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Feedlot Profitability in Wagyu-influenced Cattle

Grace A. Baxter, Kellie Curry Raper,[1] Derrell S. Peel and Eric A. DeVuyst[2]

Abstract

Feedlot profitability of Wagyu-influenced cattle is examined using data from a privately owned feedlot in the Midwest. The data contain more than 15,000 head of cattle, including full blood Angus and Wagyu-Angus crossbred cattle of 12.5%, 25% and 50% Wagyu heritage. Results indicate that steers with 25% Wagyu had higher net real returns at the mean than all other genetic combinations in the study. Heifer results are more mixed. Mean net returns for 12.5% Wagyu heifers were statistically different from full blood Angus heifers, but other pairwise comparisons were not. Cattle with 25% Wagyu exhibited the most consistent mean net returns across feedlot start weights. Angus cattle had consistently lower net returns across feedlot start weights than Wagyu-influenced cattle. This increased profitability is arguably due in part to increasing the proportion of cattle that grade USDA Prime via Wagyu genetics while also lessening Wagyu's potentially negative physical performance impacts with Angus genetics.

Introduction

Wagyu beef has grown in popularity among U.S. consumers because of its high marbling, tenderness, and palatability. The marbling composition in Wagyu beef also has higher oleic acid levels relative to traditional U.S. beef, giving it an edge with consumers for healthfulness (Smith, 2016). Some cattle producers see high relative market prices for Wagyu and Wagyu-influenced beef as incentive to differentiate into this niche market. According to Steve Bennett (2019), owner of Wagyu International, approximately 40,000 head of Wagyu and Wagyu crossbred cattle were on feed in the U.S. in 2019. For perspective, USDA (2019) reported that all cattle on feed in 2019 totaled 12 million head. While Wagyu is a growing market, it is still a very small segment of the beef industry.

Though Wagyu beef commands high prices at the consumer level, production costs are also typically higher. Wagyu cattle have lower average daily gains (ADG) and thus take longer to reach slaughter readiness than traditional U.S. beef breeds. A Black Wagyu steer in Japan is typically slaughtered between 26 to 30 months of age (Gotoh et al., 2018), while a typical steer in the US is slaughtered between 16 to 20 months of age (Pelletier, Pierog, and Rasmussen, 2010). Some producers have crossbred Wagyu with high-performing U.S. beef breeds such as Angus in efforts to achieve the unique flavor and marbling traits of Wagyu but with the higher production efficiency infused by traditional breeds. (Radunz et al., 2009). Radunz (2009) found that Wagyu-Angus cattle, through heterosis, exhibit improved production efficiency relative to purebred Wagyu and improved carcass quality characteristics relative to purebred Angus. Baxter (2023) found that Wagyu-influenced fed steers received price premiums not only for achieving desirable carcass characteristics, but also an additional premium even when the cattle did not

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[1] Corresponding Author: Kellie Curry Raper, Oklahoma State University, kellie.raper@okstate.edu

[2] Former Graduate Research Assistant, Professor and Livestock Marketing Specialist, Breedlove Professor of Agribusiness and Extension Livestock Marketing Specialist, and Professor and Rainbolt Chair, Department of Agricultural Economics, Oklahoma State University

qualify to be marketed as American Wagyu. However, the question remains whether increases in revenue outweigh any additional costs, and it is yet unclear how the degree of crossbreeding influences profitability across various genetic combinations of Wagyu and Angus.

This study uses unique data from an integrated cow-calf feedlot operation to analyze feedlot profitability of Angus and Wagyu-Angus cattle. Differences in feedlot profitability are examined between steers and heifers, as well as across genetic combinations and different feedlot start weight groups. Genetic combinations include Angus, and Wagyu-Angus with 12.5%, 25%, and 50% Wagyu, noted here as $W_{12.5}$, W_{25}, and W_{50}, respectively. While many producers choose Wagyu genetics in order to qualify beef to be marketed as American Wagyu, this feedlot's stated goal is to increase profitability by increasing the percentage of fed cattle that grade USDA Prime at slaughter.

Literature Review

Crossbreeding Wagyu with Angus is typically accomplished using Wagyu sires with Angus females to create Wagyu-Angus cattle. Incorporating Wagyu genetics through crossbreeding is expected to increase the percentage of prime quality grading cattle, even for lesser percentages of Wagyu influence (Mir et al., 1999). Oyama's (2011) research found heritability estimates for marbling in Wagyu cattle are approximately 0.55, which is considered a moderately to highly heritable trait. The marbling heritability estimate for Angus averages 0.45 with residual feed intake considered moderately heritable at 0.40 (Suther, 2009).

Radunz et al. (2009) found that Wagyu-sired fed cattle with an Angus dam graded USDA Prime at a rate of 65% compared to 21% of Angus-sired fed cattle with an Angus dam, resulting in higher value carcasses. For comparison, in fiscal year 2023, USDA's Agricultural Marketing Service (AMS) reported that 9.3% of all quality-graded beef graded USDA Prime (USDA, 2023). While evidence shows Wagyu cattle achieve more desirable USDA quality grades than domestic beef breeds, potential undesirable USDA yield grades can also result in discounts on carcasses (Lunt, Riley, and Smith, 1993).

Previous research on Wagyu cattle has only implied how differences in production cycle lengths and feed efficiencies may affect profitability (e.g., McGee et al., 2013). Wagyu-influenced cattle have exhibited lower feedlot performance and lower red meat yield compared to conventional crossbred beef cattle (Mir et al., 1999; Lunt, Riley and Smith, 1993). For example, Radunz et al. (2009) noted Wagyu-sired cattle had relatively low daily feed intake and were on feed for 77 days longer than Angus-sired cattle, on average. The impact of these differences on profitability is likely different across various genetic combinations. For W_{50} cattle, they can qualify for Wagyu-influenced certified beef programs such as American Wagyu, though other USDA-AMS specifications are also possible (Nelson, 2021). Price premiums from such branded Wagyu programs may offset additional costs and could increase profitability. For W_{25} and $W_{12.5}$ cattle, an increase in the number of animals that reach USDA Prime quality grade should influence profitability relative to Angus cattle, if negative carcass attributes are minimized.

Data

Data are sourced from a specialty ranch in the Midwest that produces Angus and Wagyu-Angus cattle and grows the cattle to harvest weight in their own feedlot before marketing. Data contain 17,763 observations composed of 15,457 Angus and 2,306 Wagyu-Angus cattle from 2012 to 2020. Wagyu-Angus observations include cattle of W_{50}, W_{25}, and $W_{12.5}$ genetics. Data are on a per head basis. The detailed feedlot data include gender, feedlot start weight, feedlot start date, DOF, ADG, harvest weight, sale price per head, feed rations and costs, and degree of Wagyu influence for each animal. Secondary data used in the analysis include the USDA-Agricultural Marketing Service (AMS) weekly Oklahoma City feeder cattle average price series compiled by the Livestock Marketing Information Center (LMIC), the Federal Reserve Economic Data (FRED) monthly Corn Producer Price Index (PPI) and monthly Slaughter Cattle PPI. Data for these secondary data series correspond to the 2012–2020 production and cost data timeline from the feedlot. The daily yardage fee estimate from Lardy's (2018) study of custom feeding cost is also used. While the yardage fee estimate is pre-COVID and thus is likely higher now, we would not expect it to affect relative net returns between genetic categories.

The feedlot reported rations and feed costs with September 2022 prices. Since feedlot data range over an eight-year period from 2012 to 2020 for feedlot start dates, feed costs are adjusted, i.e. deflated backward, to the corresponding time period for the *ith* animal using a monthly Corn Producer Price Index sourced from Federal Reserve Economic Data (FRED). Monthly Slaughter Cattle Producer Price Index was also acquired from FRED for adjustment of net returns from nominal dollars to real dollars.

The impact of potential data error and statistical outliers is minimized by deleting the top and bottom 0.5% of observations for adjusted net returns. Following Stevens (2009), observations of ADG outside of three standard deviations ($ADG_\mu \pm 3\sigma$) were considered outliers and removed (Stevens, 2009). Usable observations for profitability analysis total 15,137 with 13,070 Angus cattle and 2,067 Wagyu-Angus cattle.

Table 1 reports summary statistics for selected feedlot data. Eighty percent of feedlot cattle are steers, which is not surprising since the integrated operation also sells heifers as seedstock to other operations. The highest percentage of feedlot cattle are Angus (86.34%), followed by W_{25} (9.74%) and $W_{12.5}$ (3.75%). W_{50} cattle represent only 0.16 percent of observations. Higher USDA quality grades result in carcass premiums, impacting profitability from the revenue side of the equation. Table 1 details the USDA Quality Grade distribution across genetic combinations for cattle included in the study. Of the feedlot's Angus cattle, 20 percent reach USDA Prime, 78 percent reach USDA Choice and only 2 percent grade lower than USDA Choice. For Wagyu-influenced cattle, the percentage of cattle grading USDA Prime increases with the percent of Wagyu, as expected, with $W_{12.5}$ at 50 percent, W_{25} at 62 percent and W_{50} at 68 percent. Less than one percent of $W_{12.5}$ and W_{25} cattle grade lower than USDA Choice and no W_{50} cattle grade less than USDA Choice. Over half (52.82%) of cattle enter the feedlot weighing between 500 and 699 lbs. Lighter start weight cattle (200–499 lbs.) represent nearly 25 percent of observations. Cattle weighing 700–899 lbs. represent 20 percent of the observations, while the heaviest category (900–1299) represents only 2.27 percent.

Methods & Procedures

Net returns (*NR*) are modelled on a per head basis as a function of sales price per head (SP), transfer price (TP), feed cost (FC), and yardage cost (YC) as below:

$$(1) \qquad NR_i = SP_i - TP_i - FC_i - YC_i$$

where *i* is an individual animal and other terms are as previously defined.

Transfer Prices

The feedlot data contain no transfer prices for calves as they move from the cow-calf segment into the feedlot, since those calves are raised on the feedlot's ranch rather than purchased from the marketplace. In this case, the expected market value of the calf if sold rather than transferred from the ranch to the feedlot, becomes the feedlot's input cost for the calf, i.e. the transfer price. To remedy this missing information, weekly USDA-AMS Oklahoma City feeder cattle price data are used to assign transfer prices to incoming calves based on corresponding feedlot start date, feedlot start weight and gender. Transfer price per hundredweight is calculated on a linear price slide using midpoints of 50-pound increments as shown below,

$$(2) \qquad P_t^{w_c} = \frac{(w_c - w_l)}{50} * P_t^{w_u} + \frac{(w_u - w_c)}{50} * P_t^{w_l},$$

where w_c is calf feedlot start weight, w_l is lower weight midpoint, w_u is upper weight midpoint, $P_t^{w_u}$ is price (\$/cwt) at time t for the upper weight midpoint, and $P_t^{w_l}$ is price (\$/cwt) at time t for the lower weight midpoint. Prices for upper and lower midpoints are determined by the corresponding feedlot start date (*t*) or date immediately prior. When price was missing in either the lower or upper weight bracket, price from the next adjacent 50-pound category was used with a 100-pound increment instead. Cattle with missing prices in both their respective weight bracket and adjacent brackets were omitted, since a larger price slide could not be calculated. Transfer price per head (TP_i) was then calculated as transfer price in dollars per hundredweight multiplied by feedlot start weight divided by 100.

Feed Costs

Feed costs are based on feedlot ration protocols, nutrient requirements of beef cattle (National Academies of Sciences, Engineering, and Medicine, 2016)[3] and length of time on each ration. Feed costs are calculated for the individual animal. Feedlot protocol dictated how many days cattle were on each of the four rations, including 14 days on Starter (S), 14 days on Grower 1 (G1), and 14 days on Grower 2 (G2), as illustrated in Figure 1. Cattle are then transitioned to the Finisher (F) ration until marketing. Ration protocols adjust cattle palettes and digestive systems across the feeding period from a forage heavy diet typical of most calves from the cow-calf sector to a higher grain diet for finishing cattle to harvest weight. Price per pound of feed for each ration (P_{feed}) is calculated using data on feed ingredients, total ingredient costs, and pounds per head per day on an as fed basis. Ration cost assumptions account for pounds gained in the previous feeding phase. This weight gain is calculated as ADG times days on the previous ration and is added to the previous phase's start weight to calculate start weight for the new ration phase. The NRC nutrient requirement of beef cattle is given as 0.029 times body weight in pounds of feed on an as fed basis and was used in calculations for ration cost (National Academies of Sciences, Engineering, and Medicine, 2016). Cost of each ration for each animal is denoted as S_{cost_i}, $G1_{cost_i}$, $G2_{cost_i}$, and F_{cost_i} below.

$$(3) \qquad S_{cost_i} = Feedlot\ Start\ Weight * 0.029 * P_{feed}^{S} * 14$$

$$(4) \qquad G1_{cost_i} = (Feedlot\ Start\ Weight + 14 * ADG) * 0.029 * P_{feed}^{G1} * 14$$

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[3] This resource is commonly known as the NRC Nutrient Requirements for Beef Cattle manual.

(5) $$G2_{cost_i} = (G1\ Start\ Weight + 14 * ADG) * 0.029 * P^{G2}_{feed} * 14$$

(6) $$F_{cost_i} = \left[\frac{Harvest\ Weight - (G2\ Start\ Weight + 14 * ADG)}{2}\right] * 0.029 * P^{F}_{feed} * (DOF - 42)$$

The sum of these four ration costs equals total feed cost (FC_i) for each animal i.

Feedlot ration base price was calculated for September 2022, based on feedlot data. Nominal feed cost is then created by indexing total feed cost to corn price using a six-month moving average of the monthly FRED Corn PPI with feedlot start date assigned as month t. Feed costs from 2022 prices were then transformed to nominal prices associated with the fed time period by:

(7) $$FC^{adj}_i = FC_i * \frac{CP_{avg_t}}{CP_{9/2022}}.$$

Yardage Costs

Yardage costs (YC) include anything not accounted for in feed costs such as labor, medicine, and feedlot overhead. Many feedlot operations will charge a daily yardage fee (YF) to account for these various costs on a dollars per head per day basis (Lardy, 2018). Feedlot data did not include daily yardage fee estimates so an assumption of 40 cents per head per day is taken from Lardy's study of custom feeding costs (2018). The yardage cost formula for an individual animal i is:

(8) $$YC_i = YF * DOF_i\ .$$

Adjusted Net Returns

All components of net returns at this point are calculated in nominal dollars. The FRED monthly slaughter cattle PPI, noted as *SCP* below, is used to transform nominal net return values to an adjusted net return for animal *i* in real dollars, denoted as NR_i^{adj}, where

(9) $$NR^{adj}_i = NR_i * \frac{SCP_{HD}}{SCP_{9/2022}},$$

SCP_{HD} is slaughter cattle producer price index value corresponding to the animal's harvest date month and $SCP_{9/2022}$ is slaughter cattle producer price index base in September 2022 prices, the same month associated with feed value prices.

Adjusted Net Return Comparisons

Analysis of Variance (ANOVA) procedures coupled with F-tests are used to evaluate differences in means of adjusted net returns per head across sex, feedlot start weights, and genetic combinations of Angus and Wagyu-Angus cattle. ANOVA measures variability ratio across and within groups and uses an F-distribution to determine statistical significance of the following hypotheses:

(10) $$H_0{:}\ \mu_{a1} = \mu_{a2} = \cdots \mu_{an}$$

$$H_A{:}\ \mu_{a1} \neq \mu_{a2} \neq \cdots \mu_{an}$$

where H_0 is that no statistical differences exist across means of the group. Tukey's HSD (Honestly Significant Difference) method is then used to analyze pairwise differences within groups since there are unequal observation sizes in subgroups within a larger group (McHugh, 2011). Tukey's hypothesis for pairwise differences is expressed below:

$$(11) \quad H_0: \mu_i = \mu_j$$

$$H_A: \mu_i \neq \mu_j,$$

where i and j are subgroups within a larger group. SAS 9.4 is used for all analysis.

Results & Discussion

Prior to calculating net returns, differences in ADG and DOF distributions were examined across the genetic groupings of cattle. Figure 2 illustrates differences in ADG. Angus cattle outgained Wagyu-Angus cattle, with Angus cattle averaging 3.4 pounds per day and Wagyu-influenced Angus cattle ADG ranging from 2.75 to 3.1. This difference is further illustrated in a comparison of DOF across Angus and Wagyu-Angus cattle (Figure 3). Angus cattle averaged 230 DOF, while Wagyu-Angus cattle averaged 260 to 290 DOF, with the highest DOF for W_{25} cattle. DOF is also influenced by management factors such as start weight and feedlot turnover rate, among others. However, the results here are still an indication of potential differences in feedlot profitability from a physical efficiency perspective.

All Cattle—Steers versus Heifers

The mean adjusted net returns are calculated at $435.28 per head across all steers and $437.14 per head across all heifers. Interestingly, Tukey's HSD pairwise comparison test indicates that the null hypothesis of equal means across sex is not rejected ($F = 0.17$, $p = 0.6785$). Figure 4 is a schematic box and whisker plot illustrating the distribution of adjusted net returns per head for steers and for heifers (see Liu, 2008). Mean values of adjusted net returns are represented by the diamond in the box with the median represented by the horizontal line through the box. The box and whisker plot allows a comparison of distributions and, in this case, determines that not only are the means statistically equal, but adjusted net returns are also similarly distributed across the two sexes. This result is in contrast to industry research that provides evidence of steers being relatively more profitable in the feedlot than heifers (Koknaroglu et al., 2005). Note that we do not compare mean net returns for steers and heifers across years, but this could be an interesting expansion of the research.

Genetic Combinations

Figure 5 illustrates mean adjusted net returns per head across genetic categories for all cattle and by sex. Mean adjusted net returns ranged from $411.67 to $524.50 for all cattle, from $396.71 to $557.03 for steers and from $426.63 to $487.31 for heifers. W_{25} cattle achieved the highest mean returns across all cattle and steers, but $W_{12.5}$ cattle achieved the highest mean returns for heifers. Further examination of net returns between steers and heifers reveals that Koknaroglu et al.'s (2005) results hold for W_{25} and $W_{12.5}$ cattle, with higher mean net returns for steers, but heifers have higher mean net returns for Angus and W_{50} cattle. There is little difference in the means for Angus, $W_{12.5}$ and W_{50} cattle. Table 2 reports Tukey test results for pairwise comparisons of mean adjusted net returns per head across genetic combinations for all cattle, for steers and for heifers. The null hypothesis that mean adjusted net returns are equal across genetic combinations for all cattle is rejected ($F = 110.46$, $p < 0.0001$). When comparing across all cattle, mean adjusted net returns are statistically different between Angus and W_{25}, between Angus and $W_{12.5}$, and between W_{25} and W_{50}. $W_{12.5}$ and W_{25} cattle exhibited statistically higher mean returns than Angus at a difference of $78.00 and $101.47 per head, respectively. Based on conversations with the feedlot operators, they considered W_{25} cattle to have the highest net returns. These results support that claim.

Genetic Combinations—Steers

Mean adjusted net returns per head for steers across genetic combinations are reported as Angus at $420.54, $W_{12.5}$ at $503.96, W_{25} at $557.03, and W_{50} at $396.71, again supporting feedlot operators' prediction of highest returns from W_{25} cattle (see Figure 5). F test results indicate that these net returns as a group are not statistically equal ($F = 133.72$, $p < 0.0001$). Pairwise differences in means (see Table 2) are statistically different between Angus and W_{25}, W_{25} and $W_{12.5}$, W_{25} and W_{50}, and between $W_{12.5}$ and Angus. Mean adjusted net returns for W_{25} are significantly higher than all other genetic combinations, with $W_{12.5}$ steers besting both Angus and W_{50} steers.

Genetic Combinations—Heifers

Average adjusted net returns for heifers by genetic combination are Angus at $433.75, $W_{12.5}$ at $487.31, W_{25} at $445.94, and W_{50} at $426.63 per head (Table 2). When evaluating heifer mean adjusted net returns across genetic combinations, surprisingly the null hypothesis of equal adjusted net return means is not rejected, indicating statistically equal means across genetic groups ($F = 2.36$, $p = 0.0693$). The same is true for pairwise differences among genetic combinations for heifers.

Feedlot Start Weight Groups—All Cattle

Cattle feedlot start weights ranged between 244 and 1,298 pounds and were designated as four groups for ANOVA analysis, including: Light (244–499 pounds), Medium-Light (500–699 pounds), Medium (700–899 pounds), and Heavy (900–1,299 pounds). Note that this comparison is based on start weights only with no genetic distinction. Light start weight cattle averaged adjusted net returns of $464.71 per head while heavy start weight cattle averaged only $234.39 per head, with adjusted net returns for start weights decreasing as start weight increases, as expected based on previous literature (Table 3). The null hypothesis that means are equal across feedlot start weight groups is rejected ($F = 209.10$, $p < 0.0001$). Table 3 also reports that adjusted net return means are statistically different across all start weight pairwise comparisons.

Feedlot Start Weight Groups—Steers

Adjusted net returns across start weights for steers are reported as Light at $455.17, Medium-Light at $439.59, Medium at $401.67, and Heavy at $265.89 (see Table 3). F-test results reject the null hypothesis that these returns are equal across groups ($F = 66.57$, $p < 0.0001$). As with all cattle combined, mean adjusted net returns decrease from light to heavy start weights. Pairwise differences are statistically significant between all groups.

Feedlot Start Weight Groups – Heifers

Mean adjusted net returns for heifers across feedlot start weights are also reported in Table 3. Values range from $593.30 for light heifers to $208.65 for heavy heifers. Pairwise means testing indicates higher profits for lighter feedlot start weights. The null hypothesis of equal mean adjusted net returns across feedlot start weights for heifers is rejected (F = 273.77, $p < 0.0001$). Pairwise differences in means are statistically significant between all heifer feedlot start weight groups, similar to the result for all cattle and for steers. This result is consistent with previous research findings that returns per head decrease as start weight increases.

Genetic Combinations and Feedlot Start Weight Groups

Mean adjusted net returns for genetic combinations across feedlot start weights are shown in Figure 6. Means are more broadly dispersed across genetic combinations for cattle placed as Lights. Note that statistical reliability of W_{50} means here is low, as the already few W_{50} observations are now also split across 4 start weight classes. They are included here for interest only. Angus cattle exhibit the lowest mean adjusted net returns in every weight category when W_{50} cattle are omitted, though mean returns are still strongly positive across start weight categories. F-tests indicate that Angus mean returns as a group are statistically different from each of the Wagyu-influenced groups, including $W_{12.5}$ (p=0.016), W_{25} (p=0.038), and W_{50} (p=0.0002). The same is true for W_{50} cattle as compared to $W_{12.5}$.(p=0.038) and W_{25} (p=0.015). Again, when ignoring the W_{50} cattle, $W_{12.5}$ cattle have the highest mean adjusted net returns across start weight categories with the exception of Medium weight placements at 700-899 lbs. F-tests indicate that $W_{12.5}$ and W_{25} means are not statistically different from each other across feedlot start weights (p=0.631). Mean adjusted net returns for Angus, $W_{12.5}$ and W_{25} cattle range from a low of $287.27 per head to a high of $448.84 per head across feedlot start weights. Note that this study evaluated net returns only on a per head basis without consideration of impacts of DOF on the feedlot's turnover rate, i.e., the number of cattle marketed in a year divided by the feedlot's capacity.

Conclusions

This study provides a basic assessment of differences in mean adjusted net returns as a measure of feedlot profitability across varying degrees of Wagyu influence in Angus cattle. Overall, the results lend support to the feedlot's perspective that W_{25} cattle yield the highest net returns on average in their setting. When the Angus operation decided to incorporate Wagyu genetics, it soon shifted its Wagyu focus from W_{50} cattle in the feedlot to more efficient W_{25} and $W_{12.5}$, using W_{50} cattle in the breeding herd instead. This strategy looks to be the appropriate choice for their case from our results, as it increased the proportion of cattle achieving the USDA Prime quality grade while also achieving reasonable performance in the feedlot.

Results indicate that differences do exist in feedlot profitability among cattle with Angus and Wagyu-Angus genetics, as examined across sex and feedlot start weights. These results imply that the additional costs of producing Wagyu type cattle to target niche markets or premiums may be reduced with crossbreeding. Wagyu-Angus with W_{50} had the lowest net returns on average, though these cattle qualify to be marketed as American Wagyu. This could also be attributed to the objectives of this specific feedlot and their buyers, as marketing branded American Wagyu is not their goal, but rather increasing the percent of carcasses that achieve USDA Prime quality grades. While these results do not reflect the whole industry, they do provide an insightful snapshot for individual producers or feedlots considering incorporating Wagyu genetics.

Detailed private data such as that used here provides opportunities for further exploration, such as evaluation of cow-calf costs across degrees of Wagyu influence and assessing overall profitability for an integrated system. There is also a possibility that as cattle move from ranch to feedlot, transfer prices would be higher than the values we imputed for Wagyu influence if the feeder market values Wagyu influence with a premium. A more extensive examination of feedlot profitability for Wagyu-influenced cattle as a function of performance variables, market variables and other information would also prove valuable.

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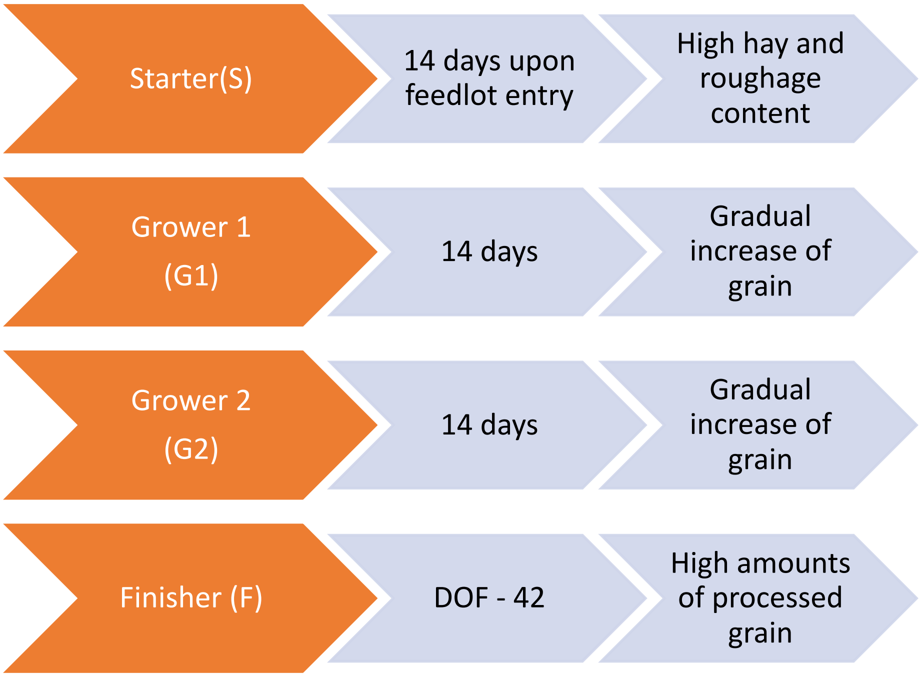


Figure 1. Feedlot rations, time period and content.

Table 1. Summary Statistics for Selected Feedlot Data

	n	Frequency	Percent of Observations	
Sex	15137			
Steers		12198	80.58	
Heifers		2939	19.42	
Wagyu %	15137			% USDA Prime
Angus		13070	86.34	20
$W_{12.5}$		568	3.75	50
W_{25}		1475	9.74	62
W_{50}		24	0.16	68
Feedlot Start Weights	15137			
200-499 lbs.		3757	24.82	
500-699 lbs.		7994	52.82	
700-899 lbs.		3039	20.08	
900-1299 lbs.		344	2.27	
	n	Mean	Min	Max
Average Daily Gain (lbs)	15137	3.42	0.5	9.69
Days on Feed	15137	235.2	36	461
Feedlot Start Weight (lbs)	15137	597.6	184	1314
Harvest Weight (lbs)	15137	1385.9	976	1897

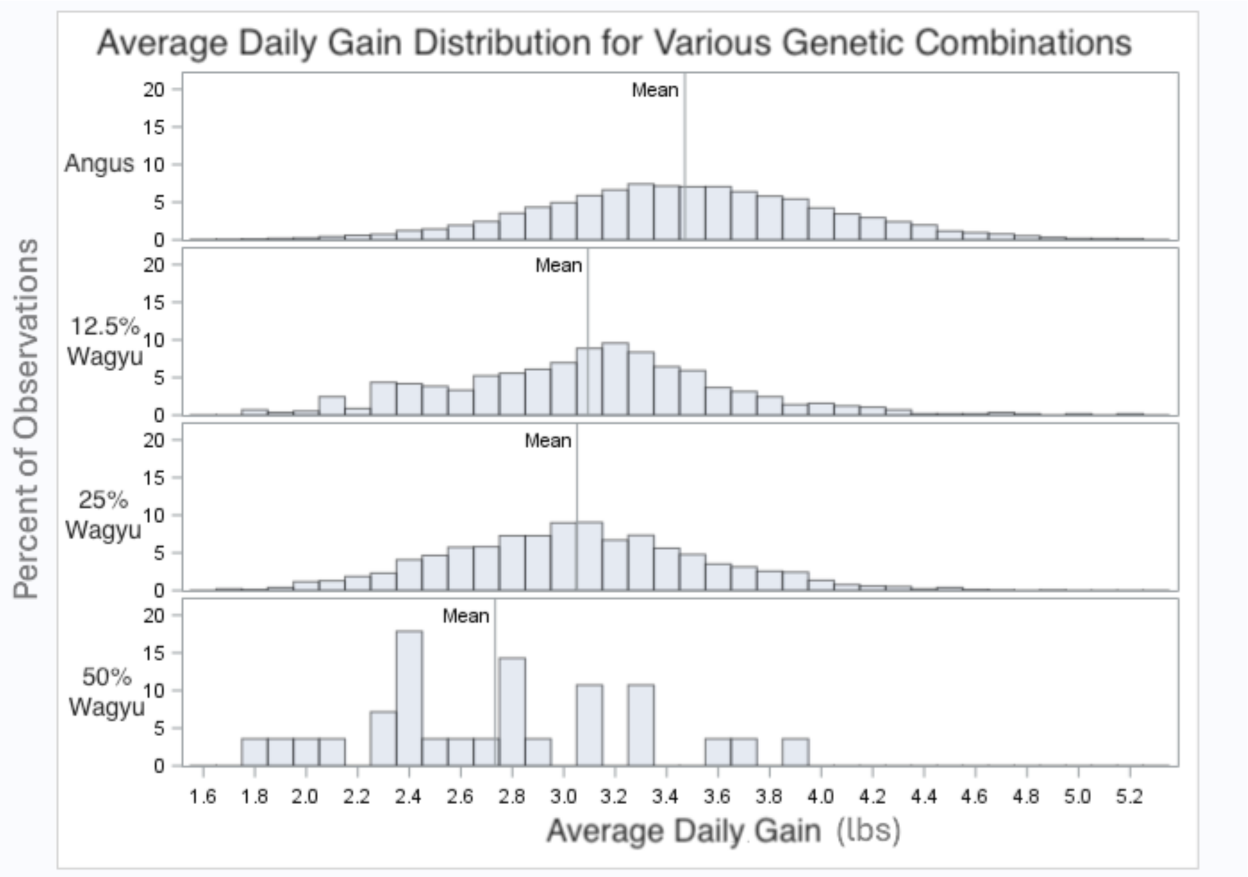


Figure 2. Average Daily Gain (lbs/day) Distribution across Genetic Combinations

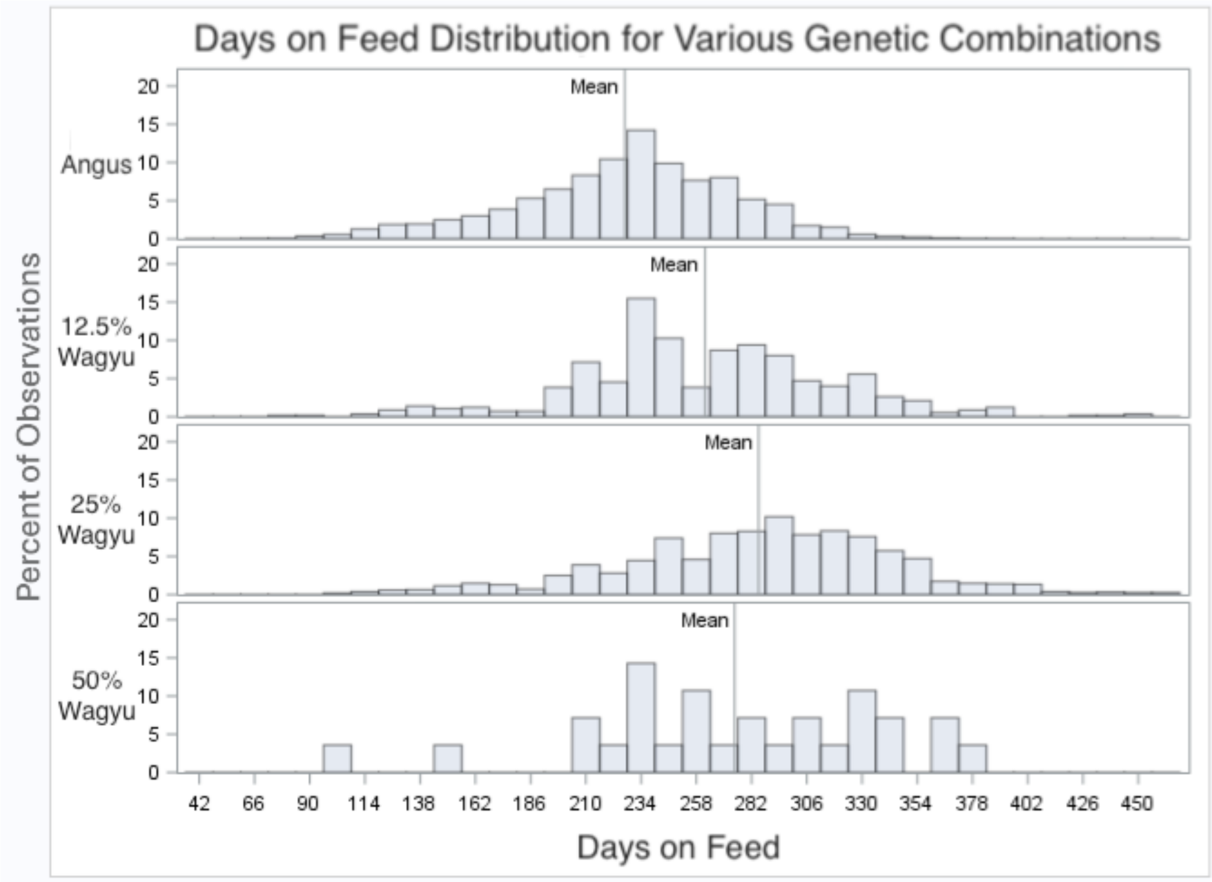


Figure 3. Days on Feed Distribution across Genetic Combinations

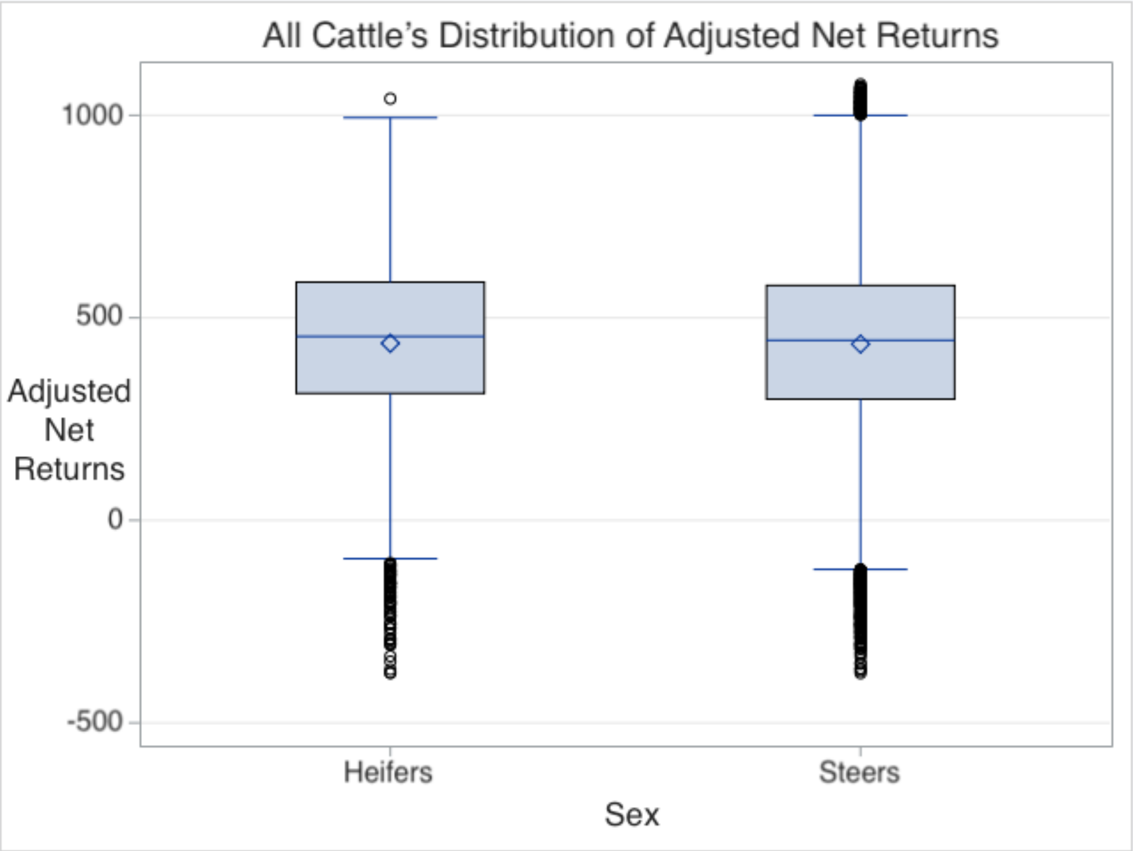
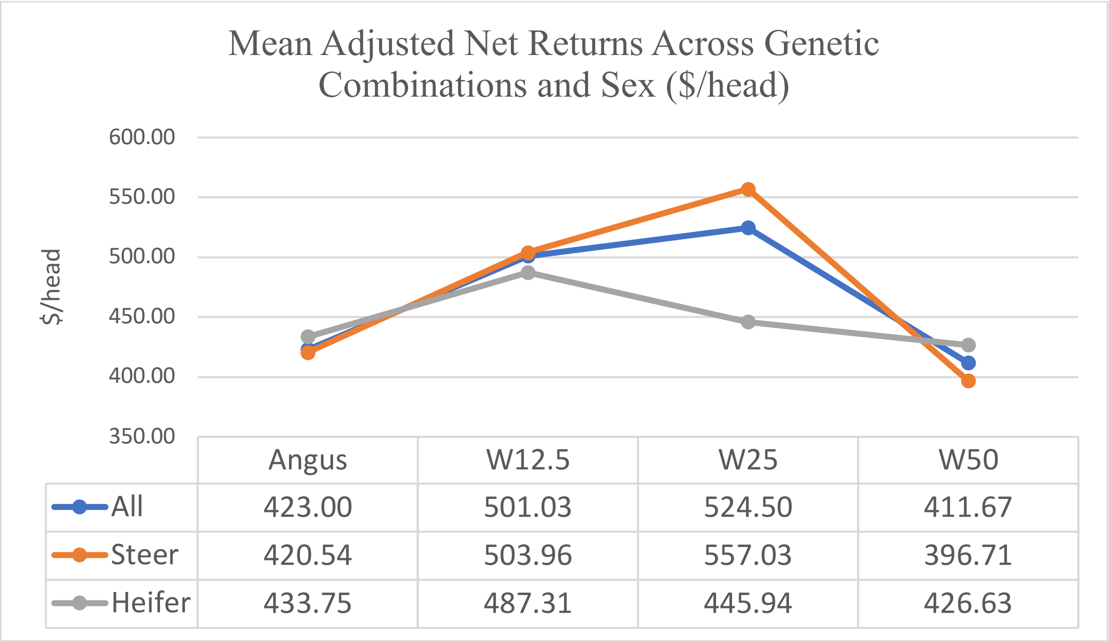


Figure 4. Heifer vs Steer - Distribution of Adjusted Net Returns by Sex ($/head)



	Angus	W12.5	W25	W50
All	423.00	501.03	524.50	411.67
Steer	420.54	503.96	557.03	396.71
Heifer	433.75	487.31	445.94	426.63

Figure 5. Mean Adjusted Net Returns across Genetic Combinations and Sex ($/head)

Table 2. Pairwise Comparisons of Mean Adjusted Net Returns by Wagyu Genetic Combinations (Tukey Test) ($/head)

Genetic Combination$_1$	μ_1	**Genetic Combination$_2$**	μ_2	**Difference Between Mean Net Returns**
All Cattle				
$\boldsymbol{W_{12.5}}$	\$501.03	A	\$423.03	$\mathbf{\$78.00}^{*}$
$\boldsymbol{W_{12.5}}$	\$501.03	W_{25}	\$524.50	(\$23.47)
$\boldsymbol{W_{12.5}}$	\$501.03	W_{50}	\$411.67	\$89.36
$\boldsymbol{W_{50}}$	\$411.67	W_{25}	\$524.50	$(\mathbf{\$112.83})^{*}$
$\boldsymbol{W_{50}}$	\$411.67	A	\$423.03	(\$11.36)
$\boldsymbol{W_{25}}$	\$524.50	A	\$423.03	$\mathbf{\$101.47}^{*}$
Steers				
$\mathbf{W_{12.5}}$	\$503.96	A	\$420.54	$\mathbf{\$83.42}^{*}$
$\mathbf{W_{12.5}}$	\$503.96	$\mathrm{W_{25}}$	\$557.03	$(\mathbf{\$53.07})^{*}$
$\mathbf{W_{12.5}}$	\$503.96	$\mathrm{W_{50}}$	\$396.71	\$107.25
$\mathbf{W_{50}}$	\$396.71	$\mathrm{W_{25}}$	\$557.03	$(\mathbf{\$160.32})^{*}$
$\mathbf{W_{50}}$	\$396.71	A	\$420.54	(\$23.83)
$\mathbf{W_{25}}$	\$557.03	A	\$420.54	$\mathbf{\$136.50}^{*}$
Heifers				
$\mathbf{W_{12.5}}$	\$487.31	A	\$433.75	$\mathbf{\$53.56}^{*}$
$\mathbf{W_{12.5}}$	\$487.31	$\mathrm{W_{25}}$	\$445.94	\$41.37
$\mathbf{W_{12.5}}$	\$487.31	$\mathrm{W_{50}}$	\$426.63	\$60.68
$\mathbf{W_{50}}$	\$426.63	$\mathrm{W_{25}}$	\$445.94	(\$19.31)
$\mathbf{W_{50}}$	\$426.63	A	\$433.75	(\$7.12)
$\mathbf{W_{25}}$	\$445.94	A	\$433.75	\$12.19

* Denotes statistical significance at $\alpha = 0.05$

( ) denotes negative value.

Note: $W_{12.5}$ = 12.5% Wagyu; W_{25} = 25% Wagyu; W_{50} = 50% Wagyu; A = Angus

Table 3. Pairwise Comparisons of Mean Adjusted Net Returns by Feedlot Start Weight Group (Tukey Test) ($/head)

Feedlot Start Weight Group$_1$	μ_1	**Feedlot Start Weight Group$_2$**	μ_2	**Difference Between Mean Net Returns**
All Cattle				
Light	$464.71	Medium – Light	$448.96	$15.75*
Light	$464.71	Medium	$398.12	$53.09*
Light	$464.71	Heavy	$234.39	$230.32*
Medium – Light	$448.96	Medium	$398.12	$50.84*
Medium – Light	$448.96	Heavy	$234.39	$214.56*
Medium	$398.12	Heavy	$234.39	$163.74*
Steers				
Light	$455.17	Medium – Light	$439.59	$15.89*
Light	$455.17	Medium	$401.67	$53.50*
Light	$455.17	Heavy	$265.89	$189.28*
Medium – Light	$439.59	Medium	$401.67	$37.91*
Medium – Light	$439.59	Heavy	$265.89	$173.70*
Mediums	$401.67	Heavy	$265.89	$135.78*
Heifers				
Light	$593.30	Medium – Light	$498.02	$95.28*
Light	$593.30	Medium	$392.90	$200.40*
Light	$593.30	Heavy	$208.65	$384.65*
Medium – Light	$498.02	Medium	$392.90	$105.12*
Medium – Light	$498.02	Heavy	$208.65	$289.38*
Medium	$392.90	Heavy	$208.65	$184.25*

* Denotes statistical significance at $\alpha = 0.05$

Note: Lights (200–499 pounds), Medium–Lights (500–699 pounds), Mediums (700–899 pounds), and Heavys (900–1,299 pounds)

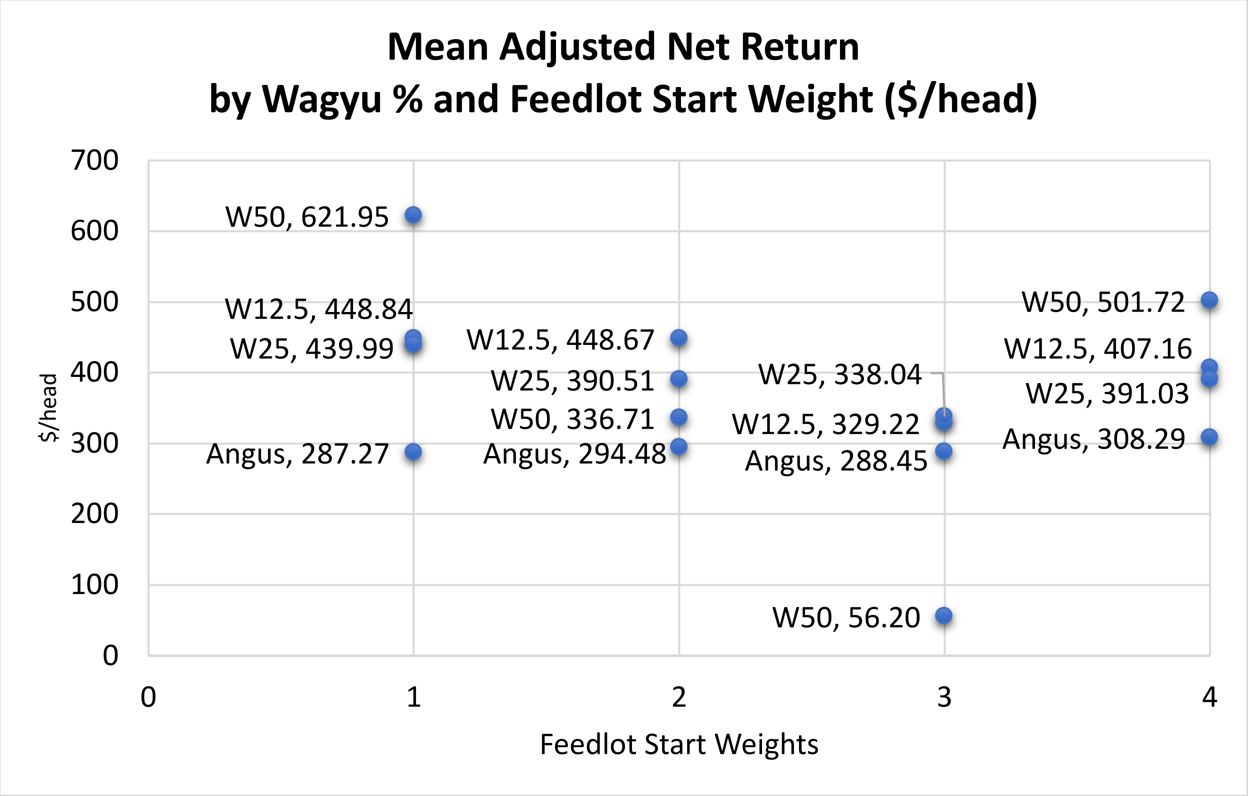


Figure 6. Mean Adjusted Net Return by Wagyu % and Feedlot Start Weight
Note: 1 = Lights (200–499 pounds); 2 = Medium– Lights (500–699 pounds); 3 = Mediums (700–899 pounds); and 4 = Heavys (900–1,299 pounds).