American Angus Association®
Functional Longevity (FL) Research Report
Updated October 25, 2023

Background

Profitability and sustainability of beef cattle production depend on many factors and cow longevity is certainly one of them. Angus breeders have ranked cow longevity as a priority, along with associated research and the development of new tools and programs, within the American Angus Association.

With that in mind, Angus Genetics Inc. (AGI®) set their sights on additional research around the topic starting in 2018. This was not the first time that research around the topic had commenced. In fact, about 8 years prior, similar research had been conducted. At that time, however, more whole herd data was needed to support this evaluation. Therefore in 2012, the MaternalPlus® program, now included within the AHIR® Inventory Reporting program, was created to capture when females were successful in the calving season; and if they weren't, when and why they left the herd.

Since then, a lot of research has been done both internally and in collaboration with universities, such as the University of Guelph, Purdue University, and the University of Georgia. Recent efforts focused on data exploration and trait definition.

Several trait definitions and statistical models have been proposed in scientific literature and utilized to evaluate maternal function in both beef and dairy cattle. A few examples are traditional longevity (TL), functional longevity (FL), productive life (PL), stayability (STAY), survival models (SM), etc.

After researching different models, the **functional longevity** definition made the most sense to accommodate the data reported by Angus breeders within the Association's database and for its alignment with selection goals.

Despite modeling differences, the selection objective is often the same: to select sires that will produce daughters that remain in the herd and produce a calf every year. With that in mind, the word functional in the name of this trait is not without reason. Being functional means staying in herd and producing a calf every year. This contrasts with early stayability models where cows were only assessed as to whether they survived in the herd to a certain age.

Our research also explored the dam production data provided by breeders in the form of disposal codes, which allows separating active versus culled females in the database and provides insight as to why those cows are leaving the herd. From those data, there is variability for the reasons why females leave the herd. When available, disposal codes will be leveraged in the FL research evaluation.

Additionally, several analyses were conducted to determine the optimal window of data to be included in the evaluation. The initial research started by including cows with data reported from 2 to 15 years of age. However, for the purpose of estimating variance components, heritability estimates, and predicting the FL expected progeny difference (EPD) to rank sires, data from cows that are between 2 to 10 years of age was optimal, and only data up to 10 years of age is used for the genetic evaluation of FL. The FL evaluation includes records from cows born after 1990 and it also includes data from the Canadian Angus Association, bringing additional phenotypic data to predict the research EPDs.

Breeders are still encouraged to record and submit breeding, calving and culling records on all cows for as long as they stay in the herd, as this data is valuable for management and studying maternal characteristics.

If you want more technical details about the initial development of the functional longevity trait, two peer-reviewed papers have been published by Oliveira et al., 2020 and Oliveira et al., 2021.

Functional longevity research EPD

The research FL EPD predicts on average, the number of calves a sires' daughter is expected to produce by 6 years of age compared with other sires' daughters in the population.

The unit of the trait is number of calves produced by 6 years of age, with a higher EPD meaning that on average, sires' daughters are predicted to produce more calves by 6 years of age, compared with a lower EPD.

As an example, if sire A has a FL EPD of 1.5 and sire B has a FL EPD of 0.5, on average, the daughters of sire A are expected to produce one more calf by age 6 compared with the daughters of sire B.

	FL EPD
Sire A	1.5
Sire B	0.5
Difference	**1.0**

The breed average for the FL EPD is 1.01, ranging from 0.39 to 1.48, with a standard deviation of 0.08. Because functional longevity is both a new EPD and a lowly heritable trait, the initial spread in the EPD is not wide, but breeders will still be able to make selection decisions and achieve genetic gain over time.

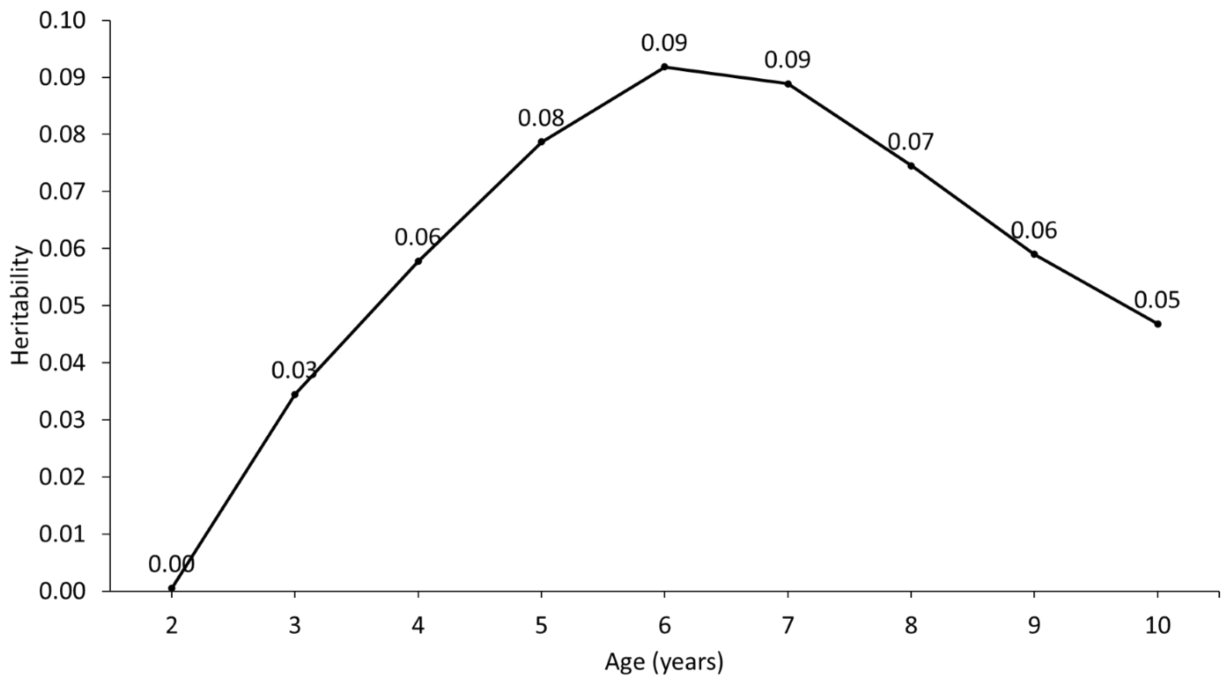
In addition, an investigation of sires born up to 2010 with at least 10 daughters showed that daughters of sires in the top 1 percentile produced on average 1.3 more calves in their lifetime compared with daughters of sires in the bottom 99 percentile. These results need to be interpreted with caution as there are many non-genetic factors that impact the actual number of calves a female will produce in her lifetime, but they demonstrate nonetheless that the FL EPD is appropriately ranking sires.

Heritability and genetic correlation across ages

The FL evaluation implements a random regression model, which allows the creation of the heritability estimates and variance components across time. Figure 1 shows the heritability trajectory for FL from ages 2 to 10.

From Figure 1, there are at least two notes to make. First, the heritability is close to 0 at ages 2 and 3. This is because the variability is very small at this stage. All females must calve at 2 years of age to enter the evaluation; therefore, all females have the same number of calves (n=1) recorded as she enters the evaluation. Second, there is a clear pattern in the trajectory as heritability increases until age 6, then plateaus until age 7, and finally levels off from years 8 to 10. This demonstrates the maximum amount of genetic variation in the trait is captured by year 6, and therefore supports predicting the FL research EPD at year 6, with a heritability of 0.09.

Figure 1: Functional longevity heritability trajectory across ages.



Another feature of the random regression model is the ability to calculate the genetic correlation across ages. Table 1 shows the heritabilities (diagonals) and genetic correlations (off-diagonals) across ages for FL.

Table 1: Heritabilities and genetic correlations across ages.

Age	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
3	**0.03**	0.99	0.97	0.94	0.9	0.84	0.79	0.73
4		**0.06**	0.99	0.97	0.94	0.91	0.86	0.81
5			**0.08**	0.99	0.98	0.95	0.91	0.87
6				**0.09**	0.99	0.98	0.95	0.92
7					**0.09**	0.99	0.98	0.96
8		*symmetric*				**0.07**	≥0.99	0.98
9							**0.06**	≥0.99
10								**0.05**

*Correlations to age 2 were ignored because the genetic variance and heritability are close to 0.

The genetic correlations in Table 1 indicate that while there would be some reranking between EPD predicted at ages 3-5, for ages 6 and older the correlations are ≥0.92 and the sire reranking is minimal.

The random regression model allows us to utilize all the records, and then predict the EPD at both a time point when heritability is maximized and a point that aligns with production objectives and selection goals.

The results in Figure 1 and Table 1 help us understand that within the Angus population, using the data from cows up to 10 years of age, the heritability is maximized at age 6, and genetic correlations are high across the ages greater than 6 years, which makes it the optimal point to predict the EPD.

Conclusion

The current research completed by AGI® in collaboration with universities supports the release of a research EPD for functional longevity predicted at 6 years of age, with a heritability of 0.09. While the current FL research EPD is a good tool to help Angus breeders start to understand how sires rank for this important trait, data recording and participation in Inventory Reporting are of the utmost importance to allow further research. Ideally, in the future the functional longevity model be able to leverage only data inside of Inventory Reporting, which will continue to add accuracy to this new evaluation.

It is also imperative to understand that the Association will take the next several months to hear feedback from the membership and industry to continue to make this tool the best it can be. Members involved in Inventory Reporting who have access to the FL research EPD on their females, as well as all members with access to the sire list are encouraged to submit feedback.

Producers wanting to see the FL research EPD on females in their herd need to enroll in Inventory Reporting. The next enrollment period is open from November 1 to January 15 and is best suited for primarily spring calving herds. Primarily fall calving herds should enroll May 1 to July 15.

Together, we may find details that need to be critiqued, and updates to the research FL EPD may be warranted between now and when this trait moves into the final production stage. Currently, the final production stage is slated for June 2024 during the annual updates to the genetic evaluation.

Oliveira, H.R.; Brito, L.F.; Miller, S.P.; Schenkel, F.S. Using Random Regression Models to Genetically Evaluate Functional Longevity Traits in North American Angus Cattle. Animals 2020, 10, 2410. https://doi.org/10.3390/ani10122410

Oliveira, H.R.; Miller, S.P.; Brito, L.F.; Schenkel, F.S. Impact of Censored or Penalized Data in the Genetic Evaluation of Two Longevity Indicator Traits Using Random Regression Models in North American Angus Cattle. Animals 2021, 11, 800. https://doi.org/10.3390/ani11030800