The potential of feeding young cattle with irrigated crops to manage supply chain challenges in north Australian beef enterprises

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Abstract

The northern Western Australian (WA) beef industry is characterised by a reduction in dry-season forage quality leading to weight loss in livestock and reduced market readiness. A potential solution is the use of irrigated forage to provide a reliable source of energy and protein to finish cattle before sale. The feasibility of this feeding strategy was simulated using the Crop Livestock Enterprise Model (CLEM) and compared with the baseline of the usual practice of grazing on dry native pasture. Calving occurs during the wet season and weaning and mustering during the dry season, with a finishing scenario for castrated males (steers) based on feeding irrigated forage during the dry season. The CLEM results showed an improvement in livestock productivity under this scenario, with higher live weight (LW) at sale due to faster weight gain while fed the irrigated forage. Furthermore, selling a higher proportion of animals at an earlier age, could potentially reduce methane emissions (and thereby create a more sustainable system) or there is the possibility of diversifying the market to include animals with higher LW but at an older age. Overall, integrating cattle production with irrigated pasture/forage, presents a significant opportunity to enhance the efficiency of beef production.

Introduction

Despite its economic importance, the beef industry of northern Western Australia (WA) experiences some challenges such as limited market opportunities and relies heavily on live exports (Chilcott et al. 2018). The climate is one of distinct wet-dry (tropical) conditions with a reduction in forage quality during the dry season resulting in weight loss in cattle. This results in animals failing to reach the target sale weight for market, such as the live weight (LW) of approximately 350 kg for two-year-old steers intended for live export for some markets like Indonesia (MacLeod et al. 2018), and as a result they might be sold at a lower price. One potential solution is to put cattle onto high-quality pastures as an improved source of energy and protein to enhance weight gain (Webster et al. 2024). Feeding products from irrigated crops and forages, such as sorghum silage and cotton seed and direct grazing of irrigated pasture, can be a valuable source of energy and protein offering opportunities to target broader markets, implement effective herd management strategies, provide a reliable feed source during dry seasons when pasture availability is limited, and diversify the business through fodder sales (Moore et al. 2021).

The economic benefit of integrating irrigated crops and forages into the beef cattle enterprises through increasing total carrying capacity and increasing the weight at sale has been reported (MacLeod et al. 2020). This study aimed to evaluate the effective utilization of irrigated forages in a beef finishing system to increase the proportion of animals that meet market specifications, and thereby to maximize productivity. The inclusion of irrigated pasture in the feedbase was assessed against a standard native pasture base scenario, focusing specifically on castrated male animals.

Methods

Scenarios

In this study, two scenarios were considered: 1) The baseline scenario where the herd grazed only native pastures, and 2) An irrigated feed scenario in which weaned calves were moved to irrigated pasture during May in the dry season. For both scenarios calving occurred during the wet season (November to April), weaning at 5 months (twice a year, May, September), with phosphorus supplement during the wet season. In the baseline scenario, animals received a urea supplement during the dry season, and hay was provided during the first two months after the May weaning (June and July).

CLEM modelling

The case study farm with each feeding scenario was simulated with the Crop Livestock Enterprise Model (CLEM, Version 2023.3.7172.0, Liedloff et al. 2024); integrated with the APSIM Next Generation (APSIMNG; Holzworth et al. 2018) framework. The simulation was set up to represent a small property, on clay soils, with approximately 2,250 breeders and with bulls included at 4% of breeding herd numbers. Feed resources were described in separate input files for native pasture (modelled with GRASP; McKeon et al. 2000) and irrigated pasture/forage (modelled with APSIM; Holzworth et al. 2014). The productivity of individual animals was simulated in CLEM in response to feed quantity and quality. Herd management activities were implemented to represent the farm for each scenario. Mating was enabled from January to May with conception based on breeder condition. Breeders of 10 years were culled each May, and bulls purchased as needed in April. Individuals who meet the LW criteria for sale were sold in either May or September. All simulations were run over a period of 12 years (from June 2010 to June 2022).

Descriptive analysis

The biophysical outputs of each scenario were reported by CLEM and summarised using the R environment. For each resource (e.g. weight gain or average quantity of beef sold), descriptive statistics were then calculated, and metrics such as growth rate of individuals were plotted using the “ggplot2” package.

Results

Based on our CLEM simulation results, livestock productivity was higher in the irrigated pasture scenario compared to the baseline (Table 1). In addition to the increased quantity of beef sold (kg LW), a higher percentage of castrated animals reached the sale weight at an earlier age (before 12 months) under the irrigated pasture scenario compared to the baseline (94.6% vs. 83.7%) (Table 1).

Table 1. The difference in steer sales and weight gain between CLEM simulations using only native pasture and feeding with irrigated forages for a representative northern Australia property.

Biophysical parameters	Simulation	
	Native pasture	Irrigated forage
Average annual castrated beef sold (kg LW)[1]	136,229	156,950
Average weight (kg LW) of castrated males, age 7-11 mo., September sale	242.0 ± 27.2 (n=5045)	278.0 ± 34.8 (n=5749)
Percentage of castrated males, age 7-11 mo. sold, September sale	83.7	94.6
Average weight (kg LW) of castrated males, age 15-20 mo., September sale	263.0 ± 11.7 (n=212)	318.0 ± 14.0 (n=101)
Average monthly weight gain of castrated males, age 5-10 mo. (kg LW)[2]	14.03	22.02
Average monthly weight gain of castrated males, age 15-20 mo. (kg LW)[2]	1.7	14.7

1. LW= Live weight.
2. These calculations were based on a weighted average due to the unequal number of animals per month. The calculation did not consider the weight gain during the final month, which was the time of sale.

As expected, the average monthly weight gain (Table 1) and average weight (Figure 1) increased when feeding growing males with high-quality pasture forage, with better performance for castrated animals at older ages (Figure 1B). This resulted in achieving the LW target for live export to a much greater extent under the irrigated pasture scenario compared to the baseline.

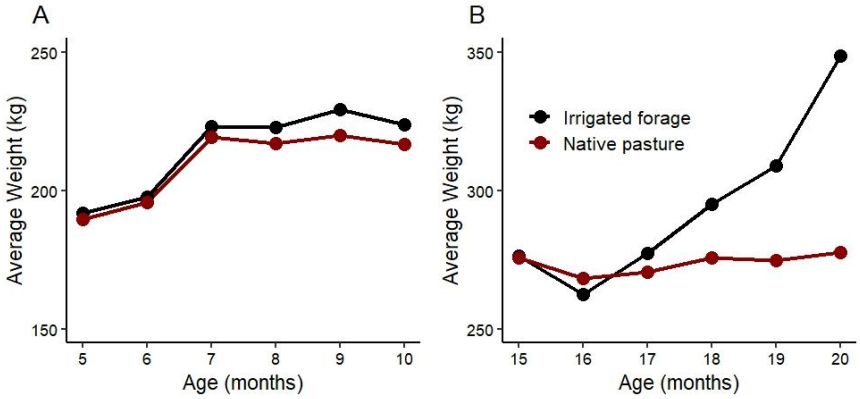

Figure 1. Difference in average liveweights (kg) for castrated animals between the native pasture and irrigated pasture/forage scenarios, A) immediately after weaning (ages 5–10 months) and B) the following year (ages 15–20 months). Note: A maximum gain of 0.83 kg/day (A) was observed at the start of the dry season (May-June) when native pasture quality remained good, and urea (throughout the dry season) and hay supplementation (June-July) were provided. This growth rate was expected, as the weaned castrate calves were in their active growth phase and had been weaned at a heavy weight. A similar trend of liveweight gain (with seasonal effects) for heifers (e.g., Fordyce and Chandra 2019) and weaners (Tyler et al. 2012) has been reported in northern Australia.

Conclusion

The use of irrigated forage was shown to increase the productivity of northern cattle herds through an increase in the average weight of animals at sale, consistent with previous studies (MacLeod et al. 2018; Monjardino et al. 2015; Webster et al. 2024). Our results also indicated that there is a potential opportunity to finish steers with alternate quality feed sources and sell a portion of them at an early age or hold them to achieve heavier weights at sale. Additionally, due to the differing rates of weight gain in 1-year-old and 2-year-old steers (Figure 1), the time of introducing animals to irrigated pastures is crucial for optimizing the use of this feed resource. For instance, selling stock at an earlier age could lead to a reduction in the enteric methane emissions of the herd, contributing to a more sustainable livestock system. On the other hand, achieving heavier weights provides opportunities for market diversification and helps meet the target LW for live export (MacLeod et al. 2018). However, a comprehensive assessment of the whole beef cattle enterprise is necessary that will consider factors such as market demand and the logistics of transporting animals for live export, including associated costs for trucking (i.e. larger animals will require more space for transport).

Overall, recommendations should be made with caution, as these results need to be economically evaluated to determine the net profit of using irrigated forage, especially considering the high capital costs associated with irrigation developments. Additionally, this study focused on castrated males (steers) over a short period, but the findings could be extended to other categories of livestock or different age groups and timeframes. Other factors, such as the size of irrigated land exploited and incorporating the animals into a feedlot system as well as considering other selling rules such as out of season to support the supply chain when there is a shortage, could also be evaluated using the CLEM framework. The next phase of this project will economically evaluate the findings of this study, as well as explore additional production scenarios that could contribute to the profitability and sustainability of the beef cattle industry in northern WA.

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