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Factsheet

Cattle Feedlot Evaporation Rates

Policy Position

The evaporation rate from beef cattle feedlot pads and ponds is equal to pan evaporation. This is a conservative position with evidence suggesting evaporation rates from pugged manure and wastewater effluent ponds is equal to or greater than pan evaporation.

Previous Assumptions

According to the MLA guidelines on feedlot effluent holding pond design, the evaporation factor considered in calculating pond sizing is between 0.7- 0.8 (as a coefficient) (Watts et al. 2016). It was therefore the assumption that wastewater in holding ponds evaporates at a slower rate than pan evaporation.

Context

Evaporation is a key design consideration for beef cattle feedlots as it effects the rainfall runoff from a catchment (feedlot pad) and water containment infrastructure (feedlot ponds) size. Predicting catchment runoff volumes and evaporative losses are the biggest factors in designing beef cattle feedlots in Western Australia (WA).

Definitions

Pan Evaporation – Often referred to as ‘Class A Pan’, is a standardised method of measuring evaporation. This is the reading presented by weather station data, and is generally higher than dam evaporation due to the measurement method.

Clear Water Evaporation - also known as ‘Dam Evaporation’ is the evaporation of natural, or relatively clear waters from dams and ponds.

Wastewater Evaporation – the evaporation of wastewater from a pond.

Policy Rationale

Factors effecting manure and wastewater evaporation were found to be the same across the studies carried out. Therefore, both evaporation rates from cattle feedlot pads and ponds are addressed simultaneously.

- The **colour** of water increases the rate of evaporation due to the typically dark brownish colour from the presence of bacteria, which absorbs more incoming solar radiation and promotes evaporation (Cluett et al. 2020; Izady et al., 2016; Parker et al., 1999). Research by Cluett et al. (2020), which looked at surface covers affecting evaporation rates of manure, showed that dyed black water had higher solar radiation and cumulative evaporation levels than clear water by up to 25.5%.

  This is due to clear water having a higher albedo level to dyed water (0.17 and 0.13 respectively). This lower albedo increases longwave radiation and solar radiation, which contributes to the higher evaporation level (Cluett et al. 2020). In Izady et al.'s study (2016) which looked at modelling wastewater evaporation in anaerobic lagoons, the dark brown colour of wastewater (due to non-biodegradable solid materials floating on the surface) had the highest evaporation rates compared to clear water class A pan evaporation measurements.

- A higher proportion of **solid** content and **opacity** can increase shortwave radiation at the surface, increasing the evaporation rate due its higher energy level (Cluett et al. 2020). Feedlot effluent with suspended sediment was tested under varying conditions, including varied plywood colour backgrounds; evaporation rates were recorded for white plywood and dark plywood backgrounds of 8.3% and 10.7% higher than clear water, respectively.

  In comparison, clearer effluent that was a week old with a lower amount of sediment had evaporation rates between 3.2% and 0% higher than clear water (Parker et al. 1999). These studies provide evidence that the presence of sediment can increase the evaporation rate of water.

- The **salinity** of the wastewater could reduce the rate of evaporation due to a decrease in vapour pressure of the solution (Izady et al. 2016; Parker et al. 1999). In Parker et al.'s (1999) experiment, salinity impacts to evaporation were shown to be minimal, with a 1.8% difference in evaporation between the lowest and highest salinity (0.6 to 11.4 mS/cm respectively). The study also notes that water temperature, an evaporation factor, was not significantly affected by salinity differences.

- **Crusting** is a significant factor, and may reduce evaporation rates below pan evaporation (Cluett et al. 2020; Aguerre et al; Sutitarnnontr et al. 2014). In Cluett et al.'s study (2020), all treatments with a cover were statistically lower in terms of cumulative evaporation in comparison to water, dyed water and manure treatments. In cattle feedlots, fresh manure is consistently deposited on the pen surface and physically broken down by cattle hooves – for this reason, crust formation is assumed to be low and is not considered in manure evaporation. Crusting in cattle feedlot ponds is rarely seen due to the low Fat, Oil and Grease (FOG) content of the wastewater, therefore not considered as a factor in pond evaporation.

Although the factors were not outlined, experiments by Lott (1997) measured feedlot manure weight loss over time could be up to three times higher than pan evaporation.

Modelling wastewater evaporation by Izady et al. (2016) concluded on a simplified evaporation factor of 1.292, meaning that wastewater is expected to evaporate at an additional rate of 29% of clear water, or dam evaporation. Additional research by Cluett et al. (2020), Parker et al. has shown similar relationships, but few go as far as to estimate coefficients.

The vast majority of Western Australia's (WA) feedlots are located in the South-West (SW) (Watts et al., 2016), where Class A Pan: Dam evaporation factors reported by Luke et al. (1987) range from 0.75 to 0.97.

Multiplying the dam coefficients for clear water with findings by Izady et al. (year) we can estimate a more accurate evaporation rate for the SW vs Class A pan evaporation. This ratio is between 0.969 and 1.25. Therefore, in the absence of location specific data and modelling, Class A pan evaporation is a conservative estimate for evaporation from feedlot pads and wastewater ponds.

References

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