The Influence of Natural Disasters on Beef Price in Australia

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Abstract. Beef holds significant importance for Australia, both in trade exports and domestic farming and sales, making beef prices a key concern for producers and consumers. However, as a country frequently affected by natural disasters, beef prices in Australia are often influenced by such events. This study analyzes the impact of natural disasters on monthly beef prices based on the event attribution method. Results show that wildfires, storms, extreme weather, and droughts caused price drops for BULLS, with droughts having the largest total impact (average CAR -15.5996%). Wildfire and storm effects disappeared after three months, but extreme weather and droughts had prolonged negative effects, with droughts even showing a growing downward trend. In contrast, floods had a positive impact on bull prices, and shorter floods led to earlier price increases. YEARLINGS showed similar trends to BULLS, but the effects of disasters were milder, and the impact of droughts on YEARLINGS decreased over time, in contrast to BULLS. Overall, droughts and floods had the most significant effects on cattle prices due to their direct impact on herd development, while the other three disasters had only minor effects.

Keywords: beef price; natural disaster; event attribution method; Australia

1 Introduction

Australia has an extensive land area, containing about 47,000 beef farms across each state. Livestock production uses approximately 43% of the land area, which contributes significantly to the economic status of Australia's beef production. The annual total revenue of meat and livestock production was AUD 81.7 billion from 2022 to 2023. At the same time, the value of beef exports in Australia was about AUD 11.5 billion, making it the second largest beef exporter in the world. This large-scale industry offers a vast number of job opportunities. Therefore, the monitoring of beef prices is very important for this industry.

However, Australia is a country that frequently experiences natural disasters, which have a significant impact on beef prices. The drought in 2017 led to a shortage of feed and an increase in its price, which also resulted in poorer beef quality and a drop in prices. A classic beef farm suffered during this period, with annual profits decreasing from a positive AUD 60,000 to a negative AUD 5,000, compared with a normal year

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before the drought. The wildfires in 2019, caused by long-term drought, further aggravated livestock losses. After that, a period of intense rainfall prompted livestock farmers to rebuild their herds, leading to a temporary decrease in the supply of beef and an increase in prices. Meanwhile, the Queensland flood caused approximately 600,000 livestock (91% of them cattle) to die or go missing, resulting in beef prices rising by 10% to 20% over 12 months.

Different natural disasters have different levels of impact on beef price changes. Therefore, this article researches the impact of different natural disasters on beef prices in Australia from 2000 to 2021. To clarify how natural disasters affect beef prices, the next section reviews relevant literature. Section 3 provides a detailed explanation of the event attribution method, including the analytical steps involved, the data sources used in this study, and basic descriptive statistics of the data; Section 4 analyzes the impact of disasters based on the calculated Abnormal Returns (AR) and Cumulative Abnormal Returns (CAR), and explores the underlying mechanisms behind these effects; Section 5 summarizes the main findings and conclusions drawn from the previous sections and offers relevant policy implications and recommendations.

2 Literature Review

Beef is one of the most important foods in the world, and there has been a long history of research to identify fluctuations in price. Norton (2005)[1] and Almadani et al. (2021)[2] studied the impact of global beef prices and found that price was affected by some "local impacts" such as drought and disease. Furthermore, Papadopoulos (1973)[3] noted that supply quantity, seasonal factors, and substitute meats affected beef prices in Australia. He also proposed that seasonal impacts were caused by natural disasters like drought, leading to feed shortages. Wu et al. (2024)[4] used a VAR model to demonstrate the impact of corn price on beef price and indicated that the impact of corn, as cattle feed, was 8%.

Guanghan and Cawdell-Smith (2025)[5] and Rasool et al. (2021)[6] studied the influence of natural disasters on livestock and showed that the impact was detrimental. Belasco et al. (2015)[7] analyzed the impact of weather on beef profit through weather index research, which showed that the worse the weather, the more significant the impact was. Cheng et al. (2022)[8] explained that climate change could directly affect livestock production by increasing heat stress, and indirectly by reducing the quantity and quality of forage and crop-based feed, as well as the availability of land and water resources. However, natural disasters in Australia include not only temperature changes but also frequent droughts and storms, which lead to increased retail food prices and aggravate price fluctuations (Quiggin, 2007)[9]. Different natural disasters have different impacts on the cattle industry. Cattle-farm households believe that they are most affected by floods (62.08%), followed by strong storms (57.83%), heavy rainfall (54.00%), thunderstorms (44.79%), drought (24.07%), and riverbank erosion (9.66%) (Amin et al., 2021)[10].

In the current study, the focus is on the impact of one type of natural disaster—drought—on beef, but other natural disasters experienced in Australia also have significant impacts on beef, leading to price fluctuations. At the same time, existing studies do not directly reflect the impact of natural disasters on prices, so this article will explore the influence of different natural disasters in Australia on local beef prices.

3 Methodology and Data

3.1 Method

Event Attribution Method is a research method used to assess the extent to which the occurrence probability of a specific event. In this study, the method begins by identifying the timing of the selected natural disaster. An ARMA model is then built using the actual return of beef observed prior to the event to estimate the expected return in the absence of the disaster.

$$R_t=\varphi_0+\varphi_1 R_{t-1}+\cdots\varphi_j R_{t-j}+\theta_1 a_{t-1}+\cdots\theta_k a_{t-k}+a_t \tag{1}$$

Where R_t denotes the return of beef price in month t. φ_j and θ_k are the coefficients of the autoregressive and moving average terms, respectively, where j and k denote the lag order. R_{t-j} is the return from j months before and a_{t-k}, a_t are the error terms. The model can be extended to include multiple lags depending on the data.

Finally, the event study approach used, as described by Chen et al. (2023)[11], shows that the abnormal returns (AR) are calculated as the difference between the actual post-disaster return $\hat{R}_{i,t}$ and the predicted value $R_{i,t}$ based on model (1).

$$AR_{i,t}=\hat{R}_{i,t}-R_{i,t} \tag{2}$$

Where i denotes the disaster number.

For disasters of the same type that occur multiple times, cumulative abnormal returns (CAR) are also computed, allowing to understand the overall impact of such disasters on price fluctuations.

$$CAR_i(t1,t2,t3)=\sum_{t=t1}^{t3} AR_{i,t} \tag{3}$$

Where $t1, t2, t3$ represent the month when the disaster occurs and the two consecutive months that follow, corresponding to the cumulative abnormal returns over these three months.

3.2 Data

The price data used in this study is sourced from Meat & Livestock Australia (MLA), which provides cattle price information that indicates beef prices. While MLA categorizes beef into several groups, only four types—BULLS, COWS, GROWN_STEERS, and YEARLINGS—have continuous and complete monthly price records from January

2000 to December 2021. Therefore, this study focuses on these four categories. All prices are measured in cents per kilogram of carcass weight (c/kg cwt).

This study focuses on natural disaster events including floods, wildfires, storms, extreme temperatures, and droughts. All data were collected from the EM-DAT database. For each type of disaster, the top five events with the highest total damage were selected as research subjects. However, since extreme temperatures and droughts only occurred three times between January 2000 and December 2021, the total number of natural disaster events analyzed was 24. Table 1 presents the statistical breakdown of event selection.

Table 1. Natural disaster events

	No.	start	end	Total Damage, Adjusted ('000 US$)	Magnitude
flood	1	2010/12/25	2011/2/4	10200717	911256Km2
	2	2019/1/27	2019/2/9	2383672	/
	3	2021/3/18	2021/3/19	2361421	/
	4	2007/6/8	2007/6/12	1910425	11380Km2
	5	2008/2/13	2008/2/26	1556749	44350Km2
wildfire	1	2019/9/1	2020/2	2383672	169967Km2
	2	2009/2/2	2009/2/14	1846358	3100Km2
	3	2003/1/8	2003/2/18	496909	30000Km2
	4	2013/10/18	2013/10/31	350537	/
	5	2015/11/25	2015/11/28	257114	/
storm	1	2011/2/2	2011/2/5	3386490	290Kph
	2	2017/3/27	2017/4/6	3356298	263Kph
	3	2013/1/23	2013/1/30	2615947	/
	4	2010/3/22	2010/3/22	1942328	120Kph
	5	2010/3/6	2010/3/10	1858487	100Kph
Extreme temperature	1	2009/1/27	2009/2/8	/	48.8°C
	2	2014/1/13	2014/1/18	/	52°C
	3	2018/12	2019/1	/	49.3°C
Drought	1	2002/4	2002/11	3387927	/
	2	2018/1	2018/8	1456122	/
	3	2006/10	2006/12	/	/

Table 2 presents key statistics on returns for four types of cattle. COWS experienced the highest average return (0.5514), while BULLS had the lowest (0.4805), with Yearling and Grown steer falling in between at 0.5092 and 0.4937 respectively. In terms of volatility, COWS also showed the greatest fluctuation with a standard deviation of 3.9371, followed by BULLS at 3.5878, whereas GROWN_STEER recorded the lowest variability (2.9998), indicating more stable price movements. Overall, while COWS showed the strongest price growth, this was accompanied by the highest level of risk, whereas Grown steer offered more consistent performance.

Table 2. Descriptive Statistics of Cattle Returns

	BULLS	COWS	GROWN_STEER	YEARLING
Mean	0.4805	0.5514	0.4937	0.5092
Median	0.3450	0.4700	0.5243	0.3416
Maximum	14.4060	17.4102	10.2406	21.4677
Minimum	-12.9076	-11.7609	-10.6493	-12.9274
Std. Dev	3.5878	3.9371	2.9998	3.2514

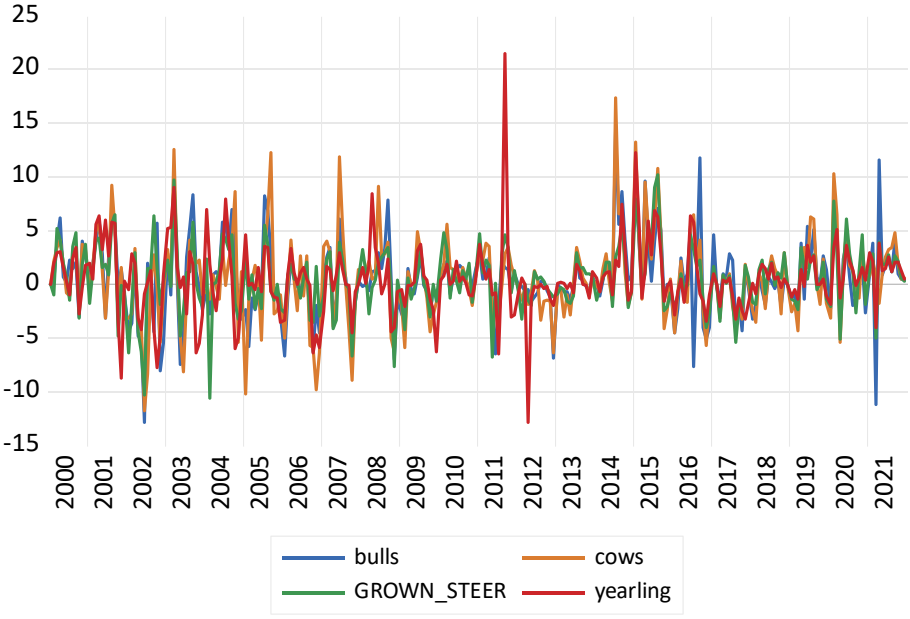

Fig. 1. Cattle Returns

According to Figure 1, BULLS exhibited pronounced peaks in returns in 2003, 2005, and 2008 and reached cycle lows at the end of 2016 and 2021 before swiftly rebounding; COWS likewise experienced significant rises in 2003, 2005, and 2007, recorded their largest surge in 2014 and then saw volatility gradually subside; GROWN_STEERS followed a relatively stable pattern, with only modest peaks in mid-2002 and late-2004; Yearling underwent its most dramatic spike in 2011 followed by a deep reversal in mid-2012, while its other fluctuations remained comparatively muted.

Figure 1 shows that the price volatility of BULLS, COWS, and GROWN_STEERS is similar. Therefore, a correlation analysis was conducted among the four categories. As shown in Table 3, the correlations between BULLS, COWS, and GROWN_STEERS are all above 0.6, indicating strong relationships. This suggests that subsequent research on these three categories would yield highly similar results. Among them, BULLS exhibit stronger correlations with both COWS and GROWN_STEERS, making BULLS a representative category for further analysis. YEARLINGS are studied separately.

Table 3. Correlation of Cattle Returns

	BULLS	COWS	GROWN_STEERS	YEARLING
BULLS	1.0000	/	/	/
GOWS	0.7302	1.0000	/	/
GROWN_STEERS	0.7207	0.6950	1.0000	/
YEARLING	0.4743	0.4954	0.5986	1.0000

Unit root tests are conducted on all variables and confirm their stationarity, thereby permitting the direct construction of ARMA models.

4 Empirical Analysis

Prior to model construction, disaster dates were classified based on their occurrence within the month, given that monthly price data were utilized. If a disaster took place before the 15th, the month was considered affected by the disaster and was therefore excluded from the ARMA model dataset. Conversely, if the disaster occurred after the 15th, the month was retained. Once the ARMA model was established, the study proceeded to forecast returns for three specific periods: the month when the disaster started (M0), and the following two months (M1 and M2). E1 to E5 represent events, ranked in descending order based on their total adjusted damage.

As show in Table 4, the abnormal returns for flood events vary significantly. For E1, E2, and E3, the returns show an upward trend, while for E3 and E5, they decline. This discrepancy is largely due to differences in the duration of the floods. Both E3 and E5 lasted fewer than five days, and interestingly, shorter events appear to have a greater immediate impact on prices, which are 14.8210% and 7.6307% more than usual respectively. In contrast, E2 and E3 lasted more than ten days, with E1 extending over a month. As a result, a more noticeable price effect is observed in the third month. Flooding often leads to the loss or death of cattle. After the disaster, farmers typically begin to rebuild their herds, which reduces the number of cattle available for sale or slaughter. This decline in supply pushes prices up. When the flood duration is short, herd rebuilding begins earlier, leading to a more timely increase in prices.

The impact of wildfires on bull prices was negative in the event month, indicating a price drop for bulls. Overall, prices rebounded by M2, suggesting that the effect of wildfires did not last long. This could be because wildfires mostly occur in forests, which have little impact on cattle farming areas. As for the outlier in Event E3, one possible reason is that the event happened early, in 2003, when there was a lack of proper equipment and disaster response experience. This may have led to public panic and stockpiling behavior, which in turn caused a rise in bull prices.

For storm events, the abnormal returns in the month of occurrence show no consistent positive or negative pattern and remain relatively small. This suggests that such disasters have minimal impact on BULLS prices. One possible explanation is that storms do not significantly affect cattle, and their duration is typically short.

In contrast, extreme weather events result in negative abnormal returns both in the month of occurrence and on a three-month average basis. This indicates that these disasters tend to drive down BULLS prices. Moreover, the abnormal returns for E1 (-2.7494) are significantly lower than those of the other two events (-0.3343, -0.8433 for E2, E3 respectively) indicating that monthly prices dropped more compared to usual. This may be due to the fact that E1 lasted for ten days, longer than the other two events. Although E3 does not have a specific start and end date, it spans two months, while E2 lasts only five days. Therefore, the longer the period of extreme heat, the greater its impact on prices. A likely reason is that high temperatures increase the cost of storing beef, prompting retailers to sell their inventory more quickly to maintain freshness.

Table 4. Abnormal returns of BULLS

		E1	E2	E3	E4	E5	mean
flood	M0	0.2048	-0.7359	14.8210	7.6307	-0.6102	4.2621
	M1	0.5752	-3.5992	-0.4586	2.1314	-0.1970	-0.3096
	M2	2.2533	3.4918	1.6459	-0.7988	1.0519	1.5288
wildfire	M0	-1.7004	-2.5277	4.8936	-0.5071	-0.7053	-0.1094
	M1	-0.5414	0.7753	0.8197	0.6097	-5.0846	-0.6843
	M2	1.8642	-0.7095	11.0131	-0.1784	-2.8032	1.8372
storm	M0	-0.6506	0.2194	-1.1712	-1.7858	1.1691	-0.4438
	M1	0.4206	0.3860	-1.4852	0.2397	-1.3582	-0.3594
	M2	2.3508	2.4069	-1.2356	1.2092	0.3205	1.0104
extreme weather	M0	-2.7494	-0.3343	-0.8433	/	/	-1.3090
	M1	1.0665	-1.1781	-1.6511	/	/	-0.5876
	M2	-1.0012	0.4539	-1.1317	/	/	-0.5596
Drought	M0	-8.0562	-2.8750	-5.2478	/	/	-5.3930
	M1	-6.9886	-2.4879	-1.6392	/	/	-3.7052
	M2	-15.5407	0.4332	-4.3966	/	/	-6.5014

Droughts, across all three events studied, consistently exhibit negative abnormal returns in the month they occur (-8.0562, -2.8750, -5.2478 for E1, E2, and E3 respectively). The absolute values of these returns are significantly larger compared to other types of disasters, indicating that droughts have a much stronger negative impact on BULLS prices. Furthermore, due to the prolonged nature of droughts, the abnormal returns in the following two months remain noticeably negative, showing no signs of returning to zero. E1, a drought event, recorded the highest total adjusted damage and was among the longest in duration, thus exerting the most pronounced effect on prices. This outcome can be attributed to feed shortages caused by the drought, which led to rising feed costs. To minimize losses, cattle farmers were likely to sell their BULLS earlier than planned. This increased the supply of beef on the market, ultimately driving prices down.

As shown in Figure 2, the average cumulative abnormal returns for wildfire, storm, and extreme weather events remain very close to the 0 line, indicating that these disasters have a limited impact on the overall price of BULLS. After M2, the average CAR for wildfire and storm turns positive, suggesting that after a three-month period, the

overall negative impact of the disaster has dissipated. In contrast, extreme weather events show a continued slight decline, which indicates that the impact of the disaster has not disappeared, but its effect is gradually diminishing. However, overall, the effects remain minimal.

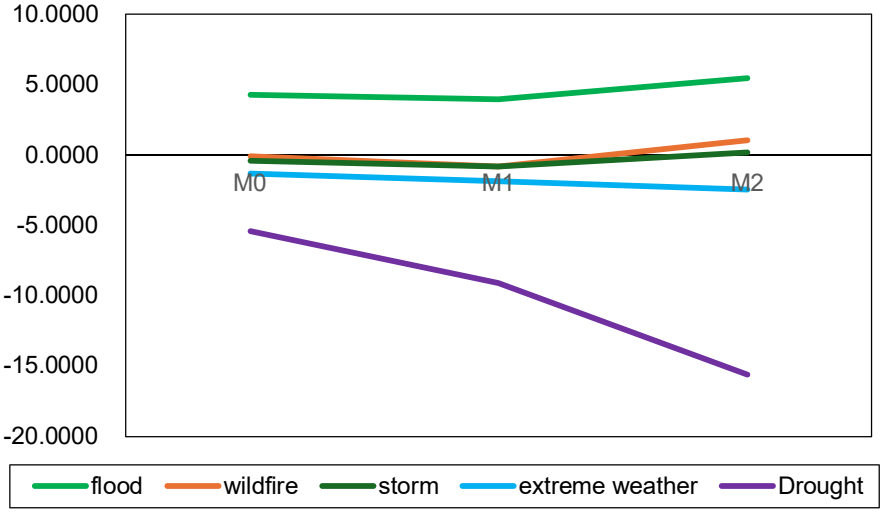

Fig. 2. Average CAR of BULLS for each disaster

Table 5. Abnormal returns of YEARLINGS

		E1	E2	E3	E4	E5	mean
flood	M0	3.2684	-0.3498	5.8869	2.2459	-0.8857	2.0331
	M1	1.5488	-1.5963	0.8499	1.2079	1.6195	0.7260
	M2	0.4970	1.0177	0.4426	0.0650	8.6264	2.1297
wildfire	M0	-1.0685	-1.9628	3.4982	-1.2183	0.0344	-0.1434
	M1	-0.2198	-0.1478	4.4574	1.1474	-3.0319	0.4411
	M2	0.2906	-0.1539	8.8521	0.5790	-0.7582	1.7619
storm	M0	-0.3915	1.0123	-0.3215	-0.8809	1.4689	0.1775
	M1	0.1972	-0.4339	-0.1484	0.2113	-0.0074	-0.0363
	M2	1.7467	-0.2597	-0.3921	2.3499	0.3500	0.7590
extreme weather	M0	-1.9628	-0.2478	-0.3241	/	/	-0.8449
	M1	-0.1478	-0.7866	-1.2286	/	/	-0.7210
	M2	-0.1539	0.7958	-0.4930	/	/	0.0496
Drought	M0	-4.8920	-0.1490	-6.5751	/	/	-3.8720
	M1	-5.8356	-1.7463	-5.3293	/	/	-4.3038
	M2	-2.4561	0.3358	-6.5825	/	/	-2.9009

Floods consistently show positive average cumulative abnormal returns, with a notably stable trend. This suggests that BULLS prices tend to be approximately 4% higher than normal as a result of flooding. The average CAR for droughts shows the greatest

slop, with a clear upward trend. This indicates that the cumulative price decline becomes increasingly significant over time. Both disasters also show a renewed impact in the later stages of the observation period, as indicated by the increasing absolute value of the slope.

The direction and trend of the impact of various natural disasters on YEARLINGS are generally similar to those observed for BULLS, as show in Table 5. However, when comparing the average abnormal returns of the two types of cattle, the absolute values for YEARLINGS are smaller than those for BULLS. This suggests that natural disasters have a less pronounced effect on YEARLINGS.

In the case of droughts, when cattle farmers are forced to sell their cattle earlier than planned, they tend to prioritize selling older BULLS over younger YEARLINGS. YEARLINGS have a longer growth cycle, which ensures a future supply of cattle for sale. Similarly, after flooding, BULLS are more critical for herd reconstruction, leading to a more significant reduction in their sale. This results in a greater change in supply for BULLS, amplifying the price effect.

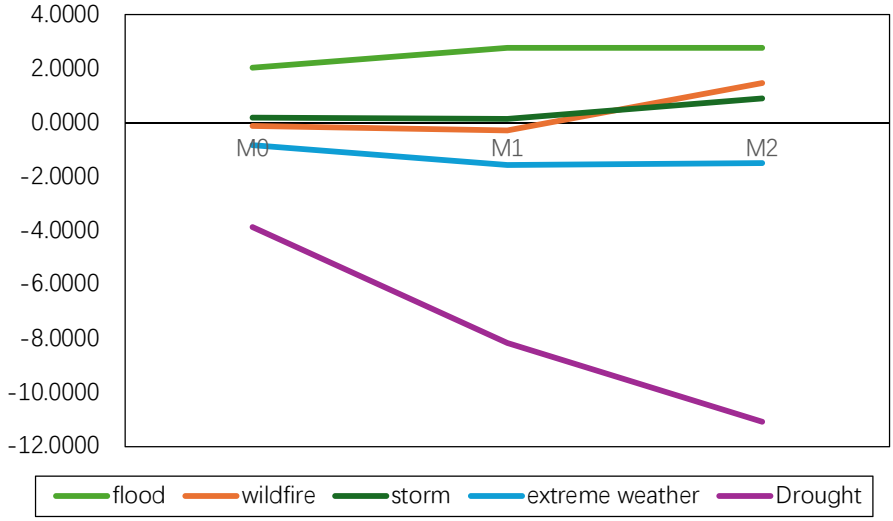

Fig. 3. Average CAR of YEARLINGS for each disaster

Figure 3 show that the average CAR of wildfire, storm and extreme weather for yearling closing to 0 line and their trend are same like that for BULLS. The flood and drought change more in M1 than in M2 (the slop from M0 to M1 bigger than that between M1 and M2), that is different form average CAR for BULLS which change more in M2 than in M1. This indicates that the impact of the disaster on YEARLINGS is diminishing, which is a key difference compared to BULLS. At the same time the absolute value of average CAR for yearling smaller than that for BULLS. Therefore, this mean that the total price return change by disaster for yearling (11.0767% less than usual) smaller than that for BULLS (15.5996% less than usual).

5 Conclusion

Natural disasters have similar effects on both bulls and yearlings. Floods generally lead to price increases, especially after the disaster ends. This is mainly because farmers begin to rebuild their herds, and the supply of bulls drops more significantly than that of yearlings, causing a sharper rise in bull prices. In contrast, wildfires, storms, and droughts tend to push prices below normal levels. However, the impact of wildfires and storms is relatively mild, with average CARs (Cumulative Abnormal Returns) staying close to zero. In the case of wildfires, the CAR even turns positive after three months, suggesting that the negative impact disappears over time. Droughts, however, have the most severe and lasting effects. They cause the largest price declines for both bulls and yearlings and due to the long duration of drought events, their influence persists beyond three months. Bulls are more strongly affected by droughts, and the effects last longer compared to yearlings.

For the two most impactful disasters—floods and droughts—both farmers and traders need to make preparations in advance. Floods often lead to cattle loss or death, which results in farmers reducing cattle sales after the disaster to ensure herd recovery. Therefore, traders are advised to stock frozen beef in advance to help ease market shortages. Farmers, on the other hand, should consider purchasing livestock insurance to cover post-disaster recovery costs. When it comes to droughts, which have the most severe impact, the main issue for farmers is the rising cost of feed. It is recommended that they sign futures contracts ahead of time to stabilize feed prices. Additionally, from a technical perspective, research into alternative feed sources—such as more drought-resistant plants—can offer long-term solutions to cope with feed shortages.

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