth rates could be enhanced for hot and humid conditions. Tropically adapted *Bos taurus* breeds could be a better option for the SR in the face of climate change and evolving market preferences. The higher average temperatures predicted under climate change suggest the most appropriate cattle breeds for the SR are *Bos indicus* or *Bos indicus*-infused. These breeds currently dominate the SR, but a recent study indicates their 12-year average rate of natural increase is only 52%.[14]	Research is needed into: 1. Improving reproductive rates in *Bos indicus* and *Bos indicus*-infused herds. 2. The potential for tropically adapted *Bos taurus* breeds to raise reproductive rates and better meet target market specifications. 3. The potential for *Bos taurus* bull breeds to raise the reproductive performance of *Bos indicus* and *Bos indicus*-infused herds through higher pregnancy rates in the short term and higher reproductive rates in the medium to long term. 4. The performance of existing *Bos taurus* herds in the region – Shorthorn, Angus, Red Angus, Murray Grey, Hereford and Devon.
Professional development	There is an urgent need for skilled staff and managers in the SR.	3-month station skills course Secondary education curriculum Tertiary education course
Carbon farming	The annual income of some SR pastoralists has benefitted greatly from selling carbon credits through the Australian ACCU scheme.	Modelling work is needed to determine the best time for pastoralists to enter the carbon farming market and how to balance the benefits and risks of selling carbon credits vs retaining them to offset future emissions obligations.

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