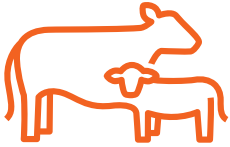


TECHNICAL BULLETIN

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INHERIT SELECT™ FOR COMMERCIAL FEMALES TECHNICAL BULLETIN

Validation of GEPD for Carcass Traits and the Zoetis Feedlot | Carcass Index

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PRODUCT & STUDY SUMMARY

KEY POINTS

Product Overview

- INHERIT Select™ is a test and genetic evaluation for commercial crossbred animals that provides Genomic Expected Progeny Differences (GEPD) and Percentile Rankings for sixteen traits and three economic indexes, as well as parentage and genomic approximations of breed composition, to collectively enable more informed selection, breeding, marketing and management decisions.
- INHERIT Select is intended for use in crossbred Bos Taurus animals comprised of the following breeds: Angus, Red Angus, South Devon, Hereford, Simmental, Gelbvieh, Limousin and Charolais.

Study Outcomes

- This study substantiates the efficacy of individual carcass trait GEPD and the Zoetis Feedlot | Carcass (ZFC) index reported as features of INHERIT Select, in predicting associated carcass measures and value.
- Animals in the top GEPD quartile for all three individual carcass traits (FAT, REA, IMF) expressed significantly ($P < .05$) more desirable carcass performance than animals in the bottom GEPD quartile group, and all groups ranked as predicted.
- The top quartile ZFC genetic group produced the most valuable carcasses that earned the highest price per CWT, were the heaviest and of the highest marbling score as compared to the other groups ($P < .05$). In contrast, the bottom quartile ZFC genetic group produced the least valuable carcasses (\$100 less than the top quartile group), primarily due to significantly ($P < .05$) lighter carcass weight and slightly lower marbling score.
- Results support the efficacy of predictions for individual carcass traits and the ZFC index for breeding and feeder cattle, to effectively inform decisions related to selection, mating, retained ownership, price discovery, method of fed cattle marketing, sorting strategy, and perhaps other management considerations.

INTRODUCTION

The INHERIT Select genomic test and genetic evaluation were created to enable commercial cow-calf producer access to genetic information that historically was only available to seedstock breeders. Such access has wide-ranging potential benefits, from more informed replacement heifer selection and breeding decisions for enhanced net returns, to more effective bull-buying through greater understanding of the strengths and weaknesses of the cow inventory, to more informed price discovery, marketing and management of feeder and fed cattle throughout the beef supply-chain. However, these possible benefits depend upon the magnitude of efficacy, or the ability of genetic predictions to yield intended expressed productivity.

Genomic Expected Progeny Differences (GEPD) reported through the INHERIT Select genetic evaluation are computed exclusively from genotypes of tested animals and the genomic connectedness to seedstock animals in the evaluation that possess pedigree and phenotypic performance information. As a somewhat new form of genetic prediction, and in order to formulate dependable value propositions from adoption of INHERIT Select testing, it is important to document the efficacy of GEPD and economic selection indexes derived therefrom. Hence, this study focused on understanding relationships between INHERIT Select carcass trait and index predictions from tested crossbred commercial animals - derived using ultrasound scan phenotypes from genetically related seedstock - and their expressed carcass trait and economic performance.

MATERIALS AND METHODS

INHERIT Select predictions for Carcass Weight (CW), Fat Thickness (FAT), Ribeye Area (REA) and percent Intramuscular Fat (IMF), as well as the ZFC index, were derived for 671 animals (213 heifers and 458 steers) from 18 different contemporary groups (CG) fed at Lincoln County Feedyard LLC, located near Stapleton, Nebraska.¹ The cattle were born in the Spring of 2018 and harvested from July 2 to September 12, 2019 at Cargill Meat Solutions, Fort Morgan, Colorado. The sources of the cattle were commercial cow-calf producers who purchased bulls from Leachman Cattle of Colorado, that were predominantly STABILIZER™ composites.

Diamond T Livestock Services Inc. collected DNA samples using Allflex Tissue Sampling Units (TSUs), were on site during each harvest to ensure effective transfer of identity from animal to carcass, assembled and reported carcass data provided through Cargill's beef carcass imaging technology approved by the United States Department of Agriculture (USDA). Prior to analysis, USDA marbling scores were converted to numeric scores as recommended by the Beef Improvement Federation².

Carcass contemporary groups (CG) were formed based on genomic sex, lot number which also represented the feeding pen and cow-calf source of the cattle, and harvest date. The CGs ranged in size from 8 to 128 animals. Following preliminary analysis, since animals within pen were sorted for harvest when visually deemed market-ready and for the avoidance of heavyweight and yield grade 4 and 5 discounts, harvest date was removed from the definition of CG for the evaluation of carcass weight.

Unfortunately, birth dates and harvest ages for individual animals were not available, however based on calving information from cow-calf sources, age mostly varied by 45 days or less within each harvest group.

The data analysis for this study was executed using SAS software (version 9.3, SAS Institute Inc., Cary, NC; SAS, 2011). Dependent variables were the observed phenotype of the animal, including expressed carcass weight, fat thickness, ribeye area, marbling score, carcass value and price/CWT. Fixed effects included quartile genetic group for animals based on GEPD for each trait and the ZFC index (quartiles contained 161 to 174 animals per group) and the random effect of carcass CG as described above.

RESULTS AND DISCUSSION

The Zoetis Multi-Breed Evaluation (ZMBE) is a proprietary genetic evaluation that generates INHERIT Select GEPD using methodology and software from the University of Georgia called ssGBLUP³ - single-step Genomic Best Linear Unbiased Prediction - as well as proprietary Zoetis procedures. The GEPD for animals in this study were exclusively informed through genomic connectedness to related seedstock from Leachman Cattle of Colorado as well as Cooperators and Dollar Profit Partner herds in the evaluation that possess pedigree, ultrasound scan phenotypes measured in yearling age breeding cattle, and in some cases genomic information. With no direct phenotypic data of any kind from tested animals contributing to GEPD, and only ultrasound scan data included in the

INHERIT Select evaluation from related seedstock (no actual carcass data), the key objective of this study was to determine the extent to which GEPD and index predictions translated to expressed measures of actual carcass and economic performance.

Individual Trait Predictions

The GEPD and carcass outcomes were normally distributed. Average predicted genetic merit of the 667 animals, as benchmarked against the reference population of other tested commercial animals (appendix table 1), indicated slightly below average genetic merit for IMF (60th percentile), well above average merit for REA, FAT (30th percentile) and carcass weight (20th percentile). Mean GEPD for each quartile genetic group are provided in table 1, along with least square means for associated carcass trait outcomes.

Carcass contemporary group significantly affected all carcass outcomes ($P < .05$). Animals in the top GEPD quartile for all three individual carcass traits (FAT, REA, IMF) expressed significantly ($P < .05$) more desirable carcass performance than animals in the bottom GEPD quartile group, and all groups ranked as predicted. Means for expressed carcass performance by quartile genetic groups that do not share the same superscripts indicate significant differences at the $P < 0.05$ level (table 1). The relatively small p-value indicates strong evidence that under the given model the underlying carcass response would not have occurred by chance.

CW Index

Since the carcass trait phenotypes from seedstock animals in the INHERIT Select

evaluation were exclusively ultrasound scan records, carcass weights were not directly available for the INHERIT Select evaluation to enable GEPD for CW. However, the INHERIT Select evaluation computes and reports predictions for carcass weight based on an index that includes correlated traits, namely post-weaning growth and measures of carcass composition.

Overall, the power of the CW index to predict expressed carcass weight approached significance ($P = .057$), with the two heaviest CW genetic groups having the heaviest and second heaviest average carcass weights. While not significantly different, the lightest two quartile CW genetic groups expressed lower but similar average carcass weights as compared to the heaviest two genetic groups.

Sorting animals within pen for harvest when visually deemed market-ready - for the avoidance of heavyweight and yield grade 4 and 5 discounts - and not having the ability to adjust expressed carcass weights for differences in age, could have contributed to lower significance for the CW index. As well, these results suggest that rather than an index that predicts CW, direct GEPD for CW based on carcass weight phenotypes should provide more effective predictions.

FAT GEPD

The leanest genetic group as indicated by the lowest average FAT GEPD expressed significantly ($P < .05$) lower measured carcass fat thickness, while the fattest genetic group had significantly higher measured carcass fat thickness, as compared to the other genetic groups. Fat thickness least squares means for all four genetic groups ranked as predicted. Differences in the mean

FAT GEPDs for the leanest and fattest quartile groups was .013 (-.034 vs -.021), while differences in observed carcass fat thickness for corresponding groups was .174 (.526 vs .700) inches.

These results indicate that FAT GEPD were dependably informative but extremely conservative as to predicted differences in expressed carcass fat thickness (over 10X FAT EPD difference observed in carcass fatness). This is likely the result of notably less overall variation in ultrasound scan fat thickness measures as compared to carcass records, because scans were collected from notably leaner and younger, yearling-age breeding cattle, that were used to compute FAT GEPD.

REA GEPD

Quartile genetic groups that represented differences in carcass muscularity as determined by REA GEPD, had least square means for observed carcass ribeye areas that ranked as predicted. The most and least muscular quartile REA GEPD groups each had average carcass ribeye areas that were significantly ($P < .05$) different than the two quartile groups in the opposite bottom and top two quartiles, respectively. The smaller magnitude of difference between the average REA GEPD of the most and least muscular genetic groups (.21 in^2) as compared to the difference in expressed carcass ribeye areas (.80 in^2), again indicated that the REA GEPD were conservative.

Together with FAT GEPD and the CW index, REA GEPD contribute to genetic differences in USDA yield grade and associated economic premiums and discounts. It follows that animals with genetic merit for larger REA may be fed to heavier and often more profitable

carcass weight endpoints prior to reaching levels of carcass fat thickness that is the primary contributor to yield grade 4 and 5 discounts.

IMF GEPD

Each of the quartile genetic groups based on IMF GEPD had least square means for carcass marbling scores that were significantly different ($p < .05$) and ranked as predicted. Recognizing that IMF GEPD are expressed in units of percent, the difference in average genetic merit between the highest and lowest IMF group was .21, while the average difference in least square means for these

groups was 1.3 units of BIF marbling score, or nearly one and one-third units of USDA quality grade.

The Beef Improvement Federation Guidelines² indicate that the difference in intramuscular fat between Small (5.0) and Modest (6.0) carcass marbling is expected to be 1.68 percent (5.04% vs 6.72%, respectively). Hence, like GEPD for FAT and REA, GEPD for IMF in this study dependably under-predicted (conservative) the magnitude of expressed differences in carcass marbling score and USDA quality grade.

Table 1. Least square means for expressed carcass performance and means for individual carcass trait predictions by quartile genetic group.

Genetic Groups by Trait	CW Index	Carcass Weight (lbs)	FAT GEPD	Fat Thickness (in)	REA GEPD	Ribeye Area (in ²)	IMF GEPD	Marbling Score ¹
Top 25%	835	876	-0.034	0.526 ^a	0.63	14.8 ^a	0.35	6.7 ^a
26 - 50%	826	866	-0.028	0.610 ^b	0.56	14.5 ^{a,b}	0.27	6.1 ^b
51 - 75%	821	859	-0.026	0.644 ^b	0.51	14.3 ^{b,c}	0.23	5.8 ^c
Bottom 25%	812	861	-0.021	0.700 ^c	0.42	14.0 ^c	0.14	5.4 ^d

¹Beef Improvement Federation (BIF) marbling score where 5.0 is Small and 6.0 is Modest USDA Marbling Score, respectively

^{a-d}Marginal means within column and trait with different superscripts differ ($p < .05$)

Zoetis Feedlot | Carcass Index

The ZFC index was designed to simplify proper selection for combined genetic merit across feedlot and carcass traits, including post-weaning gain, dry matter intake, carcass weight, fat thickness, ribeye area, and marbling score. Indexes are typically challenging to fully validate, because either there are traits for which genetic predictions are unavailable that impact net returns, or there are predictions included in the index but

for which individual phenotypes are unavailable for validation. Such is the case here, where genetic predictions for health traits that may have affected costs as well as feedlot and carcass outcomes were not available, and GEPD for dry matter intake that contributed to the ZFC index (from genomics) was not specifically measured for individual animals and was not economically accounted for in this study.

With the above in mind, quartile genetic groups were formed based on ZFC index values and associated with least square means for carcass value, carcass price per CWT, and with contributing carcass traits (table 2). The top quartile ZFC genetic group produced the most valuable carcasses that earned the highest price per CWT, were the heaviest and of the highest marbling score as compared to the other groups (P<.05). In contrast, the bottom quartile ZFC genetic group produced the least valuable carcasses, primarily due to a significantly (P < .05) lighter least square mean for carcass weight. Importantly, quartile genetic groups based on the ZFC index aligned as predicted with least square means for carcass value.

These results indicate that heifer selection or feeder cattle purchase decisions based on top versus bottom quartile ZFC index values are expected to produce more valuable, heavier and higher quality grading carcasses with comparable ribeye areas and carcass fat thickness. As documented for individual

traits, differences in ZFC index values for net return appear to conservatively yield differences in least square means for realized carcass value. In these cattle, the \$32 difference in mean ZFC index between the top and bottom quartile genetic groups, produced carcasses that differed in value by \$100 – recognizing that animals would have expressed their full breeding value for ZFC (2 X \$32 = \$64 per head average difference between the two groups) - and differences in predicted and realized dry matter intake were not evaluated.

Assuming the top and bottom quartile groups represented tested sets of 700-pound feeder cattle and using the conservative ZFC predicted difference in net return, the top quartile group was predicted to be just over \$9/CWT (\$63/head) more valuable as compared to the bottom quartile group. Depending on the DMI component and related costs of gain, the realized difference may be closer to \$14/CWT (\$98/head) more valuable. For comparison, the price of the test is \$28/head.

Table 2. Least square means for carcass value, carcass price per cwt and individual carcass traits by quartile genetic group based on ZFC index.

Genetic Groups by ZFC Index	ZFC Index	Carcass Value	Carcass Price/CWT	Carcass Weight (lbs)	Fat Thickness (in)	Ribeye Area (in ²)	Marbling Score ¹
Top 25%	137	\$1,541 ^a	\$174.54 ^a	883 ^a	0.61	14.5	6.2 ^a
26 - 50%	125	\$1,491 ^b	\$172.46 ^b	864 ^b	0.62	14.3	6.0 ^b
51 - 75%	118	\$1,468 ^{b,c}	\$169.60 ^c	866 ^b	0.63	14.4	5.9 ^b
Bottom 25%	105	\$1,441 ^c	\$169.59 ^c	850 ^c	0.63	14.3	5.8 ^b

¹Beef Improvement Federation (BIF) marbling score where 5.0 is Small and 6.0 is Modest USDA Marbling Score, respectively

^{a-c}Marginal means within column and trait with different superscripts differ (p<.05)

CORRELATIONS

Additional analysis yielded estimated correlations between genetic predictions and adjusted carcass phenotypes (table 3). Since one definition of heritability is a measure of the relationship between phenotypic performance and breeding values, figures on the diagonal for individual carcass traits are within the range of expectations. It is worth noting that in these data, negative, unfavorable correlations existed between: the CW index and expressed marbling score; GEPD for FAT and expressed ribeye

area as well as marbling score; GEPD for REA and observed marbling score; and GEPD for IMF and expressed carcass weight, fat thickness and ribeye area. Conversely, while relatively low, favorable correlations existed between the ZFC index and all measures of observed carcass performance and value. As such, these correlations support use of the ZFC index to inform selection and feeder cattle purchase decisions in order to yield optimum performance across evaluated traits that in turn contribute to carcass value and net return.

Table 3. Correlations between genetic predictions (individual traits and the ZFC index) and expressed, adjusted carcass trait and economic measures of performance.

GEPD Index	Adjusted Carcass Performance					
	Carcass Weight	Fat Thickness	Ribeye Area	Marbling Score	Carcass Value	Carcass Price / CWT
Carcass Weight (CW)	0.22	-0.31	0.32	-0.22	0.11	-0.13
Fat Thickness (FAT)	-0.13	0.39	-0.36	0.32	0.04	0.26
Ribeye Area (REA)	0.14	-0.09	0.24	-0.07	0.04	-0.13
Intramuscular Fat (IMF)	-0.09	0.32	-0.27	0.56	0.14	0.37
ZFC Index	0.14	-0.07	0.11	0.16	0.18	0.13
Carcass Price / CWT	0.10	0.14	-0.07	0.56	0.63	1.00

SUMMARY

Results from this study substantiate the efficacy of INHERIT Select individual carcass trait predictions and the ZFC index. Notably, the ZFC index effectively described differences in carcass value, through optimizing combined genetic merit across carcass traits, some of which were antagonistically related. Based on these results, selection using the ZFC index is expected to yield more valuable carcasses that are heavier

with superior marbling and quality grades and similar ribeye area and fat thickness, as compared to unselected animals with lower ZFC values. Beyond selection, results from this study indicate that ZFC index and individual trait predictions available for feeder cattle, could effectively inform decisions related to retained ownership, price discovery, method of fed cattle marketing, sorting strategy and perhaps other management considerations.

REFERENCES

¹Data on File, Lincoln County Study Data on Validation of GEPD for Carcass Traits and the Zoetis Feedlot | Carcass Index, Zoetis Services LLC, 2020.

²Guidelines for Uniform Beef Improvement Programs, Beef Improvement Federation, 9th Edition (v1.0).

³University of Georgia. Animal Breeding and Genetics Group. Single-Step Genomic Best Linear Unbiased Prediction (ssGBLUP). <http://nce.ads.uga.edu/research/>.

Zoetis wishes to thank the specific data and technical contributors for development of the INHERIT Select evaluation, as well as to this validation.

Appendix table 1. Percentile ranks and associated INHERIT Select GEPD and index values from the inaugural reference population.

Top %	BW	WW	YW	DMI	F:G	YH	MW	MILK	TUC	DOC	SC	CW	FAT	REA	IMF	TND	PAP	ZCC	ZFC	ZTR	\$R	\$P
0	-5.3	65	106	-89	-0.41	1.3	63	35	0.49	0.18	1.61	856	-0.074	1.10	0.89	-0.68	-2.33	86	144	265	89	23086
1	-4.1	60	98	-70	-0.32	1.2	55	32	0.40	0.15	1.38	847	-0.062	0.96	0.75	-0.65	-1.89	78	134	254	82	20368
5	-2.4	53	88	-43	-0.19	0.9	44	29	0.29	0.12	1.10	835	-0.048	0.80	0.61	-0.60	-1.30	70	123	238	72	16750
10	-1.7	51	83	-28	-0.13	0.8	39	27	0.23	0.10	0.98	829	-0.041	0.71	0.54	-0.58	-0.92	65	118	229	66	14654
15	-1.1	48	79	-19	-0.08	0.7	35	26	0.19	0.09	0.89	825	-0.038	0.65	0.49	-0.57	-0.68	63	115	223	62	13289
20	-0.8	46	76	-12	-0.05	0.7	32	25	0.16	0.08	0.81	821	-0.034	0.61	0.45	-0.56	-0.46	60	112	219	58	12217
25	-0.5	45	74	-6	-0.02	0.6	29	24	0.13	0.07	0.74	818	-0.030	0.57	0.42	-0.55	-0.27	58	109	215	56	11212
30	-0.2	44	72	0	0.00	0.6	27	24	0.10	0.06	0.69	816	-0.027	0.54	0.39	-0.49	-0.08	56	107	211	53	10264
35	0.1	43	70	5	0.03	0.6	25	23	0.08	0.06	0.63	813	-0.025	0.50	0.37	-0.39	0.08	55	105	209	51	9391
40	0.3	41	68	9	0.05	0.5	23	22	0.06	0.05	0.58	811	-0.022	0.47	0.34	-0.37	0.23	53	103	205	49	8478
45	0.5	40	66	14	0.07	0.5	21	22	0.04	0.05	0.54	808	-0.019	0.45	0.32	-0.35	0.38	52	101	203	47	7741
50	0.8	39	64	19	0.09	0.4	19	21	0.02	0.04	0.49	806	-0.016	0.41	0.29	-0.34	0.51	50	100	200	45	6941
55	1.0	38	63	23	0.11	0.4	17	21	0.00	0.03	0.45	804	-0.013	0.39	0.27	-0.29	0.65	49	98	197	43	6231
60	1.3	37	61	28	0.13	0.4	15	20	-0.02	0.03	0.40	801	-0.011	0.36	0.25	-0.28	0.77	47	96	194	41	5524
65	1.5	36	59	32	0.15	0.3	13	19	-0.04	0.02	0.35	799	-0.008	0.33	0.23	-0.26	0.91	46	94	191	40	4813
70	1.8	35	57	37	0.18	0.3	11	19	-0.07	0.02	0.31	796	-0.005	0.30	0.20	-0.25	1.05	44	92	188	38	4081
75	2.1	33	55	43	0.20	0.2	9	18	-0.09	0.01	0.26	793	-0.002	0.27	0.18	-0.14	1.20	42	90	184	35	3249
80	2.4	32	53	48	0.22	0.2	6	18	-0.12	0.00	0.20	790	0.002	0.24	0.15	-0.09	1.34	41	87	180	33	2427
85	2.7	30	50	55	0.25	0.1	3	17	-0.15	-0.01	0.13	786	0.006	0.20	0.11	-0.06	1.50	38	85	176	30	1513
90	3.2	28	47	64	0.29	0.1	-1	16	-0.20	-0.02	0.04	781	0.012	0.16	0.06	-0.04	1.70	35	82	170	26	337
95	3.9	25	42	78	0.35	-0.1	-7	14	-0.26	-0.03	-0.09	774	0.019	0.10	-0.02	0.16	2.02	30	77	162	21	-1153
MIN	-6.8	6	11	-110	-0.55	-0.6	-37	4	-0.62	-0.14	-0.63	743	-0.089	-0.22	-0.33	-0.89	-2.9	-1	54	111	-4	-8780
MEAN	0.8	39	65	18	0.09	0.4	19	21	0.02	0.04	0.50	806	-0.016	0.43	0.30	-0.34	0.4	50	100	200	46	7311
MAX	6.8	76	116	147	0.76	1.5	77	38	0.60	0.21	1.93	869	0.049	1.22	1.13	0.41	3.6	97	157	289	103	26831
SD	1.9	9	14	36	0.16	0.3	16	5	0.17	0.05	0.36	18	0.020	0.22	0.19	0.22	1.0	12	14	23	15	5503

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