# UNIVERSIDAD AUTÓNOMA DE BAJA CALIFORNIA


**Instituto de Ciencias Agrícolas**
**Instituto de Investigaciones en Ciencias Veterinarias**


# "Efecto del peso de arribo al corral de engorda a una edad similar sobre el comportamiento productivo, características de la canal y análisis económico de novillos Holstein"

**T E S I S**

**QUE COMO REQUISITO PARCIAL PARA OBTENER EL GRADO DE:**

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La presente tesis **“Efecto del peso de arribo al corral de engorda a una edad similar sobre el comportamiento productivo, características de la canal y análisis económico de novillos Holstein”** realizada por el C. Rodrigo Flores Garivay, dirigido por el Dr. Alberto Barreras Serrano, ha sido evaluada y aprobada por el Comité Particular abajo indicado, como requisito parcial para obtener el grado de:

## Doctor en Ciencias Agropecuarias

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**RESUMEN**

Aspectos de la fase de crianza y el peso corporal de arribo influyen en el desempeño del crecimiento en el corral de engorda. En consecuencia, se distribuyeron 300 becerros Holstein (edad 113 ± 1-d) en un diseño completamente al azar desbalanceado y se dividieron en cinco categorías (105 kg, 112 kg, 117 kg, 123 kg y 129 kg) de peso corporal de arribo (PCA) para evaluar el efecto del peso de arribo a una edad similar sobre el desempeño del crecimiento en corral de engorda, características de la canal y resultados económicos en novillos Holstein. Los becerros se pesaron al llegar al corral de engorda y posteriormente a los días 112, 224 y 361 del estudio. Se evaluó el rendimiento del crecimiento y la energía neta de la dieta estimada para cada período y para la fase entera del estudio (1 a 361-d). La utilidad económica se estimó restando el costo de compra de los becerros más el costo total de alimentación de los ingresos obtenidos por la venta de los novillos. Durante el período de crianza, la GDP aumentó (efecto lineal, $P$ <0.01) al incrementar el peso al nacimiento. El peso al nacimiento se relacionó ($P$ <0.05) con el PCA ($r^2$ = 0.47) y el peso final al sacrificio ($r^2$ = 0.36). En general, la GDP aumentó ($P$ <0.01) con el incremento del PCA. La ingesta de materia seca aumentó linealmente durante los primeros 224 días, pero cuadráticamente durante los últimos 137 días. En general, hubo un efecto cuadrático ($P$ <0.05) del PCA sobre la eficiencia de la ganancia y la energía neta observada de la dieta sobre la energía esperada, con eficiencias estimadas más bajas (4%) para los grupos de los novillos con PCA más livianos y más pesados. El peso de la canal caliente, el área musculo longissimus dorsi, el marmoleo y el grosor de la grasa dorsal aumentaron (efecto lineal, $P$ ≤ 0.03) a medida que aumentó el PCA, mientras que el grado de rendimiento, la grasa de riñón, pelvis y corazón no se vieron afectados. La eficiencia de la alimentación fue mayor para los grupos de PCA intermedio (112 y 117 kg), siendo los novillos con peso corporal de 112 kg los más rentables (5.93%) en comparación con los otros grupos. El rendimiento del crecimiento, la eficiencia energética estimada y las características de la canal de novillos Holstein de edad similar están influenciados por el PCA. El efecto es más pronunciado en los novillos de menos de 112 kg.

**Palabras clave:** Peso corporal de llegada, novillos Holstein, corral de engorda, resultados económicos

**ABSTRACT**

Aspects of rearing phase and arrival body weight influence feedlot growth performance. Consequently, three hundred calf-fed Holstein steers (age 113 ± 1-d) were distributed in a completely random unbalanced design and divided into five categories (105 kg, 112 kg, 117 kg, 123 kg and 129 kg) initial shrunk weight (SIW) to evaluate the effect of arrival weight on feedlot growth performance, carcass characteristics and the economic results of calf-fed Holstein steers of similar age. Calves were weighed upon arrival at the feedlot and subsequently on d 112, 224 and 361 of the study. Growth performance and estimated dietary net energy were evaluated for each period and for the study, as a whole (1 to 361-d). Profit was estimated by subtracting the purchase cost of calves plus the total feed cost from the revenue obtained from the sale of the steers. During the rearing period, ADG increased (linear effect, $P < 0.01$) with increasing birth weight. Birth weight was related ($P < 0.05$) with SIW ($r^2 = 0.47$) and final harvest weight ($r^2 = 0.36$). Overall ADG increased ($P < 0.01$) with increasing SIW. Dry matter intake increased linearly during the first 224-d, but quadratically during the last 137 days. Overall, there was a quadratic effect ($P < 0.05$) of SIW on gain efficiency and observed vs expected dietary NE, with lower estimated efficiencies (4%) for steers in both the lightest and heaviest SIW. Hot carcass weight, LM area, marbling score and fat thickness increased (linear effect, $P \leq 0.03$) as SIW increased, whereas KPH and yield-grade were unaffected. The efficiency of feeding was better for intermediate ABW groups (112 and 117 kg), being the steers with ABW of 112 kg the most profitable (5.93%) when compared to the other groups. Growth performance, estimated energetic efficiency and carcass characteristics of Holstein steers of similar age are influenced by the SIW. The effect is more pronounced in the steers less than 112 kg.

**Keywords:** Arrival body weight, Holstein steers, feedlot, economic results

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# Capítulo I

## INTRODUCCIÓN

Durante varios años la producción de carne de novillos Holstein ha jugado un papel importante en el negocio de los corrales de engorda y se ha utilizado para satisfacer las necesidades del mercado que el ganado bovino de carne no puede cubrir fácilmente (Burdine *et al.,* 2004). Además, se ha observado que los novillos Holstein pueden alimentarse para obtener carne de calidad (ZoBell *et al.,* 2001) y pueden generar utilidades (Dyt, 2013). Por otra parte, los novillos Holstein generalmente llegan al corral de engorda con un peso corporal más liviano y permanecen por períodos más largos que las razas especializadas de carne (Duff y Mcmurphy 2007; Zinn 2016). Se han realizado estudios que evalúan el peso inicial en corral de engorda y se ha encontrado que las diferencias en el peso de arribo influyen en el rendimiento del crecimiento (Hicks *et al*., 1990; Koknaroglu *et al*., 2005; Demircan 2008; Zinn *et al*., 2008; Hicks *et al*., 2015).

Con base en análisis de cierres de corrales de engorda, Zinn y Oltjen (1991) observaron que para los becerros cruzados que ingresan al corral de engorda a una edad similar, el desempeño del corral de engorda es una función predecible del peso inicial. En los novillos Holstein, este puede no ser el caso. Mientras que los pesos de llegada típicamente pueden variar en > 45% (110 a 160 kg; Duff y McMurphy, 2007), la edad de los becerros al llegar al corral de engorda típicamente difiere en solo unos pocos días. De la misma forma, se ha observado una relación del peso inicial con los costos totales en el corral de engorda y el precio de equilibrio. Esto es importante porque los costos de compra de los novillos y los del alimento representan la mayor proporción (> 50%) en la variación de la rentabilidad en el corral de engorda (Darrell et al., 2000 y Koknaroglu *et al*., 2005).

Hasta el momento, no existen estudios que evalúen directamente los efectos del peso de llegada de terneros Holstein con edades similares sobre el rendimiento del crecimiento, la energía de la dieta, las características de la canal y resultados económicos.

**Por lo tanto, el objetivo de este estudio consistió en evaluar el desempeño del crecimiento, las características de la canal y los aspectos económicos de novillos Holstein en corral de engorda con diferentes pesos de arribo, pero con edades similares.**

# Capítulo II
# REVISIÓN DE LITERATURA

## *2.1 Fase de crianza*

Actualmente, es poco lo que se sabe acerca de la nutrición y el manejo durante el período de crianza sobre el desempeño a largo plazo de los novillos Holstein. Sin embargo, se tiene conocimiento de que durante las prácticas de manejo tradicional con terneros Holstein, se lleva a cabo la separación de la cría poco después del nacimiento. Así mismo, en la mayoría de los establos lecheros (52.9%) se retiran los terneros inmediatamente después del nacimiento, otros (22.5%) los retiran después de la enfermería, pero en menos de 12 h después del nacimiento, mientras que el resto de las industrias lácteas informa que retira sus terneros de 12 a 24 h después del parto (Duff y Anderson, 2007). La transferencia pasiva de anticuerpos a través del calostro es un componente vital para la supervivencia de los terneros (USDA-APHIS-VS-NAHMS, 2002). De forma similar Faber et al. (2005) informan que la cantidad de calostro ofrecido durante la primera hora después del nacimiento influye posteriormente en la salud y el rendimiento de la lactancia en vaquillas. Por otra parte, los terneros se destetan generalmente a una edad promedio de 8.4 semanas (USDA-APHIS-VS-NAHMS, 2002).

En general, el 8.4% de vaquillas lecheras nacidas vivas mueren antes del destete (USDA-APHIS-VS-NAHMS, 2002). El becerro de carne y el becerro Holstein que son criados para la producción de carne son alimentados con diferentes dietas como resultado de cada tipo de explotación. Lo anterior recae en una diferencia marcada en el desarrollo ruminal. Se han realizado trabajos donde evalúan diferentes iniciadores para los terneros. Lesmeister y Heinrichs (2004) sugirieron que el tipo de maíz procesado (maíz entero, rolado tostado, rolado en seco, o con vapor) que se utiliza en la mezcla de iniciador influye en la ingesta, el crecimiento y los parámetros del rumen en terneros neonatales.

## *2.2 Importancia de la nutrición y manejo en la fase de cría respecto a la etapa productiva.*

Los programas de alimentación acelerados para el becerro Holstein en la etapa de crianza están siendo implementados cada vez más en un esfuerzo por acelerar el crecimiento de las hembras para que estén listas para la cría a una edad temprana. Los resultados de estudios en terneros Holstein durante los últimos 20 años han demostrado que el consumo de nutrientes en el pre-destete, ya sea leche natural o sustituto de leche, pueden tener profundos efectos sobre el desarrollo del ternero tal que puede mejorar su vida productiva a largo plazo (Soberon y Van Amburgh, 2013).

En algunos estudios se ha observado que en terneros Holstein alimentados con sustituto lechero (0.66 kg de MS/d con 27% PC y 17% de grasa) destetados a los 28 o 42 d obtienen ganancias de peso promedio de hasta 1.2 kg/d entre los 56 y 84 d de edad y de 0.78 kg considerando el día de nacimiento hasta los 84 d de edad. Esto al compararlos con terneros que fueron alimentados con sustitutos lecheros con concentraciones más elevadas de PC y grasa y con un periodo más largo al destete (Hill *et al*., 2009).

Por otra parte, algunos investigadores destacan que los terneros son más sensibles al nivel nutricional en el pre-destete cuando se relaciona con el impacto a largo plazo en la producción de leche (Bronw *et al.,* 2002; Soberon *et al.,* 2011). Otro factor importante que se ha relacionado desde hace bastante tiempo es el impacto que tiene el peso al nacimiento sobre la vida productiva del animal. Ya desde los años 50´s varios investigadores como Pierce *et al.* (1954), realizaron estudios con ganado de carne (novillos Hereford) en donde encontraron una variación en la ganancia de peso asociado con el peso al nacimiento. Al realizar un análisis de regresión encontraron que, para cada diferencia en el peso al nacer de 1 libra, hubo una diferencia en la ganancia por día durante el estudio de 0.013 de libra con los terneros más pesados al nacimiento ganando peso más rápido durante el periodo de la prueba.

Algunos investigadores reportan que lo que pasa en el periodo crítico neonatal tiene un impacto en el desempeño productivo en vaquillas Holstein y en general se podría asumir el mismo impacto en los novillos Holstein. Sin embargo, es necesario generar estudios donde se evalué específicamente el impacto de la crianza sobre comportamiento productivo a largo plazo en novillos Holstein.

### *2.3 Comportamiento en Corral*

Convencionalmente los becerros son destetados y luego son criados hasta aproximadamente 275 libras (125 kg) antes de enviarlos a los corrales de engorda. Estos becerros llegan al corral de engorda acostumbrados a las dietas molidas, a los comederos y a dietas altas en concentrado (aproximadamente 80% de concentrado) (Duff y McMurphy, 2007). Los novillos Holstein son diferentes al ganado de carne en lo que respecta al espacio en corral que requieren y al manejo. La diferencia más obvia es un tamaño de talla más grande. Este ganado permanece típicamente en alimentación por períodos más largos de tiempo. También tienen mayores requerimientos de energía, ya que son criados para la producción de leche, y por lo tanto producen más calor metabólico que la mayoría de las razas de carne (Rodenburg s. f.).

En general las razas lecheras requieren aproximadamente un 20% más de energía que las razas de carne (Blaxter y Wainman, 1966). Garrett (1971), mostró un incremento del 25% en el consumo de alimento en novillos Holstein para mantener la energía corporal, cuando los comparó con novillos Herford. Otro aspecto importante es que responden con mayores ganancias a las dietas altas en grano que los novillos de carne (Chester-Jones y DiCostanzo, 1996).

### *2.4 Peso de arribo al corral de engorda*

Desde varios años se ha estudiado el peso de arribo o peso inicial del ganado de carne y sus cruzas (novillos y vaquillas) al corral de engorda, la mayoría de estos estudios se han basado en análisis de la información procedentes de cierres de corrales de engorda comerciales. La información que comúnmente se recaba consiste en el peso de llegada, sexo, época de entrada al corral, peso maduro final, composición energética de la dieta, consumo de materia seca, ganancia diaria de peso, eficiencia alimenticia, rendimiento en canal, grado de rendimiento entre otros.

En un estudio Hicks *et al.* (1990), midieron el consumo de materia seca en novillos de carne en corral de engorda debido a la influencia del peso inicial, el tiempo de alimentación y la estación del año en que el ganado llegaba a los corrales de engorda. Encontraron que conforme el peso inicial en corral de engorda aumentaba el consumo de materia seca también incrementaba, y debido a la relación existente entre el peso inicial y el consumo de materia seca incluyeron el peso inicial reducido junto con los días en alimentación y el consumo de materia seca observado a partir de los 8 a los 28 días en un modelo para predecir el consumo de materia seca.

Por otra parte, Koknaroglu *et al.* (2005) evaluaron los factores que afectan el desempeño del ganado y los costos de producción, tales como los efectos del tipo de corrales, la temporada, el peso corporal inicial, el nivel de concentrado, el sexo, el tamaño del corral y la ubicación de la engorda sobre determinadas características económicas y de rendimiento, a saber, consumo de alimento, ganancia de peso, eficiencia alimenticia y rentabilidad. Los autores observaron que, con el aumento del peso corporal inicial, el consumo de materia seca y la ganancia de peso aumentaban, y el ganado se volvió menos eficiente.

De la misma manera, Zinn *et al.* (2008) evaluaron la predicción del peso al sacrificio y otras medidas del rendimiento de ganado en corral de engorda a partir del peso inicial reducido basado en miles de registros correspondientes a corrales de engorda comerciales. En el estudio, se encontró que los corrales de ganado con mayor peso inicial reducido tenían mayor ganancia diaria de peso (figura 1), consumo de materia seca y peso final reducido, pero una eficiencia alimenticia y un rendimiento en canal más bajos. Además, observaron una relación importante del peso inicial mermado con el peso final mermado, consumo de materia seca, ganancia diaria de peso, eficiencia alimenticia, rendimiento en canal y grado de rendimiento ($r^2$: 0.66, 0.83, 0.65, -0.30, -0.62, 0.44, respectivamente) en novillos cruzados.

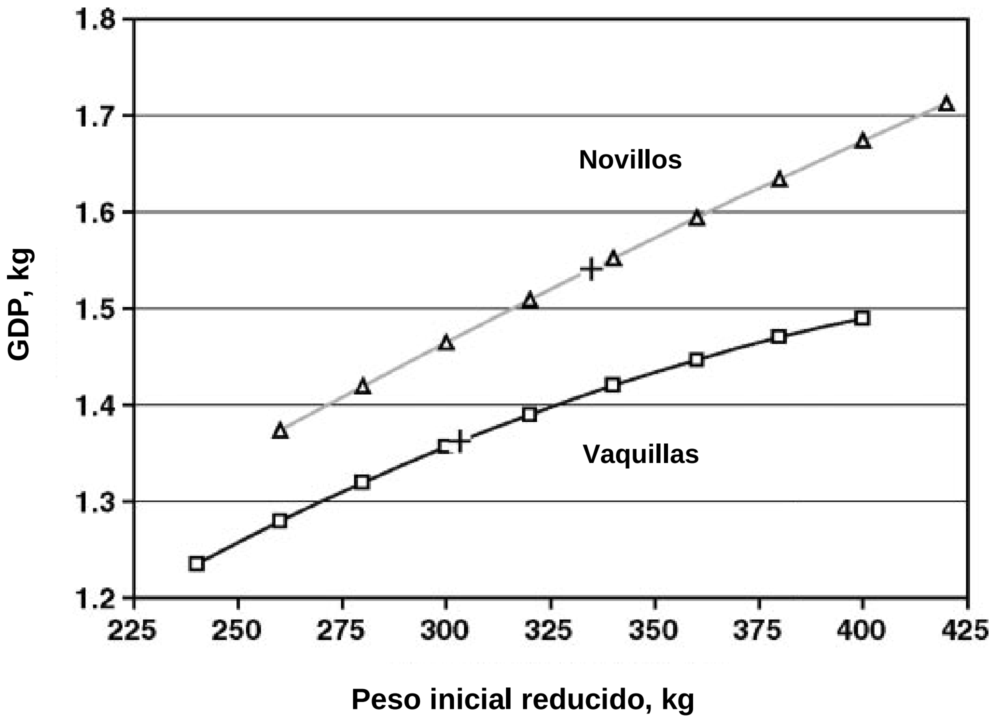


**Figura 1.** Ganancia diaria promedio estimada a partir del peso inicial reducido (SIW, por sus siglas en ingles) en novillos (GDP = 0.72 + 0.0029 SIW − 0.00000142 $SIW^2$; $r^2$ = 0.25; Sy,x = 0.147; $P$ < 0.001) y vaquillas (GDP = 0.5015 + 0.004027 SIW − 0.00000397 $SIW^2$; $r^2$ = 0.22;

Sy,x = 0.127; *P* < 0.001) en corrales de engorda comerciales (El símbolo + identifica el valor promedio para ambos sexos). Adaptado de Zinn *et al.* (2008).

Por otra parte, Bittner (2016) examinó los efectos de la edad del novillo y el peso corporal inicial en el rendimiento del crecimiento en corral de engorda en estudios realizados entre 2002 y 2015. Observo que, a medida que aumentó el peso corporal inicial, la materia seca ofrecida (kg/d) durante todo el período de alimentación aumentó de forma cuadrática. Para todos los grupos de edad y clase de peso inicial de los novillos, el cálculo de la materia seca ofrecida como porcentaje del peso corporal actual fue relativamente constante durante todo el período de alimentación. Se observó un aumento cuadrático en la ganancia diaria de peso a medida que aumentaba el peso corporal inicial. A medida que se colocó ganado más pesado dentro de cada grupo de edad, la eficiencia alimenticia disminuyó linealmente. Los autores reportaron que, la predicción de la ingesta y el rendimiento del crecimiento durante todo el período de alimentación dependen de la edad del novillo y del peso inicial al comenzar la dieta de finalización.

En otro estudio, Diler *et al.* (2016) utilizaron un total de 27 toros jóvenes (13 Brown Swiss (BS) y 14 Holstein Friesian (HF)) para investigar los efectos del peso inicial en la engorda [(grupo de peso ligero (GL = 176.0 ± 3.5 kg) y grupo de peso pesado (GP = 213.8 ± 3.7 kg)] sobre el rendimiento y características de la canal. Los autores observaron que, al aumentar el peso inicial de engorda el desempeño productivo en corral y las características de la canal también aumentaron (peso final, peso de la canal fría, peso del corazón y el peso de las patas delanteras y traseras). Todas las medidas de la canal se vieron significativamente afectadas por el peso inicial a favor de los novillos en Holstein friesian. Los autores concluyeron que los toros jóvenes en el grupo de novillos pesados tuvieron mejores características de la canal que los toros más ligeros en peso, mientras que el rendimiento y la relación de eficiencia alimenticia de los animales en los diferentes grupos de peso no fueron estadísticamente diferente.

Koçak *et al.* (2004), investigaron los efectos del inicio del engorda y de la temporada sobre el rendimiento y algunas características de la canal de novillos jóvenes Holstein en condiciones intensivas. Agruparon 1661 novillos Holstein según su peso de inicial (176-225 kg, 226-275 kg, 276-325 kg y 326-400 kg) y la temporada en la que se inició el engorda. En el estudio, los grupos que tenían un peso más bajo desde el comienzo hasta el engorda ganaron pesos más altos durante los 210 días de alimentación.

En otro estudio, Cano *et al.* (2017) dividieron cincuenta y cuatro novillos Holstein en dos grupos, ligeros y pesados (PV= 141 ± 4.9 kg y PV = 454.2 ± 7,0 kg, respectivamente), en un experimento de 56 días para evaluar la influencia de la vitamina E suplementaria sobre el rendimiento del crecimiento y concentraciones plasmáticas de vitamina. Los autores reportaron que, los novillos con mayor peso tuvieron una mayor ganancia diaria promedio, ingesta de materia seca y menor eficiencia alimenticia.

Como se ha reportado en varios estudios, el peso inicial tiene un efecto importante sobre el comportamiento productivo del ganado alimentado en corrales de engorda. Cabe mencionar que la mayoría de estas evaluaciones han sido en ganado de carne y sus cruzas, con una variación muy amplia en el peso y la edad de llegada al corral de engorda.

Por otra parte, los novillos de la raza Holstein arriban al corral de engorda con edades muy similares, pero con diferencias significativas en el peso de llegada >45% (110 a 160 kg; Duff y McMurphy 2007), señalando una diferencia en el manejo de estos animales antes de la llegada al corral de engorda.

## LITERATURA CITADA


Bittner, C. (2016). Effects of feed additives and body weight on growth performance and carcass characteristics of beef finishing cattle. [Thesis; for the Degree of Doctor of Philosophy. University of Nebraska – Lincoln]. Theses and Dissertations in Animal Science. https://digitalcommons.unl.edu/animalscidiss/130/

Blaxter, K. L., and F. W. Wainman. 1966. The fasting metabolism of cattle. British J of Nutr. 20(1): 103–10.

Brown, E. G., M. J. Vandehaar., K. M. Daniels., J. S. Liesman., L. T. Chapin. and M. S. Nielsen. 2002. Increasing Energy and Protein Intake of Holstein Heifer Calves Increases Mammary Development. J. Dairy Sci. 85:80 (Abstr.).

Cano, A. B., M. Montaño., J. Salinas-Chavira. and R. A. Zinn. 2017. Evaluation of supplemental vitamin E on 56-day feedlot growth performance and plasma tocopherol concentrations in calf-fed Holstein steers. Journal of Applied Animal Research. 45:90-92.

Chester-Jones, H., and DiCostanzo A. 1996. Holstein Feeding Programs. University of Minnesota Extension, Department of Animal Science. https://fyi.extension.wisc.edu/wbic/files/2010/11/Holstein-Feeding-Programs-MN.pdf

Diler, A., R. Kocyigit., M. Yanar., R. Aydin. and N. Tuzemen. 2016. Effects of different initial weights on fattening performance, slaughter and carcass characteristics of Holstein Friesian and Brown Swiss young Bulls. Indian J. Anim. Res. 50 (1) 112-117

Duff, G. C., and C. P. McMurphy. 2007. Feeding Holstein Steers from Start to Finish. Vet Clin Food Anim. 23: 281–297.

Faber, S. N., T. C. McCauley. and R. L. Ax. 2005. Case Study: Effects ofcolostrums ingestion on lactational performance. Prof. Anim. Sci. 420-425.

Garrett, W. N. 1971. Energetic efficiency of beef and dairy steers. J Anim Sci. 32(3):451–6.

Hill, T. M., H. G. Bateman II., J. M. Aldrich. and R. L. Schlotterbeck. 2010. Effect of Milk Replacer Program on Digestion of Nutrients in Dairy Calves. J. Dairy Sci. 93:1105–1115.

Hicks, R. B., F. N. Owens., D. R. Gill., J. W. Oltjen. and R. P. Lake. 1990. Dry matter intake by feedlot beef steers: Influence of initial weight, time on feed and season of year received in yard. Journal of Animal Science 68, 254-265.

Koknaroglu, H. D., D. Loy., D. E. Wilson., M. P. Hoffman. and J. D. Lawrence. 2005. Factors affecting beef cattle performance and profitability. The Professional Animal Scientist 21, 286-296.

Koçak, Ö., B. Ekiz., A. Yilmaz. and H. Güneş. 2004. Some Fattening and Slaughter Characteristics of Holsteın Young Bulls in Intensive Conditions. Uludag Univ. J. Fac. Vet. Med. 23, 1-2-3: 65-69.

Lesmeister, K. E., and A. J. Heinrichs. 2004. Effects of corn processing on growth characteristics, rumen development, and rumen parameters in neonatal dairy calves. Journal of Dairy Science. 87, 3439-3450.

Pierce, C. D., H. G. Avery., M. Burris. And R. Bogart. 1954. Rate and Efficiency of Gains in Beef Cattle II. Some Factors affecting Performance Testing. Station Technical Bulletin P3. Agricultural Experiment Station Oregon State College Corvallis.http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/8548/tec_bul_3_.pdf?sequence=1

Rodenburg, J., A. Godkin. Culling dairy cowsddairy producers affected by U.S. border closure. Ministry of agriculture, food and rural affairs. Available at: http://www.omafra.gob.on.ca/english/livestock/dairy/facts/cullingcows.htm.

Soberon, F., E. Raffrenato., R. W. Everett. And M. E. Van Amburgh. 2011. Preweaning Milk Replacer Intake and Effects on Long-Term Productivity of Dairy Calves. J. Dairy Sci. 95 :783–793

Soberon, F., and M. E. Van Amburgh. 2013. The effect of nutrient intake from milk or milk replacer of preweaned dairy calves on lactation milk yield as adults: A meta-analysis of current data. J. Anim. Sci. 91:706–712.

USDA -APHIS- VS- NAHMS. Dairy 2002. Part1. Reference of Dairy Health and Management in the United States. Avaialble: http://www.aphis.usda.gov/vs/ceah/ncahs/nahms/dairy/dairy02/Dairy02Pt1.pdf.

Zinn, R. A., A. Barreras., F. N. Owens. and A. Plascencia. 2008. Performance by feedlot steers and heifers: Daily gain, mature body weight, dry matter intake, and dietary energetics. Journal of Animal Science 86, 2680-2689.

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## Capítulo III

# Growth performance and carcass characteristics of calf-fed Holstein steers with different birth and arrival weights but similar ages

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Different arrival weights but similar ages in calf-fed Holstein steers

## Abstract

Aspects of rearing phase and arrival body weight influence feedlot growth performance. Consequently, three hundred calf-fed Holstein steers (age 113 ± 1-d) were distributed in a completely random unbalanced design and divided into five categories (105 kg, 112 kg, 117 kg, 123 kg and 129 kg) initial shrunk weight (SIW) to evaluate the effect of arrival weight on feedlot growth performance and carcass characteristics of Holstein steers of similar age. Calves were weighed upon arrival at the feedlot and subsequently on d 112, 224 and 361 of the study. Growth performance and estimated dietary net energy were evaluated for each period and for the study, as a whole (1 to 361-d). During the rearing period, ADG increased (linear effect, *P* < 0.01) with increasing birth weight. Birth weight was associated (*P* < 0.05) with SIW ($r^2$ = 0.47) and final harvest weight ($^{r2}$ = 0.36). Overall ADG increased (*P* < 0.01) with increasing SIW. Dry matter intake increased linearly during the first 224-d, but quadratically during the last 137 days. Overall, there was a quadratic effect (*P* < 0.05) of SIW on gain efficiency and observed vs expected dietary NE, with lower estimated efficiencies (4%) for steers in both the lightest and heaviest SIW. Hot carcass weight, LM area, marbling score and fat thickness increased (linear effect, *P* ≤ 0.03) as SIW increased, whereas KPH and yield-grade were unaffected. Growth performance, estimated energetic efficiency and carcass characteristics of Holstein steers of similar age are influenced by the SIW. The effect is more pronounced in the steers less than 112 kg.

**Keywords:** Initial body weight, Holstein calves, feedlot

## Implications

Growth-performance, estimated dietary energetic efficiency and carcass characteristics of calf-fed Holstein steers of similar age are influenced by the initial arrival weight distribution. The effect is more pronounced in the lighter 10% of steers.

## Introduction

Differences in initial arrival weight influences feedlot growth performance (Hicks et al.,1990; Koknaroglu et al., 2005; Demircan, 2008; Zinn et al., 2008; Hicks et al., 2015). Based on feedlot close-out analysis, Zinn and Oltjen (1991) observed that for crossbred beef calves entering the feedlot at similar age, feedlot performance is a predictable function of initial weight. In Holstein steers this may not be the case. Whereas arrival weights typically may vary by >45% (110 to 160 kg; Duff and McMurphy, 2007), calf age on arrival at the feedlot typically differs by only a few days. To our knowledge, there are no studies that directly assess the effects of arrival weight of Holstein calves with similar ages on growth performance, dietary energetics and carcass characteristics. Therefore, the objective of this study was to evaluate the growth performance and carcass characteristics of calf-fed Holstein steers with different birth and arrival weights at similar ages.

## Material and methods

Animal care and management were approved by the University of California, Davis, Animal Use and Care Committee (protocol #20548).

### *Animals and diets*

Three hundred Holstein calves were used in a 361-d experiment to evaluate the influence of arrival weight at similar age on feedlot growth performance, dietary net energy, and carcass characteristics. Calves were obtained from a commercial calfranch located in Tulare, CA. The body weight at birth, age in days and arrival off-truck body weight were used to estimate calf performance during the rearing phase. Upon arrival at the University of California Desert Research and Extension Center (Holtville, CA,), steers were vaccinated against bovine rhinotracheitis-parainfluenza (Cattle Master Gold FP 5 L5, Zoetis, New York, NY), clostridials (Ultrabac-7, Zoetis, New York, NY), treated against internal and external parasites (Dectomax Injectable, Zoetis, New York, NY), subcutaneously injected with 1,500 IU vitamin E (as d-alpha-tocopherol) 500,000 IU vitamin A (as retinyl-palmitate) and 50,000 IU vitamin D3 (Vital E-A + D3, Stuart Products, Bedford, TX), and 2.4 g oxytetracycline (LA-200, Zoetis, New York, NY), branded, and ear-tagged. Steers were blocked by initial shrunk (off truck) weight into five weight groupings from 105 kg to 129 kg of shrunk initial body weight. Steers were sorted into 5 weight groupings: 105 kg, 112 kg, 117 kg, 123 kg and 129 kg of initial body weight. They were then random assigned within weight groupings to 50 pens, 6 steers/pen. Pens were 78 $m^2$ with 33 $m^2$ of overhead shade, automatic waterers, and fence-line feed bunks. Calves were fed steam flaked corn-based diets (Table 1). The receiving diet (2.21 Mcal NEm/kg DM) was fed during the initial 112-d on feed. From d 112 until harvest all steers received the finishing diet (2.27 Mcal NEm/kg DM). Diets were prepared at weekly intervals and stored in plywood boxes located in front of each pen. Steers were allowed ad libitum access to feed, which was provided twice daily. On d 120 and 224, all steers were injected subcutaneously with 500,000 IU vitamin A, and implanted with Revalor-S (Intervet, Millsboro, DE). Sequential minimum and maximum average air temperature and temperature humidity index (THI) during course of the study are given in Figure 1.

*Estimation of Dietary NE*

Energy gain (EG) was calculated by the equation: $EG = ADG^{1.097}\ 0.0557W^{0.75}$, where EG is the energy deposited (Mcal/d), W is the mean shrunk body weight (SBW in kg; NRC 1984). Maintenance energy (EM) was calculated by the equation: $EM=0.086W^{0.75}$ (NRC, 1988; Fox and Black, 1984). Dietary NEg was derived from NEm by the equation: NEg = 0.877 NEm - 0.41 (Zinn, 1987). Dry matter intake is related to energy requirements and dietary NEm according to the equation: DMI = (EM/NEm) + (EG/(0.877NEm - 0.41)), and can be resolved for estimation of dietary

NE by means of the quadratic formula: $x = (-b - \sqrt{b2\text{-}4ac})/2c$, where x = NEm, a = -0.41 EM, b = 0.877EM + 0.41 DMI + EG, and c = -0.877 DMI (Zinn and Shen, 1998).

*Carcass Data*

Hot carcass weights (HCW) were obtained at time of slaughter. After carcasses chilled for 48 h, the following measurements were obtained: LM area ($cm^2$) by direct grid reading of the LM at the 12th rib; subcutaneous fat (cm) over the LM at the 12th rib taken at a location 3/4 the lateral length from the chine bone end (adjusted by eye for unusual fat distribution); KPH as a percentage of HCW; marbling score (USDA 1965; using 3.0 as minimum slight, 4.0 as minimum small, 5.0 as minimum modest, 6.0 as minimum moderate, etc.), and estimated retail yield of boneless, closely trimmed retail cuts from the round, loin, rib and chuck (% of HCW; Murphey et al*.,* 1960) = 52.56 - 1.95 × subcutaneous fat - 1.06 × KPH + 0.106 × LM area - 0.018 × HCW.

*Statistical Design and Analysis*

For calculating steer performance, interim and final BW were reduced 4% to account for digestive tract fill. Pens were used as experimental units. The experimental data were analyzed as completely random unbalanced design according to the following statistical model: $Y_{ij} = \mu + W_i + \varepsilon_{ij}$ (Hicks, 1973), where μ is the common experimental effect, Wi represents initial weight effect (df = 4), and εij represents the residual error (df = 45). Treatments effects were tested using the orthogonal polynomials: linear and quadratic. Significant effect was considered at $P < 0.05$ (SAS Inst. Inc., Cary, NC).

**Results and discussion**

Morbidity and mortality were low (4.3 and 1.0%, respectively), and not affected by weight grouping ($P > 0.20$). The influence of body weight at birth on growth performance during the rearing phase is shown in Table 2. During the rearing period, ADG increased (linear effect, $P < 0.01$) with increasing birth weight. Birth weight was positively associated with feedlot arrival weight ($r^2 = 0.47$, $P < 0.01$) and final harvest weight ($r^2 = 0.36$, $P < 0.05$). Consistent with the present study, Maccari et al. (2015) observed an average birth weight of 44 kg and ADG of 0.69 kg/d for Holstein calves during rearing phase. Likewise, Bailey and Mears (1990) observed a positive correlation between birth weight of Holstein calves and ADG from birth to weaning (100 kg), accounting for between 24 and 42% of the variation in preweaning ADG. They also observed an association between birth weight and both rate ($r^2$ = 0.21) and efficiency ($r^2$ = -0.30) of post weaning ADG. Robinson et al. (2013) observed that weaning weight increased by 1.53 kg/1 kg increase in birth weight. Evaluating long-term effects of birth weight and growth to weaning on feedlot performance and carcass yield of Piedmontese and Wagyu-cross cattle, Greenwood et al. (2006) observed that lower birth-weight calves and calves that had slower birth to weaning ADG had poorer growth performance during the feedlot phase compared with high birth weight and rapid preweaning growth calves. The influence of feedlot arrival weight on growth performance and carcass characteristics are shown in Tables 3 and 4. Overall (361-d) ADG increased (linear effect, $P < 0.01$) with increasing arrival weight. Likewise, Salinas Chavira et al. (2009) and Cano et al. (2017) observed greater ADG for calf-fed Holstein steers with heavier vs lighter initial arrival weight. In as much as all steers were of similar age (113 to 114 d), differences in arrival weight are a function of both birth weight and ADG during the rearing phase. The extent to which these two factors relate to frame was not assessed in this study. However, as a breed, frame size of Holstein steers can be quite variable, with an observed range of between 7.6 to 9.3 (Reed et al., 2017). Differences in frame size are directly related to differences in mature size (USDA, 2001) and ADG (McCarthy et al., 1985; Tatum et al., 1986; Solís et al., 1989; Boyles et al., 1992; Koknaroglu and Hoffman, 2010). Steers in the 129 kg weight grouping were heavier throughout the study whereas steers in the 105 kg weight grouping remained lighter throughout the study (Figure 2). Consistent with previous studies (Salinas Chavita et al*.,* 2009) ADG among steer groups was greater during the first and second 112-d feeding periods (65.0 and 39.9%, respectively) than during the final period (224 to 361-d) of the study. As expected, differences in ADG reflected greater relative DMI (as % BW) during the initial two 112-d periods vs the final period (31.3 and 14.6% greater intake as a proportion of BW, respectively). Dry matter intake increased as initial body weight increased. The effect was linear ($P < 0.01$) until d 224 and for the overall feeding period (1 to 361 d). There was a quadratic effect ($P < 0.01$) of initial weight on DMI during the final period (last 137-d of the study), with the heavier weight grouping consuming 7.8% more DM than the average of the other groupings. The overall increase in DMI with increasing initial weight is consistent with concomitant increases in overall ADG. Salinas-Chavira et al. (2009) divided 144 newly received Holstein steers into two body weight groupings (lighter-half, averaging 117 kg and heavier-half, averaging 121 kg). Consistent with the present study, they observed that although the difference in average initial weight of the two groupings was only 5 kg, the heavier grouping had greater overall (340-d) DMI associated with greater ADG. According to NRC (1996) initial live weight accounts for 60% of the variation in DMI among feedlot cattle within sex and frame-size. Due to the protracted nature of the feeding period of calf-fed Holstein steers, relatively small differences in DMI, and hence ADG, result in appreciably significant differences in final carcass weight. This effect was most noticeable for steers in lightest initial weight grouping (representing 10% of total cattle received). The relationship between days on feed and DMI is shown in Figure 3. Consistent with previous studies (Zinn et al., 2008; Salinas-Chavira et al., 2009), trends in DMI reflect differences in initial weight. Weight groupings did not affect gain efficiency during the initial 112-d period. During the second 112-d period gain efficiency decreased (linear effect, $P < 0.05$) as initial body weight increased. During the final 137-d period and overall (1 to-361 d), there was a quadratic effect ($P < 0.05$) of initial weight grouping on gain efficiency, with efficiency being poorer (4%) for steers in both the lightest and heaviest weight groupings. Salinas-Chavira et al. (2009), observed greater gain efficiency for heavier vs lighter Holstein steers weight groupings, noting that the effect was more pronounced during late finishing phase. The overall (361-d) estimated dietary NE based on growth performance was in close agreement (100.3%) with expected based on diet formulation. The ratio of observed/expected dietary NE increased as initial body weight increased during the first 112-d (linear effect, $P < 0.01$). During the late finishing phase and overall, there was a quadratic effect ($P < 0.01$) of initial weight grouping on ratio of observed/expected NE, being maximal for steers in the 117 kg weight grouping. During the initial 112-d period the lower ratio is a reflection of dietary metabolizable amino acid deficiency (Zinn et al., 2007). The quadratic component to overall efficiency (361-d) is largely attributable to poorer performance and efficiency of steers in the lightest weight grouping. Treatment effects on carcass characteristics are shown in Table 4. Shrunk final weight, hot carcass weight, LM area, marbling score and fat thickness increased (linear effect, $P \leq 0.03$) with increasing SIW. Kidney pelvis heart fat and yield grade were not influenced ($P >$ 0.10) by the initial weight grouping. Likewise, Salinas-Chavira et al. (2009) observed greater HCW and LM area in heavier vs lighter Holstein steer groupings. Final harvest weight of the feedlot cattle predictably increased with respect to the initial weight when place into the feedlot (Zinn et al., 2008). Torrentera and Zinn (2005), observed that the final body weight explained 89% of the variation in hot carcass weight. Similarly, Cerino-Limón et al. (2012) observed for cattle of similar initial weight, increasing weight at harvest influences hot carcass weight, LM area, degree of marbling, quality grade, subcutaneous fat, and KPH.

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**Declaration of interest**

Author declare no conflict of interest.

**Ethics statement**

Animal care and management were approved by the University of California, Davis, Animal Use and Care Committee (protocol #20548).

**Software and data repository resources**

None of the data were deposited in an official repository.

**References**

Bailey CB and Mears GJ 1990. Birth Weight in Calves and its Relation to Growth Rates From Birth to Weaning and Weaning to Slaughter. Canadian Journal of Animal Science 70, 167-173.

Boyles S, Flakoll T and Ringwall K 1992. The Feeder Calf Grading System. NDSU. www.ag.ndsu.edu.

Cano AB, Montano M, Salinas-Chavira J and Zinn RA 2017. Evaluation of supplemental vitamin E on 56-day feedlot growth performance and plasma tocopherol concentrations in calf-fed Holstein steers. Journal of Applied Animal Research 45, 90-92.

Cerino-Limón G[1]*, García-Elizondo[2] R, López-Trujillo[3] R, Fuentes-Rodríguez[2] JM y Ruiz-Zarate[2] F. 2012. Characteristics of the Live Animal Related to the Grades of Quality and Yield of the Carcass of Feedlot Steers. Agraria 9, 15-25.

Demircan V 2008. The effect of initial fattening weight on sustainability of beef cattle production in feedlots. Spanish Journal of Agricultural Research 6, 17-24.

Duff GC and McMurphy CP 2007. Feeding Holstein steers from start to finish. Veterinary Clinics of North America: Food Animal Practice 23, 281-297.

Fox DG, Black JR 1984. A system for predicting body composition and performance of growing cattle. Journal of Animal Science 58, 725–739.

Greenwood PL, Cafe LM, Hearnshaw HD, Hennessy W, Thompson JM and Morris SG 2006. Long-term consequences of birth weight and growth to weaning on carcass, yield and beef quality characteristics of Piedmontese- and Wagyu-sired cattle. Australian Journal of Experimental Agriculture 46, 257-269.

Hicks CR 1973. Fundamental Concepts in the Design of Experiments. Holt, Rinehart and Winston, Inc., New York, NY.

Hicks RB, Owens FN, Gill DR, Oltjen JW and Lake RP 1990. Dry matter intake by feedlot beef steers: Influence of initial weight, time on feed and season of year received in yard. Journal of Animal Science 68, 254-265.

Hicks[1] RB, Lake[2] RP and Owens[3] FN 2015. Dry matter intake patterns of feedlot cattle. Journal Animal Science 93, Suppl. s3 (Abstr).

Koknaroglu HD, Loy D, Wilson DE, Hoffman MP and Lawrence JD 2005. Factors affecting beef cattle performance and profitability. The Professional Animal Scientist 21, 286-296.

Koknaroglu[1] H and Hoffman[2] MP 2010. Effect of frame score on performance and carcass characteristics of steers finished in the feedlot or backgrounded for various time on pasture and finished in the feedlot. Archiv Tierzucht 53, 426-435.

Maccari P, Wiedemann S, Kunz HJ, Piechotta M, Sanftleben P and Kaske M. 2015. Effects of two different rearing protocols for Holstein bull calves in the first 3 weeks of life on health status, metabolism and subsequent performance. Journal of Animal Physiology and Animal Nutrition 99, 737-746.

Mader TL, Davis MS and Brown-Brandl T 2006. Environmental factors influencing heat stress in feedlot cattle. Journal of Animal Science 84, 712–719.

McCarthy FD, Hawkins DR and Bergen WG 1985. Dietary energy density and frame size effects on composition of gain in feedlot cattle. Journal of Animal Science 60, 781-790.

Murphey CE, Hallett DK, Tyler WE and Pierce JC 1960. Estimating yields of retail cuts from beef carcasses. In: Proceedings 62nd Meeting of the American Society of Animal Production, Chicago, Illinois. p. 1–12.

NRC 1984 Nutrient Requirements of Beef Cattle. 6th rev. ed. Natl. Acad. Press, Washington, DC.

NRC 1988 Nutrient requirement of dairy cattle (6th Rev. Ed.). National Academy Press, Washington, DC.

NRC 1996. Nutrient Requirements of Beef Cattle. 7th rev. ed. Natl. Acad. Press, Washington, DC.

Reed JA, Garrison MD, McEvers TJ, May ND, Walter LJ, Hutcheson JP and Lawrence TE 2017. Objective biometric measurements of calf-fed Holstein steers fed in confinement. Journal of Animal Science 95, 1205–1208.

Robinson DL, Cafe LM and Greenwood PL 2013. Meat science and muscle biology symposium: Developmental programming in cattle: Consequences for growth, efficiency, carcass, muscle, and beef quality characteristics. Journal of Animal Science 91, 1428-1442.

Salinas-Chavira J, Lenin J, Ponce E, Sanchez U, Torrentera N and Zinn RA 2009. Comparative effects of virginiamycin supplementation on characteristics of growth performance, dietary energetics, and digestion of calf-fed Holstein steers. Journal of Animal Science 87, 4101–4108.

Solís JC, Byers FM, Schelling GT & Greene LW 1989. Anabolic implant and frame size effects on growth regulation, nutrient repartitions and energetic efficiency of feedlot steers. Journal of Animal Science 67, 2792-2801.

Tatum JD, Dolezal HG, Williams Jr FL, Bowling RA and Taylor RE 1986. Effects of feeder-cattle frame size and muscle thickness on subsequent growth and carcass development. II. Absolute growth and associated changes in carcass composition. Journal of Animal Science 62, 121-131.

Torrentera N[1] and Zinn[2] RA 2005. Prediccting Carcass Dressing Percentage in Feedlot Bulls and Heifers. Journal of Animal and Veterinary Advances 4, 659-662.

USDA 1965. Official United States standards for grades of carcass beef. Consumer and marketing services, service and regulatory announcement No. 99. Washington, DC: U.S. Government Printing Office.

USDA 2001. United States Standards for Grades of Feeder Cattle. https://www.ams.usda.gov/sites/default/files/media/Feeder_Cattle_Standard%5B1%5 D.p df.

Zinn RA 1987. Influence of lasalocid and monensin plus tylosin on comparative feeding value of steam-flaked versus dry-rolled corn diets for feedlot cattle. Journal of Animal Science 65, 256-266.

Zinn RA and Oltjen JW 1991. Feeding feedlot cattle for optimal production. In: Large Animal Clinical Nutrition. JNM. Naylor, SL Ralston Eds. Mosby Year Book. SL MO.

Zinn RA and Shen Y 1998. An evaluation of ruminally degradable intake protein and metabolizable amino acid requirements of feedlot calves. Journal of Animal Science 76, 1280-1289.

Zinn RA, Calderon JF, Corona L, Plascencia A, Montaño MF and Torrentera N 2007. Phase feeding strategies to meet metabolizable amino acid requirements of calf-fed Holstein steers. Professional Animal Scientist 23, 333-339.

Zinn RA, Barreras A, Owens FN and Plascencia A 2008. Performance by feedlot steers and heifers: Daily gain, mature body weight, dry matter intake, and dietary energetics. Journal of Animal Science 86, 2680-2689.

**Table 1** Composition of receiving and finishing diets fed to Holstein steers

| Item | Days on feed | |
|---|---|---|
| | 1-112 | 112-361 |
| Ingredient composition (% DM) | Receiving | Finishing |
| Fishmeal | 2.5 | 0 |
| Corn grain flaked | 67.25 | 62.50 |
| Distillers dried grains Plus solubles | 0 | 15.0 |
| Canola meal | 6.00 | 0 |
| Alfalfa hay | 6.00 | 6.0 |
| Sudangrass hay | 8.00 | 6.0 |
| Molasses, cane | 4.00 | 4.0 |
| Yellow grease | 4.00 | 4.0 |
| Urea | 0.50 | 0.60 |
| Trace mineral salt[1] | 0.40 | 0.40 |
| Monensin[2] | + | + |
| Limestone | 1.20 | 1.35 |
| Magnesium Oxide | 0.15 | 0.15 |
| Nutrient composition[3] | | |
| $NE_m$, Mcal/kg | 2.22 | 2.27 |
| $NE_g$, Mcal/kg | 1.55 | 1.59 |
| Crude protein, % | 14.32 | 14.27 |
| Rumen DIP, % | 59.33 | 56.32 |
| Rumen UIP, % | 40.67 | 43.68 |
| Ether extract, % | 7.65 | 8.48 |
| Ash, % | 5.89 | 5.56 |
| NDF, % | 15.37 | 18.84 |
| Calcium, % | 0.80 | 0.71 |
| Phosphorus, % | 0.40 | 0.36 |
| Potassium, % | 0.82 | 0.82 |
| Magnesium, % | 0.29 | 0.29 |
| Sulfur, % | 0.22 | 0.19 |

[1]Trace mineral salt contained: $CoSO_4$, .068%; $CuSO_4$, 1.04%; $FeSO_4$, 3.57%; ZnO, 1.24%; MnSO4, 1.07%, KI 0.052%; and NaCl, 92.96%

[2]Monensin, 23 mg/kg (Elanco Animal Health, Greenfield, IN)

[3]Based on tabular values for individual feed ingredients (NRC, 1996)

**Table 2** Influence of birth weight on growth performance in the rearing phase in Holstein calves

| | Birth weight, kg | | | | | | *P* value | |
|---|---|---|---|---|---|---|---|---|
| Item | 41.7 | 41.9 | 43.4 | 43.6 | 44.8 | SEM | Linear | Quadratic |
| Calves | 28 | 87 | 79 | 58 | 17 | | | |
| Age at shipment, d[1] | 113 | 114 | 114 | 114 | 113 | 0.63 | 0.97 | 0.54 |
| ADG, kg | 0.559 | 0.611 | 0.649 | 0.695 | 0.737 | 0.01 | < 0.01 | 0.60 |
| Arrival weight, kg[2] | 105 | 112 | 117 | 123 | 129 | 0.75 | < 0.01 | 0.99 |

[1]Age of arrival to feedlot

[2]Initial off-truck arrival weight.

**Table 3** Influence of arrival weight on feedlot growth performance of Holstein steer

| | Initial body weight, kg | | | | | | *P* value | |
|---|---|---|---|---|---|---|---|---|
| Item | 105 | 112 | 117 | 123 | 129 | SEM | Linear | Quadratic |
| Pen replicates | 5 | 15 | 15 | 10 | 5 | | | |
| Birth live weight, kg | 41.7 | 41.9 | 43.4 | 43.6 | 44.8 | 1.0 | < 0.01 | 0.98 |
| Live weight, kg[1] | 105 | 112 | 117 | 123 | 129 | 0.75 | < 0.01 | 0.99 |
| 112-d | 250.3 | 264.8 | 271.6 | 282.3 | 289.9 | 3.4 | < 0.01 | 0.38 |
| 224-d | 413.2 | 431.6 | 439.6 | 445.5 | 458.1 | 5.6 | < 0.01 | 0.45 |
| Final | 583.7 | 616.8 | 623.7 | 614.5 | 639.8 | 10.1 | < 0.01 | 0.3 |
| ADG, kg | | | | | | | | |
| 1 to 112-d | 1.30 | 1.37 | 1.38 | 1.43 | 1.44 | 0.03 | < 0.01 | 0.36 |
| 112 to 224-d | 1.44 | 1.48 | 1.49 | 1.44 | 1.49 | 0.04 | 0.49 | 0.75 |
| 224 to 361-d | 1.23 | 1.33 | 1.36 | 1.27 | 1.37 | 0.04 | 0.06 | 0.26 |
| 1 to 361-d | 1.31 | 1.39 | 1.41 | 1.37 | 1.43 | 0.03 | < 0.01 | 0.27 |
| DMI, kg | | | | | | | | |
| 1 to 112-d | 4.79 | 4.96 | 5.09 | 5.23 | 5.35 | 0.08 | < 0.01 | 0.76 |
| 112 to 224-d | 7.19 | 7.34 | 7.49 | 7.44 | 7.84 | 0.15 | < 0.01 | 0.44 |
| 224 to 361-d | 9.38 | 9.29 | 9.31 | 9.18 | 10.16 | 0.12 | < 0.01 | < 0.01 |
| 1 to 361-d | 7.29 | 7.35 | 7.43 | 7.39 | 7.93 | 0.09 | < 0.01 | < 0.01 |
| ADG/DMI | | | | | | | | |
| 1 to 112 d | 0.271 | 0.276 | 0.271 | 0.273 | 0.269 | 0.004 | 0.55 | 0.36 |
| 112 to 224-d | 0.201 | 0.201 | 0.199 | 0.194 | 0.19 | 0.005 | 0.03 | 0.34 |
| 224 to 361-d | 0.131 | 0.143 | 0.147 | 0.138 | 0.134 | 0.004 | 0.77 | < 0.01 |
| 1 to 361-d | 0.18 | 0.189 | 0.189 | 0.186 | 0.18 | 0.003 | 0.68 | < 0.01 |
| Observed to expected diet NE (Mcal/kg) ratio | | | | | | | | |
| Maintenance | | | | | | | | |
| 1 to112-d | 0.904 | 0.936 | 0.939 | 0.959 | 0.966 | 0.011 | < 0.01 | 0.33 |
| 112 to 224-d | 0.981 | 1.008 | 1.009 | 1.012 | 1.001 | 0.017 | 0.33 | 0.15 |
| 224 to 361-d | 0.931 | 1.013 | 1.033 | 1.006 | 0.979 | 0.021 | 0.1 | < 0.01 |
| 1 to 361-d | 0.950 | 1.007 | 1.018 | 1.005 | 0.992 | 0.015 | 0.05 | < 0.01 |
| Gain | | | | | | | | |
| 1 to 112-d | 0.878 | 0.919 | 0.922 | 0.948 | 0.956 | 0.014 | < 0 .01 | 0.33 |
| 112 to 224-d | 0.976 | 1.01 | 1.012 | 1.015 | 1.002 | 0.022 | 0.33 | 0.15 |
| 224 to 361-d | 0.914 | 1.017 | 1.043 | 1.008 | 0.973 | 0.026 | 0.1 | < 0.01 |
| 1 to 361-d | 0.937 | 1.009 | 1.022 | 1.006 | 0.990 | 0.019 | 0.05 | < 0.01 |

[1]Initial and final live weights reduced 4% to account for fill

**Table 4** Influence of arrival weight on carcass traits of Holstein steers

| Item | Initial body weight, kg | | | | | SEM | *P* value | |
|---|---|---|---|---|---|---|---|---|
| | 105 | 112 | 117 | 123 | 129 | | Linear | Quadratic |
| Hot carcass weight, kg | 363.1 | 383.6 | 387.9 | 382.2 | 397.9 | 6.26 | < 0.01 | 0.3 |
| Dressing percentage | 61.7 | 62.4 | 62.5 | 62.2 | 61.5 | 0.34 | 0.61 | < 0.01 |
| KPH, %[1] | 2.4 | 2.4 | 2.4 | 2.4 | 2.5 | 0.16 | 0.7 | 0.47 |
| Fat thickness, cm | 0.56 | 0.68 | 0.63 | 0.66 | 0.74 | 0.06 | 0.03 | 0.91 |
| Longissimus area, $cm^2$ | 77.6 | 77.6 | 85.1 | 85.2 | 88.1 | 2.14 | < 0.01 | 0.87 |
| Marbling score[2] | 4.4 | 5.5 | 5.5 | 5.0 | 6.5 | 0.31 | < 0.01 | 0.62 |
| Retail yield, % | 50.4 | 49.7 | 50.6 | 50.7 | 50.5 | 0.29 | 0.19 | 0.84 |
| Yield grade | 2.7 | 3.0 | 2.6 | 2.6 | 2.7 | 0.12 | 0.16 | 0.86 |

[1]Kidney, pelvic, and heart fat as a percentage of carcass weight.
[2]Coded: minimum slight = 3, minimum small = 4, etc. (USDA, 1965)

**List of figures**

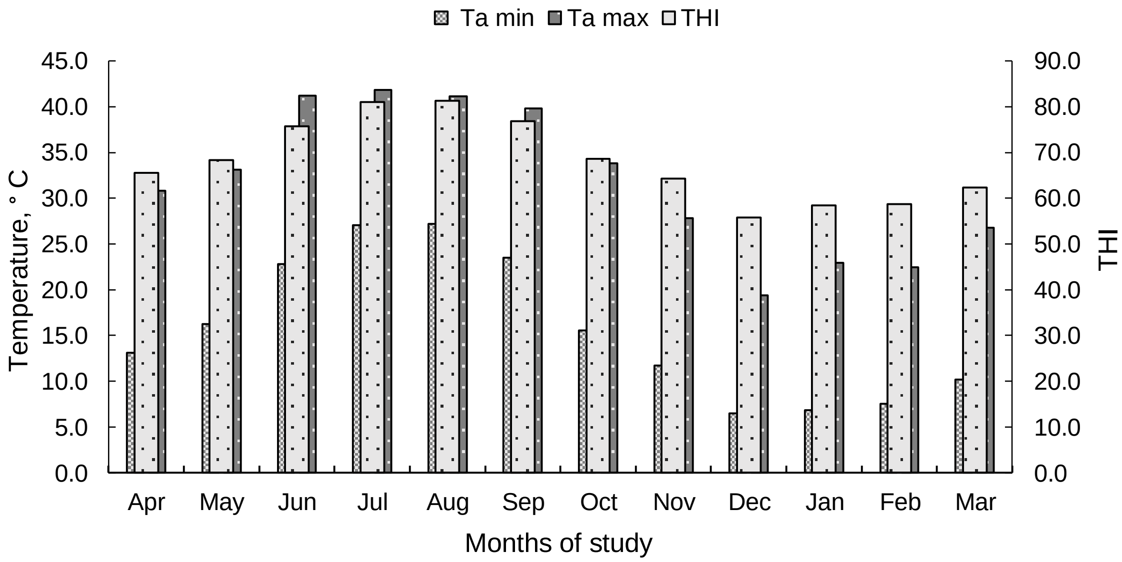


**Figure 1** Temperature and humidity index with respect to the months of the study (estimated from the model proposed by Mader et al., 2006).

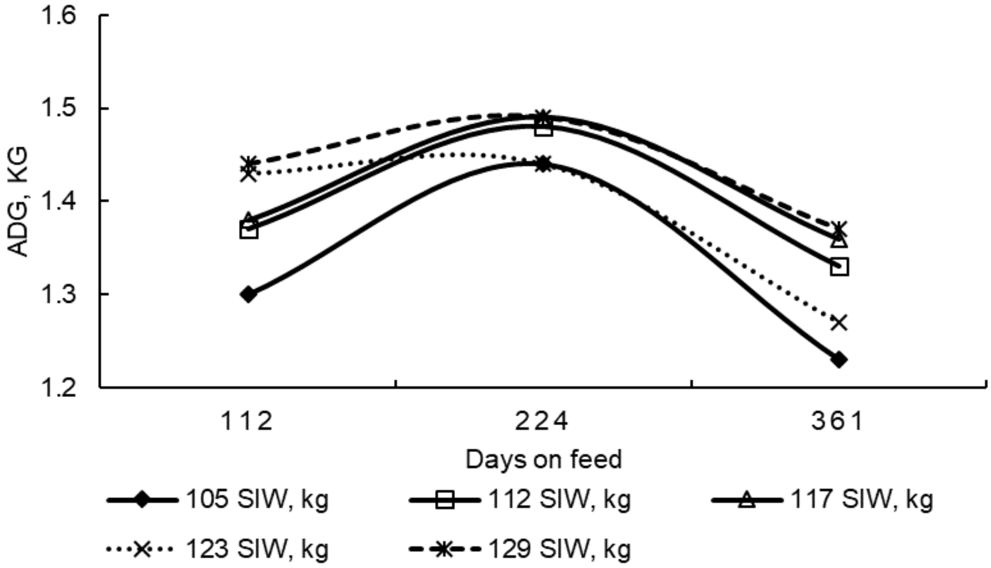


**Figure 2** Average daily gain with respect of days on feed of Calf-fed Holstein steers during the study.

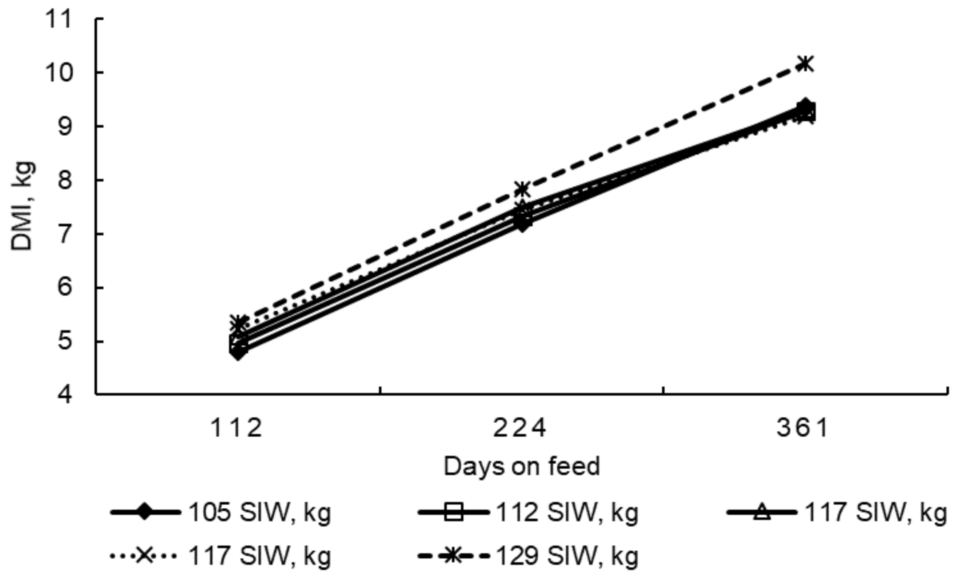


**Figure 3** Dry matter intake with respect of days on feed of Calf-fed Holstein steers during the study.

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Clave 2020-89

**Comparing the economic results obtained by feedlot Holstein steers with different arrival body weights.**

Comparación de resultados económicos obtenidos por becerros Holstein con diferentes pesos de arribo al corral.

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## ABSTRACT

The study compared the economic results between five groups of calf-fed Holstein steers with different arrival body weight but similar age in feedlot. The average arrival body weights were 105, 112, 117, 123 and 129 kg (30, 90, 87, 60 and 30 calves, respectively) with an age of 113 ± 1-d. The calves were distributed in a completely random unbalanced design. Calves were weighed upon arrival at the feedlot and subsequently on d 112, 224 and 361 of the study. Calves were fed with steam flaked corn-based diets. The receiving diet (2.21 Mcal of $NE_m$/kg DM) was fed during the initial 112 d on feed. From d 112 until harvest all steers received the finishing diet (2.27 Mcal of $NE_m$/kg DM). Due to the above, two partial feeding periods and one full period (1 to 112, 113 to 361 and 1 to 361 d, respectively) were evaluated. Each group profit was estimated by subtracting the purchase cost of calves plus the total feed cost from the revenue obtained from the sale of the steers. Overall weight gain and feed

intake were higher with ABW increased, however feeding efficiency was better for intermediate ABW groups (112 and 117 kg), being the steers with ABW of 112 kg the most profitable (15.8 dollar more than the 117 Kg. group).
Key words:

**RESUMEN**

El estudio compara los resultados económicos obtenidos por cinco grupos de novillos Holstein que arribaron al corral de engorda con diferente peso, pero edad similar. Los pesos promedios de arribo de los grupos fueron de 105,112,117,123 y 129 Kg (30, 90, 87, 60 y 30 becerros respectivamente por grupo) y con una edad de 113± 1d. Los becerros fueron distribuidos en un diseño completamente al azar desbalanceado. Los becerros fueron pesados al ingresar al corral y en los días 112, 224, y 361. La dieta se basó en maíz hojueleado. La dieta inicial (2.21 Mcal de ENm/kg MS) fue proporcionada durante los primeros 112 días. Del día 112 hasta el sacrificio los novillos recibieron una dieta de finalización (2.27 Mcal of ENm/kg MS), como consecuencia de esto dos periodos parciales de alimentación y uno completo fueron evaluados (1 a 112, 113 a 361 and 1 a 361 días, respectivamente). La utilidad de cada grupo fue estimada restando al ingreso por la venta de los novillos, la suma del precio pagado por los becerros más los costos de alimentación. La ganancia de peso total y el consumo de alimento se incrementó al aumentar el peso promedio pero la eficiencia alimenticia fue mejor para los grupos de animales de peso medio (112 y 117 Kg.), siendo los novillos del grupo de 112 Kg. los que presentaron mejor utilidad (15.8 dólares más que el grupo de 117 Kg.)

**INTRODUCTION**

For some years, the calf-fed Holstein steers beef production has played an important part in the feedlot business and have being used to fill market needs that beef cattle cannot readily fill (Maynard et al., 2004), and therefore, calf-fed Holstein steers beef production has played an important part in the feedlot business and have being used to fill market needs that native beef cannot readily fill (Maynard et al., 2004). Moreover, it has been observed that Holstein calf-fed steers can be raised for a quality beef product and can generate a profit (Dyt, 2013). On the other hand, Holstein steers generally arrive at feedlot with a lighter body weight and remain for longer periods than beef breeds (Duff and Mcmurphy, 2007 and Zinn, 2016). It has been observed that the initial body weight in feedlot is related to the productive growth performance and with the cost of feed, total cost and the equilibrium price (Koknaroglu et al., 2005, Zinn et al., 2008 and Hicks *et* al., 2015). This is important because the purchase costs of the steers and those of the feed represent the largest proportion (> 50%) in the variation of the profitability in feedlot (Darrell et al., 2000 and Koknaroglu et al., 2005). Due to the above, the present study aims to evaluate the economic results of calf-fed Holstein steers with different arrival body weight but with similar age in feedlot.

## MATERIAL AND METHODS

The study was conducted in the Desert Research and Extension Center of UC Davis, Holtville California. Three hundred Holstein calves were used in a 361 d experiment to evaluate the influence of arrival weight at similar age on feedlot growth performance, dietary net energy, and carcass characteristics. The treatment groups were: 105 kg, 112 kg, 117 kg, 123 kg and 129 kg of initial body weight. The animals were randomly assigned within weight groupings to 50 pens, 6 steers/pen. Pens were 78 $m^2$ with 33 $m^2$ of overhead shade, automatic drinkers, and fence-line feed bunks. Calves were fed with steam flaked corn-based diets (Table 1). The receiving diet (2.21 Mcal $NE_m$/kg DM) was fed during the initial 112 d on feed and from d 112 until harvest all steers received a finishing diet (2.27 Mcal $NE_m$/kg DM). Diets were prepared at weekly intervals and stored in plywood boxes located in front of each pen. Steers were allowed ad libitum access to feed, which was provided twice daily. On d 120 and 224, all steers were again injected subcutaneously with 500,000 IU vitamin A, and implanted with Revalor-S (Intervet, Millsboro, DE).

To estimate steer performance, arrival and final BW were reduced 4% to account for digestive tract fill. Pens were used as experimental units. The experimental data were analyzed as completely randomly unbalanced design according to the following statistical model: $Y_{ij} = \mu + W_i + \varepsilon_{ij}$ (Hicks, 1993), where μ is the common experimental effect, $W_i$ represents initial weight effect (df = 9), and $\varepsilon_{ij}$ represents the residual error (df = 40). Treatments effects were tested using the orthogonal polynomials: linear and quadratic. Significant effect was considered at $P < 0.05$ (SAS Inst. Inc., Cary, NC).

Due to the fact that a difference between the treatment effects was found, it was possible to proceed with a profit assessment for each of the groups. For this evaluation two expenditures were considered: cost of calf-fed Holstein steers and feed, while as a source of revenue the payment received from the sale of the final slaughter weight was used. The purchase cost of the calf-fed steers for each group was estimated by multiplying the total weight of each of the groups of Holstein steers times the market price paid for a kilogram of Holstein calf-fed steers. In the experimental phase two different rations were used receiving and finalization diets, 1 to 112 and 113 to 361 days, respectively. Because the prices of the rations are dissimilar, two partial feeding costs (PFC) were obtained, feed cost for the initial period (1 to 112 days) and for finishing period (offered from 113 to 361 days), and consequently the total price of feed was obtained by adding the cost of these two diets.

The following procedure was used to estimate each feeding period cost:

PFC= FI x P

Where:

PFC= Partial feeding costs

FI= Feed intake, as fed basis (Kg.)

P= Price of a Kilogram of feed (USD)

The two group costs were added to obtain the total feeding costs (TFC).

The cost that resulted from the purchase of calf-fed Holstein calves (PC) was calculated using the ABW (off-truck) and the price per kilogram of live weight (PLW).

PC = ABW x PLW

Where:

PC = Purchase cost (USD)

ABW = Arrival body weight, kg

PLW = Price per kilogram of live weight

The purchase cost was added to the TFC to obtain the total cost (TC)

The revenue was obtained using the final slaughter weight of each group of steers and the price paid for a kilogram of steer, the formula to obtain the revenue that resulted from the sale of the steers is presented next: RG= TWG x PLW

Where:

RG= Revenue per group

TWG: Total weight per group

PLW = Price of one kilogram of live cattle (USD).

To determine the total profit (TP) obtained in each of the five groups the total feeding cost and purchase cost of the calf-fed Holstein was subtracted to RG. Using the final average weight an individual profit (IP) was estimated for each group and with these values it was possible to compare the results.

The cost of daily feed intake (CFI) was estimated using the following formula.

CFI = TFC/FP

CFI = Cost of daily feed intake (USD)

TFC = Total feed cost (USD)

FP = Full feeding period (361 d)

## RESULTS AND DISCUSION

The influences of feedlot arrival weight on growth performance are shown in Table 1. The final live weight increased with respect to the AWB (linear effect, $P < 0.01$). The heavier group of steers (129 kg of ABW) reached a 8.8% higher final live weight compared to lighter steers (105 kg of ABW). Otherwise, body weight gain increased during the first feeding period (1 to 112-d) and complete study period (1 to 361-d) as ABW increased (linear effect, $P < 0.01$). On average, the heaviest group (129 kg of ABW) reached a weight gain 3% higher than the other groups of steers. However, during the finishing phase no effects on weight gain were found among the steers groups (113 to 361 d, $P = 0.49$. Salinas Chavira et al., (2009) found similar results and Cano et al. (2017), observing greater ADG for calf-fed Holstein steers with heavier versus lighter initial arrival weight. However Koçak et al. (2004), when evaluating the effects of initial weight and season on some fattening traits on Holstein steers found that the groups having lower initial body weights gained higher live weights during 210 days of feeding.

On the other hand, feed intake increased throughout the study and its phases (1 to 361, 1 to 112 and 113 to 361 d, respectively) as ABW increased (linear effect, $P < 0.01$). On average, during the whole period of study (1 to 361 d) the heavier steers (129 kg of ABW) obtained a DMI 7.3% higher than the othergroups of steers. In the same way, Salinas-Chavira et al., (2009) divided 144 newly received Holstein steers into two body weight groupings (lighter-half, averaging 117 kg and heavier-half, averaging 121 kg). Consistent with the present study, the same authors observed that although the difference in average initial weight of the two groupings was only 5 kg, the heavier group had greater (340-d) DMI associated with greater ADG. Besides, results of feed intake in the current study were expected because in several studies it has been shown that the DMI increases as the initial body weight increases (Hicks et al., 1990; NRC 1996; Koknaroglu et al,. 2005; Zinn et al., 2008 and Hicks et al., 2015). In general, increase in DMI with increasing ABW is consistent with concomitant increases in body weight gain. However, when comparing feed efficiency (which was estimated by the body weight gain on feed intake of each group) in whole period (1 to 361 d) for each group of ABW, it was found that steers with 112 kg of ABW obtained greater (3.7%) feed efficiency (0.169 vs 0.163, respectively) than the other groups (105, 117, 123 and 128 kg of ABW). This behavior is similar with other studies, where it has been observed that as the initial body weight increases the nutritional efficiency decreases (Zinn et al., 2008) and share similar results with studies done in steers that showed Light and intermediate weight cattle housed in confinement converted their feed more efficiently than heavier cattle (Koknaroglu et al., 2005).

**Table 1. Influence of arrival body weight on feedlot growth performance of Holstein steer.**

| | Arrival body weight, kg | | | | | | *P* value |
|---|---|---|---|---|---|---|---|
| Item | 105 | 112 | 117 | 123 | 129 | SEM | Linear |
| Pen replicates | 5 | 15 | 15 | 10 | 5 | | |
| Steers | 30 | 90 | 87 | 60 | 30 | | |
| Live weight, kg[a] | 105 | 112 | 117 | 123 | 129 | 0.75 | < 0.01 |
| Final | 583.7 | 616.8 | 623.7 | 614.5 | 639.8 | 10.1 | < 0.01 |
| Body weight gain, kg[b] | | | | | | | |
| 1 to112 d | 145.1 | 153.0 | 154.4 | 159.5 | 161.1 | 0.03 | < 0.01 |
| 113 to 361 d | 333.6 | 351.8 | 352.3 | 332.0 | 349.7 | 0.04 | 0.49 |
| 1 to 361-d | 478.7 | 504.8 | 506.7 | 491.5 | 510.8 | 0.03 | < 0.01 |
| Feed intake, kg[c] | | | | | | | |
| 1 to 112 d | 603.4 | 625.5 | 641.4 | 659.1 | 674.9 | 0.08 | < 0.01 |
| 113 to 361 d | 2349.1 | 2354.1 | 2376.2 | 2349.7 | 2551.9 | 0.14 | < 0.01 |
| 1 to 361 d | 2952.5 | 2979.6 | 3017.6 | 3008.9 | 3226.8 | 0.09 | < 0.01 |

[a]Initial and final BW reduced 4% to account for fill, [b]Average body weight gain per animal per period, [c]Total feed intake per animal per period as fed basis.

On the other hand, considering that the price for one kilogram of Holstein calves at the time of purchase was 1.47 dollars, on average, the purchase cost per calf (between initial body weight groups) increased by 19 dollars as the ABW was higher. Essentially, the feeding costs increased through the study phases (1 to 112, 113 to 361 and 1 to 361 d) as ABW increased (Table 2). The largest increase in total feeding costs (1 to 361 d) was for the heavier steers (129 kg of ABW), increasing costs on average 58.6 dollars more than the other groups of steers (105, 112, 117 and 123 kg, respectively). Koknaroglu et al., (2005) evaluated factors that affect cattle performance and production costs in feedlot and their findings were consistent with our results, considering that they found that with a higher initial body weight, DMI and ADG increased. Also feed cost, total cost, and breakeven price increased with increasing initial BW.

**Table 2. Partial, total and unit costs per group.**

| Group[1] | $PFC_1$ | $IC_1$ | $PFC_2$ | $IC_2$ | TFC | ITFC |
|---|---|---|---|---|---|---|
| 105 | 4888.0 | 162.9 | 17047.9 | 568.3 | 21935.9 | 731.2 |
| 112 | 15201.2 | 168.9 | 51252.5 | 569.5 | 66453.7 | 738.4 |
| 117 | 15068.0 | 173.2 | 50009.2 | 574.8 | 65077.2 | 748.0 |
| 123 | 10678.5 | 178.0 | 34104.4 | 568.4 | 44782.9 | 746.4 |
| 129 | 5467.2 | 182.2 | 18519.6 | 617.3 | 23986.9 | 799.6 |

[1]Arrival body weight groups kg (105: 30, 90, 87, 60 and 30 steers, respectively), PFCi; Partial feeding cost for the ith period; ICi: Unit cost for the ith period; TFC: Total feeding cost (1-361 d); ITFC: Total feeding cost/unit; US dollars.

Because the final body weight increased, the revenue from steers with 129 kg of ABW was higher (average 102.9 dollars), when compared to the other groups. However, the profit per animal (RG-TC) was higher for the group that arrived at the feedlot with 112 kg of body weight (Table 3) when contrasted to others groups, this was due to an increase of the feed efficiency (3.7%). Similarly, Retallick et al., (2013) observed that feed conversion was correlated with ADG, DMI and LM area and with ($r^2$ 0.84) weight gain cost. They also found, that a unit improvement in feed conversion resulted in a decrease weight gain cost, an improvement in feed conversion yielded a decreased feed costs. A 10% improvement in feed conversion allowed for a $0.14/kg reduction of weight gain cost. The same authors observed that profitability was greatest ($34.65/steer) with a 10% improvement in feed conversion concluding that feed conversion lowers feed costs mostly due to its correlation with the DMI. The lower feeding cost found in the 112 Kg group is of economic importance for the feed lot owner considering that in Mexico feedlot feeding cost represents between 60 and 75% of the total production costs (Financiera Rural, 2012)

| Table 3. Cost, revenue and profit per group. | | | | | |
|---|---|---|---|---|---|
| | Arrival body weight, kg | | | | |
| Items | 105 | 112 | 117 | 123 | 129 |
| Steers per group | 30 | 90 | 87 | 60 | 30 |
| Cost | | | | | |
| Calf-fed steers | 10207.7 | 32469.4 | 32989.7 | 23812.5 | 12492.1 |
| TFC | 21935.9 | 66453.7 | 65077.2 | 44782.9 | 23986.9 |
| TC[1] | 32143.6 | 98923.0 | 98066.9 | 68595.5 | 36478.9 |
| Revenue | | | | | |
| RG | 48137.9 | 150951.5 | 146982.9 | 100486.0 | 52932.4 |
| Profit | | | | | |
| RG-TC | 15994.3 | 52028.5 | 48915.9 | 31890.5 | 16453.5 |
| IP[2] | 533.1 | 578.1 | 562.3 | 531.5 | 548.4 |

[1]Total cost, * US Dollars, [2] Individual profit

On the other hand, it has been observed that feedlot performance is affected by ABW. Langemeier et al., (1992) reported that profit is more affected by the prices of feed when the cattle arrives at a feedlot with very light body weight, however, when the cattle arrives heavier at the feedlot, the profits are mostly affected by the costs of the feeder cattle and the average daily gain. Similarly, Mintert et al., (1993) found that feed conversion (as-fed) in feedlot cattle increased (3.9%) in animals with higher arrival weight when compared with lighter arrival body weights of cattle, reflecting reduced feed efficiency of heavier cattle. The same authors also found that ADG was also higher (5.8%) for heavier animals when compared to lighter cattle and that fed and cattle prices explained from 70% to 80% of total profit variance and feed conversion was the next most important explanatory variable, explaining 3% to 5% of profit variance.

## CONCLUSION

The DMI and ADG increased as arrived body weight at feedlot increased. The group of steers with 129 kg of ABW obtained the highest total cost and the highest revenue; however, the steers with an intermediate arrival body weight reached the higher profits and therefore should be considered as the best option by feedlot owners when they purchase Holstein steers. An improvement in profits was attributed to an improvement in feed efficiency for steers with 112 kg of ABW.

## BIBLIOGRAPHY


CANO AB, Montano M, Salinas-Chavira J, Zinn RA. 2017. Evaluation of supplemental vitamin E on 56-day feedlot growth performance and plasma tocopherol concentrations in calf-fed Holstein steers. Journal of Applied Animal Research. 45:90-92. ISSN: 0974-1844. https://doi.org/10.1080/09712119.2015.1129340.

DARRELL RM, Schroeder TC, and Jones R. Identifying Economic Risk in Cattle Feeding. 2000. Journal of Agribusiness 18,3 331S344. https://doi.org/10.22004/ag.econ.14712.

DIAS AM, De Menezes LFG, Paris W, Dos Santos PV, Biesek RR, Mafioletti RD, Marchesan R. 2017. Productive performance of Holstein calves finished in feedlot or pasture. Anais da Academia Brasileira de Ciências 89(3): 1935-1942. ISSN 1678-2690 http://dx.doi.org/10.1590/0001-3765201720170115.

DUFF GC, Mc Murphy CP. 2007. Feeding Holstein steers from start to finish. Veterinary Clinics of North America: Food Animal Practice. 23:281-297. ISSN: 0749-0720. https://doi.org/10.1016/j.cvfa.2007.04.003.

DYT W. 2013. Determine if Raising Holstein Steers Can be Profitable, While Creating a Quality Product. Bachelor of Science thesis. Polytechnic State University. San Luis Obispo CA https://digitalcommons.calpoly.edu/dscisp/105/.

FINANCIERA RURAL. 2012. `Monografía Bovinos de engorda, viewed 28 July 2019, https://www.yumpu.com/es/document/read/50952797/monografia-de-carne-de-bovino-financiera-rural.

HICKS CR. 1993. Fundamental Concepts in the Design of Experiments. Oxford University Press, Inc., New York, NY. ISBN 0-19-510581-8.

HICKS RB, Owens FN, Gill DR, Oltjen JW, Lake RP. 1990. Daily Dry Matter Intake By Feedlot Cattle: Influence of Breed and Gender. J ANIM SCI, 68:245-253. ISSN 1525-3163. https://doi.org/10.1093/ansci/68.1.245.

HICKS RB, Lake RP, Owens FN. 2015. Dry matter intake patterns of feedlot cattle J. Anim. Sci. Vol. 93, Suppl. s3/J. Dairy Sci. Vol. 98, Suppl. 2 pp 885. https://www.jtmtg.org/JAM/2015/abstracts/JAM2015_full_abstracts_book.pdf.

KOCAK, O, Ekiz, B, Yilmaz A, Gunes H. 2004. Some Fattening and Slaughter Characteristics of Holsteın Young Bulls in Intensive Conditions. Uludag Univ. J. Fac. Vet. Med. 23, 1-2-3: 65-69. https://dergipark.org.tr/tr/download/article-file/144514.

KOKNAROGLU H, Loy DD, Hoffman M.P. 2005. Effect of housing, initial weight and season on feedlot performance of steers in Iowa. South African Journal of Animal Science, 35 (4) 282-290. ISSN: 2221-4062. https://doi.org/10.4314/sajas.v35i4.3972.

KOKNAROGLU H, Loy DD, Wilson DE, Hoffman MP, Lawrence JD. 2005. Factors affecting beef cattle performance and profitability. The Professional Animal Scientist 21:286-296. ISSN: 1080-7446. https://doi.org/10.15232/S1080-7446(15)31220-1.

MAYNARD, LJ, Meyer, AL Burdine, K.H. 2004. Understanding the Market for Holstein Steers. Staff Papers 31978, University of Kentucky, Department of Agricultural Economics. https://doi.org/10.22004/AG.ECON.31978.

NRC 1996. Nutrient Requirements of Beef Cattle. 7th rev. ed. Natl. Acad. Press, Washington, DC. http://www.nap.edu/catalog/9791.html.

LANGEMEIER MR, Schroeder TC, Mintert, JR. 1992. "Determinants Of Cattle Finishing Profitability," Southern Journal of Agricultural Economics. 1992;24(2):1-7. https://doi.org/10.22004/ag.econ.29637.

MINTERT JR, Schroeder TC, Langmeyer MR' Albright ML. 1993. Factors affecting cattle finishing profitability. Kansas Agricultural Experiment Station Research Reports. Volume 0 Article #735. Available at: https://pdfs.semanticscholar.org/13a4/cd1a33386e9b5aeca480e945cc4e465b78de.pdf.

RETALLICK K. M, Faulkner DB, Rodriguez-Zas SL, Nkrumah J. D, Shike DW. 2013. Relationship among performance, carcass, and feed efficiency characteristics, and their ability to predict economic value in the feedlot[1]. J. Anim. Sci. 91:5954–5961. ISSN 1525-3163.https://doi.org/10.2527/jas.2013-6156.

SALINAS-CHAVIRA J, Lenin J, Ponce E, Sánchez U, Torrentera N, Zinn RA. 2009. Comparative effects of virginiamycin supplementation on characteristics of growth performance, dietary energetics, and digestion of calf-fed Holstein steers. Journal of Animal Science 87:4101–4108. ISSN 1525-3163. https://doi.org/10.2527/jas.2009-1959.

ZINN RA, Barreras A, Owens FN, Plascencia A. 2008. Performance by feedlot steers and heifers: Daily gain, mature body weight, dry matter intake, and dietary energetics. Journal of Animal Science; 86:2680-2689. ISSN 1525-3163 https://doi.org/10.2527/jas.2007-0561.

ZINN SA, Ivey SL, Lalman DL, Long NM, Zinn RA. 2016. Beef Cattle Nutrition Symposium: Feeding Holstein steers[1]. J. Anim. Sci. 94:3135–3136. ISSN 1525-3163 https://doi.org/10.2527/jas.2016-0412.

## Capitulo IV

## CONCLUSIONES

El rendimiento del crecimiento, la eficiencia energética estimada y las características de la canal de novillos Holstein a una edad similar están influenciados por el peso inicial. El efecto es más pronunciado en los novillos de menos de 112 kg. El consumo de materia seca y la ganancia diaria de peso aumenta a medida que se incrementa el peso de arribo al corral de engorda. Por otra parte, el grupo de novillos con un peso de arribo de 129 kg obtuvo el mayor costo total y los mayores ingresos; sin embargo, los novillos con un peso corporal de llegada intermedio alcanzaron las ganancias más altas y, por lo tanto, los propietarios de corrales de engorde deberían considerarlos como la mejor opción cuando compren novillos Holstein. Una mejora en las utilidades se atribuye a una mejora en la eficiencia alimenticia en los novillos con 112 kg de arribo al corral de engorda.