Journal of Animal Science and Research
ISSN 2576-6457 | Open Access

RESEARCH ARTICLE

Volume 3 - Issue 2 | DOI: http://dx.doi.org/10.16966/2576-6457.128

Comparison of Ultrasound and Actual Beef Carcass Measurements as Influenced by Stockering Performance and Finishing System

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Received: 11 Mar, 2019 | **Accepted:** 15 Apr, 2019 | **Published:** 19 Apr, 2019

Citation: Neel JPS, Swecker WS Jr, Brown MA (2019) Comparison of Ultrasound and Actual Beef Carcass Measurements as Influenced by Stockering Performance and Finishing System. J Anim Sci Res 3(2): dx.doi.org/10.16966/2576-6457.128

Abstract

A total of 216 Angus-crossbred steers (270 ± 19.3) kg were used in a three-year study to assess the effects of winter stocker growth rate and finishing system on beef carcass parameters as measured by ultrasound, a United States Department of Agriculture grader at a commercial slaughter facility, and laboratory analysis. During winter months (December to April) steers were randomly allotted to one three stocker growth rates: low (0.23 kg d^{-1}; LOW), medium (0.45 kg d^{-1}; MED), or high (0.68 kg d^{-1}; HIGH). Upon completion of the winter phase, steers were randomly allotted within each stocker treatment to either a corn silage-concentrate (CONC) or pasture (PAST) finishing system. All steers, regardless of finishing treatment, were finished to an equal-time. Upon completion of the finishing period, steers were ultrasounded to obtain estimates of loin muscle intramuscular fat percent (US-IMF), ribeye area (US-REA), and rib fat (US-RF). Steers were harvested and carcass data collected. Ultrasound-IMF measurement detected a finishing system effect ($P<0.0001$) but no evident impact of stocker system. Laboratory determined IMF (actual-IMF) resulted in detection of both a stocker treatment and finishing system effect ($P<0.05$). When actual-IMF and US-IMF were each converted to a USDA quality grade (QG) equivalent, and compared with the USDA grader QG (grader-QG), US-QG and grader-QG over estimated ($P<0.05$) actual IMF-QG for all treatment subgroups except HIGH-CONC, where US- and actual-QG were in agreement. Grader-QG and actual IMF-QG detected both stockering and finishing treatment effects, while US-QG did not. Our results clearly demonstrate that US-IMF measurement was unable to identify changes in loin muscle IMF deposition due to stockering plane of nutrition, whereas laboratory analysis and the USDA grader could identify changes in loin muscle IMF deposition due to stockering plane of nutrition.

Keywords: ADG; Beef; Finishing; Pasture; Stocker; Ultrasound

Introduction

Environmental variation clearly impacts livestock performance in forage based production systems, including stockering and pasture-finishing systems. Fluctuations in temperature and precipitation influence forage production and quality, maintenance requirements and intake. Loss of quality herbage availability may dictate animal liquidation at a given time. Feedlot-finishing systems reduce diet variability, provide more consistent animal performance and input costs, allow year around production, and reduce end product variability. Drouillard and Kuhl [1] referred to the high degree of segmentation within the beef industry and stated various nutritional and management regimens implemented prior to feedlot finishing could have profound impacts on carcass quality and consumer acceptability. They expressed the need for more thorough understanding of the interactions among stocker nutrition and management, finishing performance, carcass traits and consumer acceptability. Better understanding of these interactions would be especially beneficial to grass-fed and smaller scale feedlot sectors, when consideration is given to their need for animal liquidation based on harvest window rather than physiological end point.

Stocker performance on forages can vary greatly, from loss of body weight to exceptional gains and this could be a source of variability in beef quality [1]. The influence of stocker performance on carcass quality has been well documented within the feedlot sector with findings varying greatly [2-5]. The impact of stocker performance on meat quality and composition in either the feedlot or grass-fed sectors has been evaluated to a limited degree [6-8].

Ultrasound technology has been utilized extensively to evaluate finished cattle prior to marketing, and in the evaluation of breeding stock for selection and ranking purposes. To our knowledge, the accuracy of ultrasound estimates of carcass traits from cattle grown and finished under differing stocker and finishing systems has not been fully evaluated. Usefulness of ultrasound technology in evaluation of cattle depends on its robustness over a wide range of management systems or development of calibration equations to adjust ultrasound estimates for specific management background of cattle. A multi-year, multi-location experiment was conducted with the objective to compare carcass measurements estimated prior to slaughter *via* ultrasound technology, and those taken after slaughter by an onsite USDA grader or later during laboratory analysis. It was the objective of this study to compare carcass attributes of cattle managed under variable winter rate of gain and finishing systems using both conventional and ultrasound estimates of carcass traits and to evaluate the accuracy of the ultrasound estimates compared to conventional estimates.

Materials and Methods

Animals and feeding

All procedures involving animals during the study were approved by respective institutional Animal Care and Use Committees. During the winter feeding period, all steers were housed on the West Virginia University Livestock Research and Teaching Farm, Morgantown, WV. Feedlot finishing occurred at the Virginia Tech Shenandoah Valley Agricultural Research and Extension Center (feedlot), Steeles Tavern, VA (latitude: 37°56′ N; longitude: 79°13′ W; elevation: 537 m), while pasture-finishing occurred simultaneously at the WVU Willow Bend Demonstration Farm, Willow Bend, WV (latitude: 37°32′ N; longitude: 80°32′ W; elevation: 585 m. Ultrasound measures for LM area (US-REA), Rib Fat (US-RF), Rump Fat (US-RP), and % Intramuscular Fat (US-IMF) were taken on all animals throughout the study on scheduled weigh dates (approximately every 28 d) by the same national centralized ultrasound processing lab (CUP) certified technician and utilizing an Aloka 500 V real-time ultrasound unit equipped with a 17 cm, 3.5 MHz linear array transducer (certified for use by the National CUP Lab). All ultrasound images were sent to the National CUP Lab and Technology Center, Ames, Iowa for processing. Therefore no technician or computer processing variability was introduced into the evaluation of the ultrasound images. The computer image processing programs utilized were developed and maintained by the National CUP Lab, and were presented prior to our research efforts as having the capability to differentiate IMF% in a range from 1.7 to 14.7%. Animals received no growth stimulants during their entire lifespan.

Winter period

In mid-November of 2001, 2002 and 2003, 72 head (each year, total of 216 head) of spring-born English crossbred steer-calves (270 ± 19.3) kg were randomly allotted to one of three pen replicates and then allotted to three pens within replicate. Winter treatments were then randomly allotted to pen within replicate. Treatment diets were fed in bunks and were designed to produce an ADG of 0.23 (LOW), 0.45 (MED) or 0.68 (HIGH) kg h^{-1} d^{-1} based on energy and protein requirements, and DMI (NRC, 1996). Treatments were selected as being representative of a typical range in stocker performance on all-forage diets. Diets were formulated to achieve desired gains without attainment of maximum DMI to ensure all feed was consumed within a 24 hr period. Ingredients utilized included high quality tub ground timothy (*Phleum pratense L*) hay, soybean (*Glycine max* (L) Merr) meal, soybean hull pellets (as needed to increase energy density) and a commercial high calcium (6Ca:1P) beef cattle mineral mix containing a trace mineral and vitamin package (SSC-377808 Livestock Mineral. Southern States Cooperative, Inc. Richmond, VA 23260; 23.5% Ca, 4.0% P, 22.0% NaCl, 2.0% Mg, 1.5% S, 1.0% K, 63 ppm I, 970 ppm Cu, 28 ppm Co, 52 ppm Se, 2,800 ppm Zn, 2,700 ppm Mn, 363,000 IU kg^{-1} Vitamin A, 44,000 IU kg^{-1} Vitamin D, 330 IU kg^{-1} Vitamin E). Timothy hay was obtained each year from the same supplier in south central Pennsylvania. All hay was produced on one farm from contiguous fields. To maximize diet energy from fiber, soybean hulls were utilized as the fiber-based supplemental energy source for the hay (fiber) based diets. Animals were fed soybean meal, soybean hulls (if included in diet formulation) and mineral mix in the bunk prior to hay to prevent sorting and ensure consumption by all animals. In 2003, due to lower energy content of the timothy hay, soybean hulls were also included in the LOW gain diet. Animals were weighed on day 0 of the winter feeding period and every 28 d there after prior to the finishing phase. Upon completion of weight data collection for each 28 d period treatment gains were assessed by pen and diet daily DM allotment was adjusted, based on previous 28 d ADG, to achieve desired rate of gain [7]. Average diet formulations (DMB) for the three gain levels were: 1) Low Gain: 90.9% Hay, 4.7% Soybean meal, 3.5% Soybean hulls, 0.9% 6Ca:1P mineral; 2) Medium Gain: 76.7% Hay, 3.9% Soybean meal, 18.6% Soybean hulls, 0.8% 6Ca:1P mineral; 3) High Gain: 58.3% Hay, 3.3% Soybean meal, 37.7% Soybean hulls, 0.8% 6Ca:1P mineral. Nutritive values of the diets were: 1) Low Gain: 10.5% Crude Protein, 41.5% ADF, 67.4 NDF, 60.6% *in-vitro* DM Disappearance (IVDMD); 2) Medium Gain: 11.2% Crude Protein, 42.8% ADF, 66.9% NDF, 60.7% IVDMD; 3) High Gain: 12.1% Crude Protein, 44.2 ADF, 65.1% NDF, 72.3% IVDMD.

Finish period

In mid-April of each year prior to the finishing period, animals were randomly allotted within treatment and pen to either pasture or feedlot-finishing treatments. Cattle were then allotted to finishing replicates. Feedlot-finished cattle were group-fed within pen-rep in year 1 and by individual electronic gates (American Calen Inc., Northwood, NH) within pen-rep the subsequent 2 yr. Cattle from different winter treatments were commingled within replicate and no other treatments were applied during the finishing phase. The goal during pasture finishing was to provide high quality forage at all times and in adequate supply as to not compromise animal DMI. Animals were sequence grazed on mixed pasture consisting primarily of bluegrass (*Poapratensis L*), orchardgrass (*Dactylis glomerata L*), fescue (*Festuca L*) and white clover (*Trifolium repens L*); triticale (*Triticale hexaploide L*)/Italian ryegrass (*Lolium multiflorum Lam*); regrowth of an orchard grass and an alfalfa (*Medicago sativa L*) hay meadows. The majority of grazing time was spent on mixed pasture. Cattle on pasture were allowed a commercial beef cattle pasture mineral (Vigortone No. 35S, North American Nutrition Companies, Inc., P.O. Box 5002, Lewisburg, OH 45338-5002; 16.5% Ca, 3.0% P, 20.0 % NaCl, 1.0% Mg, 0.4% K, 830 ppm Cu, 26.4 ppm Se, 2,000 ppm Zn, 660,000 IU kg^{-1} Vitamin A, 66,000 IU kg^{-1} Vitamin D3, 220 IU kg^{-1} Vitamin E) free choice at all times. Pasture cattle were also allowed a commercial "bloat block" (Bloat Guard, Sweetlix, P.O. Box 8500, Mankato, MN 56002) while grazing hay meadow regrowth containing high legume content. Prior to animals being introduced to new paddocks for grazing, herbage samples for nutritive value assessment were collected *via* hand clipping. Samples were taken on a diagonal transect within each paddock with clip samples taken every 5 steps. Clip samples were dried in a 60°C forced air drying oven for later nutritional analyse. Pastures (DM basis) contained 18.0% CP, 33.4% ADF and 56.5% NDF; IVDMD was 81.3. The feedlot finishing diet consisted on average of (DM basis) 18.0% corn silage, 76.0% shell corn, 5.6% soybean meal, 0.14% limestone, 0.23% TM salt (Champions Choice, Cargill Inc., Minneapolis, MN; 96.5% NaCl, 3,500 ppm Zn, 2,000 ppm Mn, 2,000 ppm Fe, 300 ppm Cu, 70 ppm I, 50 ppm Co) and 20,000 IU Vitamin A $steer^{-1}d^{-1}$. Step-up diets were utilized in bringing cattle to full feed during feedlot finishing. Nutritive values for the feedlot diet were 10.5% CP, 6.5% ADF and 16.8% NDF (DM basis).

Pasture cattle were treated for internal parasites (Ivomec-Eprinex, Meril Limited, 2100 Ronson Road, Iselin, NJ 08830) and received fly-control treatment *via* commercial pour-on products (Durasect II, Pfizer Animal Health, Exton, PA 19341; Elector, Elanco Animal Health, A Division of Eli Lilly and Company, Indianapolis, IN 46285) throughout the grazing season on a 28 d interval. All medicinal slaughter regulations were adhered to.

Animal harvest, carcass data collection, and intramuscular fat determination

All steers were harvested at approximately 18 mo of age in two groups (one half of pasture and one half of feedlot cattle each time), with two weeks between each group, and during September each year. An equal-time end-point was chosen over a physiological end-point for several reasons: 1) Equal-time end-point may be more realistic for forage-finishing and small scale feedlot-finishing operations where diet availability often dictates when livestock are sold; 2) Desire to eliminate confounding of treatments with animal age or seasonal factors; 3) Small scale operations, in most circumstances, must sell livestock at an equal-time endpoint because of economics of scale.

Shipped animals were randomly selected from both pasture and feedlot-finishing groups, with final ultrasound measurements taken 3 days prior to shipment for slaughter. Pasture cattle were loaded around 9:00 am on two goose-neck trailers and transported approximately two hours to Steeles Tavern, VA. Feedlot and pasture cattle were then loaded onto a commercial cattle trailer and transported approximately 6.5 hours to Taylor Packing Co., Wyalusing, PA. Cattle were then unloaded, held overnight with access to water, and harvested the following morning at which time hot carcass weight (HCW) was recorded for each animal. Carcass characteristics including maturity; fat thickness at the 12th rib; 12th rib longissimus muscle area; kidney, pelvic and heart (KPH) fat; marbling score; and USDA quality grade were evaluated by a trained USDA professional grader 24 hr postmortem [9]. The left NAMP 107 ribs [10] from each carcass were identified, removed, vacuum packed, purchased and shipped to a university meat laboratory for later chemical and sensory evaluation. Individual marbling scores were converted to USDA quality grades for statistical analysis and presentation [11].

The 9-10-11th rib section was removed from the primal cut and physically separated into lean, fat and bone according to the procedures of Hankins and Howe [12] with the following modifications: longissimus muscle, s.c. fat, and intermuscular fat were individually separated and weighed. Weights were obtained for each individual component and then summed for total lean and fat weight. Samples of longissimus muscle and other lean trim were obtained for crude fat content using a Soxhlet apparatus and petroleum ether [13]. Crude fat content was subtracted from muscle and other lean trim weights and added to intermuscular/i.m. weights for fat-free lean calculations. Results from the 9-10-11th rib dissection were used to calculate carcass composition according to Lunt et al. [14].

Statistical analyses

Data were analyzed utilizing PROC MIXED of SAS (SAS®, Cary, NC, USA) with linear models including fixed effects of year, stockering treatment, finishing treatment, harvest date, estimate type (carcass *vs* ultrasound), and their interactions and random effects of rep nested in year and finishing treatment, rep nested in year, stockering treatment, and finishing treatment, rep × harvest date nested in year, stockering treatment, and finishing treatment, and a random residual effect. Covariance analyses were performed to determine the predictability of on-floor USDA grader measurements and chemical analytical results from ultrasound estimates. Linear models included fixed effects of year, stockering treatment, finishing treatment, harvest date, and their interactions, an ultrasound estimate covariate (eg., US-IMF) corresponding to a measured estimate (eg., actual-IMF) and interactions of the covariate with other fixed effects in the model to test homogeneity of slope over treatments. Hypothesis tests with observed significance levels of $P<0.05$ were considered significant while tests at $P<0.10$ were considered trends. Individual animals/carcasses were considered to be the experimental units.

Results and Discussion

The ultimate goal of this research effort was to determine the ability of ultrasound technology to identify in real-time, treatment effects on carcass parameters by comparing those measurements with actual carcass and laboratory measurements. If ultrasound measurements were capable of discerning treatment differences where/if they existed, the technology would be invaluable in the context of understanding environmental and management effects on beef quality. This technology would aid in the development of intervention strategies to overcome those impacts as needed, and also provide much needed labor and monetary savings in research situations by circumventing the need for the collection of actual carcass data and the conduction of laborious and costly laboratory analyses. Past research has looked extensively at the ability of ultrasound technology to distinguish intramuscular fat content in animals on high planes of nutrition [15-18], and particularly during concentrate finishing regimens. This technology is also used by numerous breed associations in the ranking of individual animals based on their intramuscular fat deposition ability, and these animals may or may not necessarily have been fed extremely high energy content diets. To our knowledge, an evaluation of the technology's capabilities within the context of specific managerial and finishing regimens has not been conducted.

Ultrasound measurement of IMF showed no evident difference in content due to stocker treatment, however CONC cattle had a greater content ($P<0.001$) than PAST (Table 1). For actual-IMF, there were both Stocker (S) ($P<0.05$) and Finish (F) ($P<0.001$) treatment effects, as well as a S × F interaction ($P<0.05$). In CONC cattle it appears that IMF content steadily increased as winter stocker gain increased. In PAST cattle, it appears that actual-IMF content was greater for LOW and HIGH stocker treatments than MED. In comparing ultrasound to laboratory derived measurements within sub treatment groups, ultrasound overestimated ($P<0.05$) IMF content in all groups except HIGH-CONC, where both measurements were in agreement. The overestimation ranged from a low of 0.9% for LOW and MED-CONC cattle to a high of 1.8% for MED and HIGH-PAST. Ultrasound measurements were unable to identify any apparent impact due to winter stocker treatment, which was clearly present and evidenced through laboratory analysis. It is apparent from our study that plane of nutrition during stockering impacts physiological deposition of intramuscular fat, and this change results in apparent biased ultrasound estimates with regard to IMF content. The implication to this observation may include that, when relying on ultrasound for IMF estimation: 1) unreliable breakevens could result if cattle are fed to a specific IMF content end point; 2) individual animal under-estimation of marbling capability within contemporary groups when animals originate from different sources/backgrounds; 3) unreliability of research conclusions when utilizing ultrasound IMF measurements.

Individual US and Actual-IMF measurements were converted to their respective QGs for the purpose of comparing them with USDA grader assigned QGs (Table 1). There were no S × F interactions within any of the QG groups. As with US-IMF, US-QG estimates did

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Table 1: Ultrasound (US), laboratory analysis (Actual) and carcass measurements for cattle finished (F) on either pasture (PAST) or concentrate (CONC) and previously wintered at 0.23 (LOW), 0.45 (MED), or 0.68 (HIGH) ADG (kg) during the stocker (S) phase.[1]

Measurement	LOW 0.23 kg Stockering ADG		MED 0.45 kg Stockering ADG		HIGH 0.68 kg Stockering ADG					
	Finish System		Finish System		Finish System		SE	S	F	S × F
	PAST	CONC	PAST	CONC	PAST	CONC				
US IMF, %[2]	3.87^{A}	4.53^{A}	3.96^{A}	4.83^{A}	4.14^{A}	4.86	0.18	0.19	<0.0001	0.80
Actual IMF, %	2.39^{B}	3.59^{B}	2.18^{B}	3.95^{B}	2.36^{B}	4.66	0.21	0.02	<0.0001	0.03
SE	0.19	0.20	0.20	0.20	0.20	0.20				
	PAST	CONC	PAST	CONC	PAST	CONC				
US IMF QG[3]	4.0^{A}	4.8^{A}	4.1^{A}	5.1^{A}	4.2^{A}	5.1^{B}	0.2	0.42	<0.0001	0.80
Carcass QG	2.9^{B}	4.7^{A}	3.1^{B}	5.2^{A}	3.6^{B}	5.6^{A}	0.2	<0.0001	<0.0001	0.57
Actual IMF QG	1.7^{C}	3.5^{B}	1.7^{C}	3.9^{B}	1.8^{C}	4.7^{B}	0.3	0.04	<0.0001	0.12
SE	0.2	0.2	0.2	0.2	0.2	0.2				
	PAST	CONC	PAST	CONC	PAST	CONC				
US REA, cm^2	64.8	81.9^{A}	66.6	85.1^{A}	66.8	86.4^{A}	1.3	0.03	<0.0001	0.64
Carcass REA, cm^2	65.9	78.4^{B}	66.4	79.1^{B}	66.3	82.1^{B}	1.3	0.23	<0.0001	0.32
SE	1.3	1.4	1.3	1.4	1.3	1.3				
	PAST	CONC	PAST	CONC	PAST	CONC				
US Rib fat, cm	0.47	1.09	0.50	1.11	0.46	1.18	0.04	0.46	<0.0001	0.30
Carcass Rib fat, cm	0.43	1.12	0.49	1.14	0.51	1.20	0.05	0.26	<0.0001	0.92
SE	0.05	0.05	0.05	0.05	0.05	0.05				
	PAST	CONC	PAST	CONC	PAST	CONC				
US Rump fat, cm	0.62	1.02	0.55	1.10	0.65	1.15	0.43	.08	<0.0001	0.17
	PAST	CONC	PAST	CONC	PAST	CONC				
Finishing ADG, kg	0.94	1.38	0.83	1.23	0.75	1.12	0.03	<0.0001	<0.0001	0.33

[1] Column means within measurements with unlike superscripts differ, P<0.05. Row means are presented by finishing treatment within stockering treatment due to a SXF interaction for actual IMF, %.

[2] Intra-muscular fat (IMF) of: 5-6 %=USDA QG Choice (0); 4-5 %=Choice (-); 3.5-4 %=Select (+); 3-3.5 %=Select (-); 2.5-3 %=Standard (+); 2.5 % and below=Standard (-).

[3] USDA Quality Grades: Choice (0)=QG6; Choice (-)=QG5; Select (+)=QG4; Select (-)=QG3; Standard (+)=QG=2; Standard (-)=QG1. All steers were lean and skeletal maturity A within this study.

not indicate a stockering effect on QG. Quality grade was however impacted (P<0.001) by finishing treatment for US-QG, with CONC having a higher QG that PAST cattle. For both grader and actual-IMF derived QG, stockering and finishing treatment influenced (P<0.05) QG, with QG increasing as stocker plane of nutrition increased (P<0.05), and greater for CONC than PAST finishing. It is noteworthy and interesting that the impact of treatments was apparent to the USDA grader using visual observation but not detectable *via* ultrasound scanning. It appears that whatever is occurring physiologically within the animal regarding fat deposition is apparently causing a false reading for the ultrasound measurement. With regard to the manner of QG measurement and within PAST cattle, US-QG was greater than Carcass-QG which, in turn, was greater than Actual-QG (P<0.10). For LOW-CONC and MED-CONC, US-QG and Carcass-QG were in agreement, but both were greater than Actual-QG (P<0.05). Within HIGH-CONC, Carcass-QG was greater (P<0.05) than US-QG and Actual-QG. Conversion of US-IMF to US-QG did not improve detection of stockering treatment effects on intramuscular fat deposition. The impact of plane of nutrition prior to finishing on IMF content appears to be primarily within the CONC, seemingly preventing those cattle from reaching their genetic potential while on feed. The economic impact would most assuredly be felt by the seller of the cattle for slaughter, in that a lower QG would result in lesser overall income for a given group of cattle. Our cattle were harvested at a same-time end point however, and more time on feed may have improved the QG of cattle on the lower planes of nutrition. Given that US was unable to detect stockering treatment differences, it would be unable to assist in determining the best time for slaughter in such a situation. Regarding the use of ultrasound to evaluate genetic potential or treatment effects, conclusions could be greatly compromised given its inability to detect the plane of nutrition effect found in this experiment.

Treatment and measurement type effects on ribeye area (REA) and rib fat (RF) are presented in table 1. Both stockering and finishing treatment effects were detected (P<0.05) in US-REA measurements. Ultrasound measurements indicated that REA increased with increased plane of nutrition, and that CONC cattle had a larger REA than PAST. Grader assessed carcass REA also revealed larger (P<0.05) REAs for CONC than PAST, but indicated no stockering treatment impact. Differences between method of measurement for REA was only detected for CONC, with US-REA being greater (P<0.05) than Carcass-REA. Regarding RF, both methods detected a CONC effect (P<0.001) and method of measurement did not differ.

Ultrasound rump fat (US-RP) and finishing period ADG are also presented in table 1. There was a tendency (P<0.10) for a stockering effect on US-RP, and CONC cattle had greater (P<0.001) US-RP than PAST. Finishing ADG decreased (P<0.001) with increasing stockering plane of nutrition, and CONC cattle had a greater (P<0.001) ADG than PAST.

Results from regression analyses of conventional carcass traits estimates on ultrasound estimates are given in tables 2-5. Tests for heterogeneity of slopes over stockering and finishing subclasses indicated that slopes differed among the subclasses for IMF, QG, and REA (P<0.05) and slopes differed among stockering treatments pooled over finishing systems for BF (P<0.05). Consequently, slopes are reported for each stockering and finishing subclass for IMF, QG, and REA and for each stockering class for BF. If ultrasound estimates were exactly measuring conventional estimates, a slope of 1.0 and an intercept of zero would be expected. For IMF, the only regression approximating this expectation was for feedlot finished steers stockered at the HIGH level of gain. All other ultrasound estimates overestimated measured IMF (slope <1.0, P<0.05) with the possible exception of pasture finished steers stocker at the LOW level of stocker gain (P<0.17). The regression of measured quality grade on ultrasound quality grade demonstrated consistent overestimation of QG using ultrasound for all stockering and finishing systems (slope <1.0, P<0.05) with the greatest overestimation for feedlot finished steers from the LOW stockering gain. Carcass REA measurements appeared to be reasonably predicted from ultrasound estimates for pasture finished steers stockered on either MEDIUM or LOW levels of gain. Other finishing × stockering subclasses overestimated measured REA as evidence by slopes less than 1.0 (P<0.06) and especially in pasture finished steers from LOW stockering gain levels (P<0.01). Evaluation of regression of carcass BF on ultrasound BF suggested that ultrasound estimates of BF reasonably predicted measured BF, especially for LOW and HIGH stocker gain levels. There was some indication that ultrasound estimates of BF in the MEDIUM stocker gain class overestimated measured BF (P<0.05).

Table 2: Regression of actual intramuscular fat from the longissimus dorsi on ultrasound estimated intramuscular fat as influenced by stockering rate of gain and subsequent finishing treatment.

Treatment[1]	β_1	B_0	SE	DF	t value[a]	p-value
1C	0.5672	0.9790	0.19	43	2.2518	0.0295
2C	0.5531	1.2814	0.13	43	3.3202	0.0018
3C	0.9952	-0.1709	0.18	43	0.0272	0.9784
1P	0.6625	-0.1761	0.24	43	1.4022	0.1680
2P	0.4894	0.2297	0.21	43	2.4823	0.0170
3P	0.3258	1.0245	0.17	43	4.0323	0.0002

[a]H_0: $\beta_1=1$ *vs* H_A: $B_1 \neq 1$

[1]1=0.23 (LOW), 2=0.45 (MED) and 3=0.68 (HIGH) ADG (kg) during the winter stockering phase; C=concentrate and P=pasture finishing.

Table 3: Regression of actual grader-estimated quality grade on quality grade estimated from ultrasound estimated intramuscular fat as influenced by stockering rate of gain and subsequent finishing treatment.

Treatment[1]	β_1	B_0	SE	DF	t value[a]	p-value
S1C	0.0820	4.3239	0.14	44	6.7699	2.49E-08
S2C	0.3634	3.3130	0.10	44	6.3596	9.98E-08
S3C	0.6583	2.2484	0.13	44	2.6366	0.011528
S1P	0.3743	1.4327	0.12	44	5.0746	7.53E-06
S2P	0.2057	2.2465	0.11	44	7.1047	8.03E-09
S3P	0.3366	2.1511	0.11	44	5.9127	4.53E-07

[a]H_0: $\beta_1=1$ *vs* H_A: $B_1 \neq 1$

[1]S1=0.23 (LOW), S2=0.45 (MED) and S3=0.68 (HIGH) ADG (kg) during the winter stockering phase; C=concentrate and P=pasture finishing.

Table 4: Regression of actual longissimus muscle area on ultrasound estimated longissimus muscle area as influenced by stockering rate of gain and subsequent finishing treatment.

Treatment[1]	β_1	B_0	SE	DF	t value[a]	p-value
S1C	0.7417	17.5155	0.1	41	1.9961	0.0526
S2C	0.5481	32.5297	0.1	41	3.0349	0.0042
S3C	0.5879	31.4233	0.1	41	3.5773	0.0009
S1P	0.3034	46.2368	0.1	41	4.4884	0.0001
S2P	0.8539	9.5389	0.2	41	0.8947	0.3762
S3P	0.9524	2.7149	0.2	41	0.2946	0.7698

[a]H_0: $\beta_1=1$ *vs* H_A: $B_1 \neq 1$

[1]S1=0.23 (LOW), S2=0.45 (MED) and S3=0.68 (HIGH) ADG (kg) during the winter stockering phase; C=concentrate and P=pasture finishing.

Table 5: Regression of actual carcass back fat on ultrasound estimated carcass backfat as influenced by stockering rate of gain.

Treatment[1]	β_1	B_0	SE	DF	t value[a]	p-value
S1	0.9474	0.0344	0.11	45	0.4769	0.6358
S2	0.7547	0.2075	0.11	45	2.1961	0.0333
S3	1.1591	-0.1038	0.11	45	1.4718	0.1480

[a]H_0: $\beta_1=1$ *vs* H_A: $B_1 \neq 1$

[1]S1=0.23 (LOW), S2=0.45 (MED) and S3=0.68 (HIGH) ADG (kg) during the winter stockering phase.

Summary

Carcass IMF was reasonably accurately predicted for feedlot finished steers with higher stocker gains. This type of stocker management is common in the U.S and given that ultrasound technology was primarily developed under these types of management conditions and finishing system, this result would be expected. However, gains during the stocker phase and within finishing system (feedlot *vs* pasture) influenced the usefulness of ultrasound in prediction of carcass traits. This lack of detection of attribute differences caused by management and finishing system precludes ultrasound's usage from some experimental standpoints. It also has major implications on its use within situations where qualitative assessment is being conducted in groups of fed cattle that have variable management backgrounds. Prediction of carcass BF was reasonable accurate using ultrasound estimates, but not for every stocker system. If the objective of the use of ultrasound estimates is to accurately predict individual or mean carcass traits, additional research will be needed to develop calibration equations under different management.

Acknowledgements

The authors wish to thank Bill Jones-WVU Livestock Farm Manager, David Fiske-Virginia Tech Shenandoah Valley Agricultural Research and Extension Center Superintendent, Ed Pell-WVU Willow Bend Demonstration Farm Manager, and their respective staff for assistance in animal feeding and handling, and data collection. We also thank Wade Snyder, Keith Galford, Bob Arnold and Jim Fedders, USDA, ARS, AFSRC, Beaver, WV for their technical support. Trade names are used for convenience of the reader and do not imply endorsement by USDA over comparable products or services. There are no author conflicts of interests.

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Citation: Neel JPS, Swecker WS Jr, Brown MA (2019) Comparison of Ultrasound and Actual Beef Carcass Measurements as Influenced by Stockering Performance and Finishing System. J Anim Sci Res 3(2): dx.doi.org/10.16966/2576-6457.128