**The relationship between water efficiency feed efficiency and growth traits in beef cattle: a genetic analysis**

**Application:** Estimating genetic parameters to assess the relationship between water efficiency and production traits in beef cattle is of paramount importance for implementing genetic selection as a sustainable strategy to enhance water usage efficiency while minimising any potential negative impacts on production traits.

**Introduction:** Water is a vital resource for sustaining life, and concerns about quality, scarcity and accessibility pose serious challenges in many regions (United Nations World Water Development Report, 2023). The beef industry faces increasing demands to adopt production practises that minimise water usage while enhancing animal growth and feed efficiency (Pereira et al., 2021). The objective of this study was to estimate the genetic parameters of traits associated with water intake, water efficiency, feed efficiency and growth in beef cattle.

**Materials and methods:** The data was collected from a group of 1249 seedstock bulls and heifers from six different breeds: Angus, Charolais, Hereford, Limousin, Simmental, and Sim-Angus. They were housed in a facility equipped with Vytelle SENSE® systems to measure their feed intake, water intake and in-pen body weight, located at the West Virginia University central testing centre in Wardensville, WV, USA. The animals were part of nine performance trials conducted between November 2019 and September 2023 and were sourced from 45 different consignors, each contributing a varying number of animals to the trial. The trials were conducted either in the Summer (June to September) or in the Winter (November to February). Of the total animals tested, 624 were tested in summer and 625 in winter. The average age of the animals at the start of the test was 287 days (± 21), and on average the trials lasted for 62 days in summer and 82 days in winter. The rations were formulated to achieve 1.5-1.6 kg/day of average daily gain and had a high forage inclusion (>75% corn silage and >15% dry hay, as fed). The facility consists of 5 pens and the animals were rotated through the pens every two weeks so that all animals were exposed to all pens.

This study examined the following phenotypes: Average daily water intake (DWI), Residual water intake (RWI), which is the deviation of the actual daily water intake from the expected value, Average daily dry matter intake (DMI), Residual feed intake (RFI), which is the deviation of the actual daily dry matter intake from the expected value, and Average daily gain (ADG). The traits RWI and RFI were used to measure the water and feed efficiency of the animals. The genetic parameters were estimated with multi-trait animal models using Echidna mixed model software (Gilmour, 2021). In all models, breed, sex, season, and the contemporary group (trial number and pen group) were included as fixed effects, the age at the start of the test was added as a covariate, and the consignor and animal were included as random effects. RWI and RFI were analysed by adding ADG and metabolic mid-weight as additional covariates.

**Results:** The genetic parameters for water efficiency, feed efficiency and growth are presented in Table 1. The heritability of DWI, RWI, ADG and DMI were moderate (0.28 to 0.51), while RFI showed low heritability (0.14) in this population. Average daily water intake exhibited a positive genetic correlation with RWI (0.92), DMI (0.44) and ADG (0.64). On the other hand, the genetic correlations of RWI with DMI and RFI were not significantly different from zero.

**Table 1.** Estimates of heritability (on the diagonal), genetic correlation (above the diagonal) and phenotypic correlation (below the diagonal) for water efficiency, feed efficiency and growth traits in beef cattle. SE in parenthesis.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Trait | DWI | RWI | DMI | RFI | ADG |
| DWI | **0.51 (0.09)** | 0.92 (0.02) | 0.44 (0.13) | -0.13 (0.24) | 0.64 (0.15) |
| RWI | 0.92 (0.01) | **0.45 (0.08)** | 0.15 (0.16) | -0.12 (0.24) | 0.36 (0.18) |
| DMI | 0.33 (0.03) | 0.07 (0.03) | **0.37 (0.09)** | 0.57 (0.18) | 0.86 (0.11) |
| RFI | 0.08 (0.03) | 0.09 (0.03) | 0.72 (0.01) | **0.14 (0.07)** | 0.51 (0.27) |
| ADG | 0.22 (0.03) | -0.01 (0.03) | 0.54 (0.02) | 0.01 (0.03) | **0.28 (0.09)** |

DWI = Average daily water intake; RWI = Residual water intake; DMI= Average daily dry matter intake; RFI = Residual feed intake; ADG = Average daily gain

**Conclusion:** The results suggest that the traits associated with water intake and efficiency in beef cattle have a sizable genetic component and show potential for genetic improvement. Selecting for enhanced water efficiency in beef cattle can effectively decrease the daily water consumption without any adverse effect on feed efficiency.

**References:**

Gilmour, A.R. (2021). Echidna Mixed Model Available at: Software www.EchidnaMMS.org

Pereira, G.M., Egito, A.A., Gomes, R.C., Ribas, M.N., Torres Junior, R.A.A., Fernandes Junior, J.A., & Menezes, G.R.O. (2021). *Animal*. 15 (3) 100142

United Nations (2023). The United Nations World Water Development Report 2023: Partnerships and Cooperation for Water. UNESCO, Paris 1:11-18