HOOP STRUCTURE FOR *WEAN TO FINISH PIGS*: GENDER INFLUENCES ON CARCASS IN A SUMMER TRIAL

Ioan HUTU[1], Gary W. ONAN[2]
[1]Faculty of Veterinary Medicine, Banat University of Agricultural Science and Veterinary Medicine "King Michael I of Romania" – Timisoara
[2]University of Wisconsin, 410 S, 3rd Street, River Falls, Wisconsin, 54022 Wi - SUA
e-mail: gary.onan@uwrf.edu

Abstract
The study was a wean to finish trial in a swine hoop structure at the university's Animal Experimental Unit; on 12 of July, at the delivery to the slaughter house, the body weight was 114.25±1.74 kg for 20 barrows and 108.71±2.13 kg for 19 gilts (p = 0.049). The carcass mass was 87.87±1.68 kg for barrows and 83.69±1.94 kg for gilts (p = 0.112). Back fat at the last rib measurement was 14.51±0.62 mm for barrows and 12.28±0.54 mm for gilts (p = 0.011) and the eye muscle depth was 58.58±1.41 mm for barrows and 53.65±1.22 mm for gilts (p = 0.019). The carcass mass: body weight ratio was 76.83% ±0.5% for barrows and 76.92±0.5 for gilts (p = 0.112). Fifteen of 39 animals graded S (61.56% lean), 23 animals were graded E class (58.08% lean) and 1 animal was graded U class (53.4% lean). Barrows averaged 58.77% lean vs. 59.86% for gilts (p = 0.126) which does not support the initial hypothesis that there would be a gender effect during the trial. The results of the study suggest that quality carcasses can be obtained from swine grown in a hoop deep bedded production system.
Keywords: *pigs, carcass grade, gender, hoop structure*

Introduction

Hoop structures have been used as effective alternative housing for grow-finish (G-F) swine in the United States, Canada and Australia for over 20 years *(Honeyman & Harmon, Payne, Maltman)*. In Romania a hoop structure and deep bedding system has been operable at Banat University – *Horia Cernescu* Research Unit since 2012. Hoop structures offer a distinct advantage for G-F swine production due to the substantially smaller capital investment for the structure relative to a conventional slatted-floor confinement building along with substantial reductions in energy operating cost. Energy use is reduced because these structures are not heated or mechanically ventilated. In cold seasons, pigs utilize the deep bedding layer to create warmer spaces for themselves, often burrowing into the bedding. During warm seasons, structures with a north/south long axis orientation in open areas, will experience substantial natural air flow for ventilation. In addition, the high arch-shape of the structure creates a "chimney effect" that facilitates natural air flow. Furthermore, hoop structures are also versatile buildings that are easily converted to facilities for other types of livestock or for feed or equipment storage should a farmer decide to discontinue swine production and focus on other enterprises *(Hutu & Onan).*

In the United States, the savings in operating costs of swine G-F hoops are negated by the added cost of bedding, a slight increase in feed usage and higher labor cost experienced in hoop systems. The final result is that cost/pig produced is nearly equal in both hoop structures and confinement systems *(Honeyman et al.).*

It is reasonable to assume that in Romania, where energy costs are relatively higher than in the United States, and where labor costs are lower, that hoop structures have an advantage in cost of production for G-F hogs. It should also be emphasized that for smaller producers, the substantial up-front capital investment savings for hoops may be a critical factor in the ability of the producer to move forward with a swine feeding enterprise at all *(Honeyman et al.).*

Data from the United States indicates that G-F swine in hoop structures experience annual performance levels comparable to those raised in conventional slatted-floor confinement facilities. When annual performance is broken down into warm seasons versus cold seasons, there are seasonal performance differences. Hoop raised pigs in warm seasons have higher average daily gain (ADG), reduced days to market with similar daily feed intake (DFI) and feed efficiency (F:G) as confinement raised pigs. The improved performance of hoop raised pigs is thought to be the result of slightly lower in-structure temperatures and improved air movement, as well as the ability of the pigs in hoop structures to modify their own environment. In cold seasons however, hoop raised pigs have reduced ADG, increased days to market, higher DFI and poorer (higher) F:G. This poorer cold season performance is generally explained as being the result of the physiological need for greater energy intake for maintenance of body temperature homeostasis. Cold season hoop pigs also exhibited higher backfat thickness at the 10^{th} rib *(Honeyman & Harmon, Magolski & Onan).* Both groups of authors indicate an overall 1-2% lower percent fat free lean in the carcasses of hoop raised pigs versus confinement raised pigs. Australian performance data for G-F pigs in hoops indicates improved ADG for hoop raised pigs, but also higher P_2 fat thickness in their carcasses *(Payne).*

It has long been established that barrows and gilts differ in their growth patterns *(Leach et al.).* Barrows are "earlier maturing" which results in higher ADG throughout most of the feeding period than gilts experience, but also greater fat deposition during finishing than for gilts. Since gilts are "later maturing", they maintain a higher proportion of muscle tissue versus fat tissue growth for an extended period and often exhibit larger *longissimus* area or depth at market *(Latorre et al., Hamilton et al., Leach et al.).*

The specific objective of this report was to establish baseline expectations for carcass performance of commercial hybrid G-F pigs in a hoop system in Romania during the warm season of the year and compare those to industry norms. A secondary objective was to determine if a hoop management system would influence the typical carcass differences observed between barrows and gilts that have been raised in confinement systems.

Materials and methods

Animals and data collection: Forty feeder pigs of a widely used European commercial hybrid line (primarily composed of Large White and Danish Landrace breeding) weighing approximately 25 kg were obtained from Smithfield Romania on 6 April, 2016 and placed in the swine hoop structure at the Banat University of Agricultural Science and Veterinary Medicine in Timisoara, RO. The group consisted of 20 gilts and 20 barrows which were segregated by sex and placed in adjoining pens within the hoop structure. The pigs were acclimated to their new location for 14 days. On the fourteenth day, 13 April, 2016, pigs were weighed, scanned at the last rib for P_2 fat depth, *(Whittemore)* and loin (*longissimus dorsi*) depth, and feed allocated. Pigs also received an ear tattoo for permanent identification on 13 April. The ultrasound scans were obtained either with an *Aloka 500-V (Corometrics Medical System, Wallingford, CT USA)* with a 12 cm, 3.5 MHz probe and analyzed using *BioSoft Toolbox II for Swine (Biotronics, Inc. Ames, IA USA),* or using a *Sonoscape A6V* with an L761V rectal probe operating at 4 MHz *(KeeboMed, Inc. Mount Prospect IL USA)* and measured directly on the instrument screen.

Subsequently, the pigs were weighed every two weeks and scanned every four weeks. Delivery to the abattoir occurred on 12 July, 2016. A final pig weight was obtained on 12 July. One gilt suffered a blockage of its colon and was euthanized on 20 June, 2016. That animal's performance is not included in any of the gilt data except for the calculation of feed efficiency.

Feed: Feed was obtained from Smithfield Romania for the duration of the trial. All feed was in pelleted form and consisted of the standard diets used by Smithfield Romania in their G-F swine units. Composition of the feed was adjusted periodically based on pig weight following Smithfield Romania's standard protocol. All feed was packaged in in large plastic totes and was picked up by University staff from the Smithfield feed processing site. Feed was stored on pallets in an unused portion of the hoop structure and feeders filled manually with all feed weighed using *Ranger Mate (American Calan, Northwood, New Hampshire, USA)* and recorded each time additions were made.

Housing: The forty pigs were housed in a hoop structure. The primary design feature of these types of structures consists of uniformly spaced metal arches which are covered with a tightly woven plastic tarpaulin which is stretched taut over the arches. The arches are attached to the top of vertical wooden posts inserted 1.25 to 1.50 meters into the ground. These posts serve as the foundation of the structure. The tarp is stretched by means of small winches attached to the exterior surface of the posts. The interior of the posts is typically faced with wooden boards or sheet material to create a "knee-wall" of approximately 1.25 meters in height. The arched ends of the structure are typically covered with similar plastic canvass material with some type of roll-up doorway. The end-walls are often partially or completely opened during warm weather to increase air flow and reduce internal structure temperature. The Banat University structure used for this trial has a total exterior dimension of 8.92 X 26.75 m. and has concrete flooring throughout. The two pens in which the pigs were housed were each 6.00 X 8.22 m. This allowed 2.5 m^2/pig which is well above the 1.0 m^2/pig recommended for hoop housing of G-F swine *(Honeyman & Harmon)*. Each pen was equipped with two *AQUAFINISH* wean/finish nipple/cup water fountains and 8 feeder spaces provided by a rectangular swine self-feeder *(Hog Slat, Newton Grove, NC USA)*.

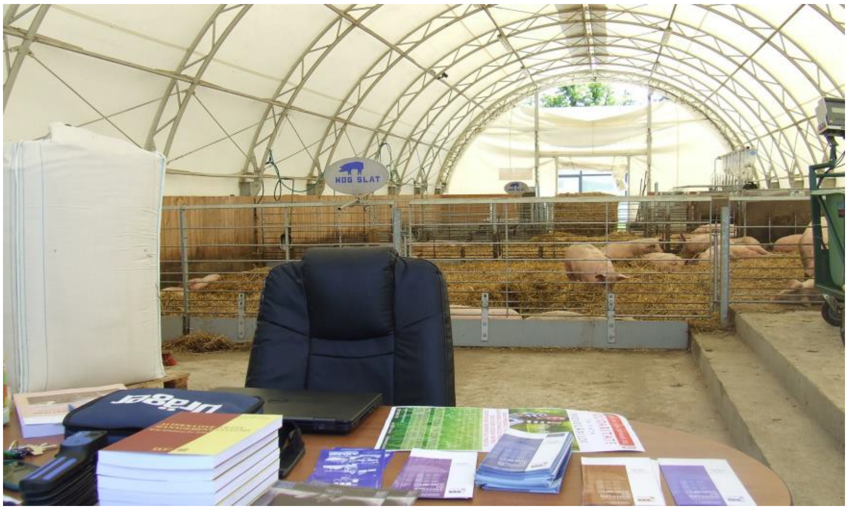

Figure no. 1: *Horia Cernescu* Research Unit – Swine Unit sector during Banatagralim Fair, 28th of May 2016

Pens were bedded to a depth of approximately 0.30 m. as needed with wheat straw obtained from the university farm. The side of the pen where feeders were located is elevated approximately 0.50 m. above the main floor area and was not bedded. Internal and external temperature and humidity were continuously monitored using a multi-functional wireless digital device *Weather Station PCE-FWS 20*.

Animal Harvest and Carcass Measurements: Thirty-nine pigs were delivered to the abattoir on 12 July, 2016 during the morning hours. The pig transport duration to the slaughter house was about 3 hours of driving time. The following data were collected during slaughter: live body weight at slaughter on 13 July, carcass weight, fat depth and loin depth. Official personnel calculated lean percent and graded the carcasses using the SEUROP system.

Statistical Analysis: Analysis of P_2 fat depth and loin depth were performed using 2-way *Analysis of Variance (ANOVA)* with replication, with date as one factor and sex as the second factor. In those instances where the overall analysis indicated significance, least significant difference post-hoc comparisons were performed to identify time points where the barrows and gilts differed. All data comparing barrows to gilts collected at the abattoir was analyzed using two-sample *Student's* t-tests.

Results

Ultrasound Scan for Body Composition: Figure 2 presents the scan data for the P_2 fat depth of barrows vs. gilts over the first two-thirds of the G-F period. There was no difference between the sexes at the outset of the feeding period, or one month later on 10 May. By the 6 June scan the barrows had significantly greater fat depth ($p < 0.001$). Similarly, there were no differences in loin depth between barrows and gilts at the first two scans, but by 6 June, the barrows had significantly deeper loin muscles (See Figure 3; $p = 0.020$).

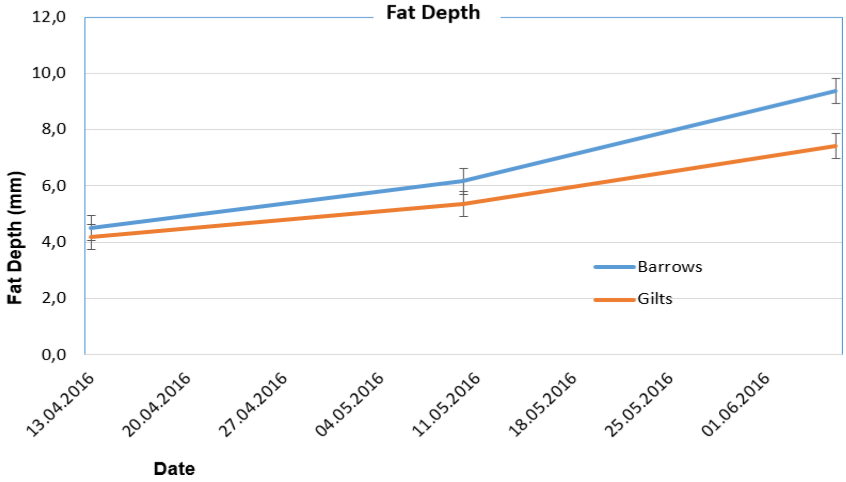

Figure no 2: Fat depth at the P_2 location of barrows vs. gilts during the first two-thirds of the G-F period. Both sexes were housed in a hoop structure in adjacent pens throughout the feeding period with ultrasound scans obtained monthly. Animals were not scanned just prior to shipment to the abattoir on 12 July, 2016 at the termination of the trial. Error bars represent the SEM from the overall ANOVA.

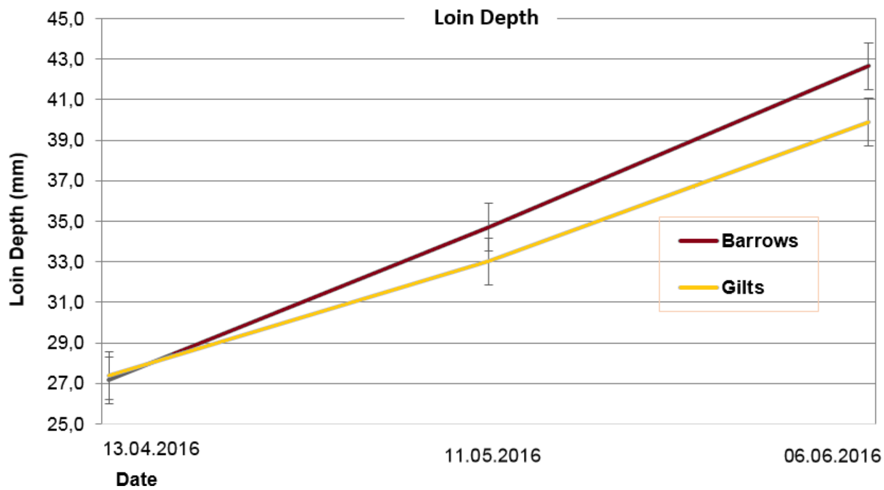

Figure 3: Loin depth at the P_2 location of barrows vs. gilts during the first two-thirds of the G-F period. Both sexes were housed in a hoop structure in adjacent pens throughout the feeding period with ultrasound scans obtained monthly. Animals were not scanned just prior to shipment to the abattoir on 12 July, 2016 at the termination of the trial. Error bars represent the SEM from the overall ANOVA.

Carcass Data: Table 1 presents a summary of slaughter and carcass data. Barrows were statistically heavier at delivery to the slaughter plant (p = 0.049), had greater P_2 fat depth (p = 0.011) and loin (eye muscle) depth (p = 0.019). There was no statistical difference between barrows and gilts for carcass weight, dressing percent or percent lean. Overall, 15 of the 39 carcasses graded S (61.56% lean), 23 graded E (58.08% lean) and 1 graded U (53.40% lean) (Table 2).

Table 1

Slaughter and Carcass Data[a]

Gender	**Slaughter Live Weight** *(kg)*	**Carcass Weight** *(kg)*	**Dressing Percent** *(%)*	**P_2 Fat Depth** *(mm)*	**Eye Muscle Depth** *(mm)*	**Percent Lean** *(%)*
Barrows	114.25 (1.74)	87.87 (1.68)	76.83 (0.50)	14.51 (0.62)	58.58 (1.41)	58.77
Gilts	108.71 (2.13)	83.69 (1.94)	76.92 (0.50)	12.28 (0.54)	53.65 (1.22)	59.86
Combined[b]	111.55	85.83	76.87	13.42	56.18	59.30
p^c	0.049	0.112	0.112	0.011	0.019	0.126

[a] Mean values with SEM in parentheses
[b] Weighted averages computed from barrow and gilt means
[c] Comparison of gender effect

Table 2

SEUROP Breakdown

Classification	**Number of Carcasses**	**Percent Lean**[a]
S *(superior, > 60% lean)*	15	61.56
E *(excellent, 55 to 60% lean)*	23	58.08
U *(very good, 50 to 55% lean)*	1	53.40

[a] Mean percent lean for carcasses in each group

Discussion

The primary objective of this research trial was to establish baseline expectations for carcass performance for pigs produced in a hoop structure management system. General observation of the data would indicate that hoop raised pigs produce carcasses with relatively similar characteristics to those of pigs grown in confinement systems. British data indicate that the average P_2 fat depth in heavy (> 80 kg carcass weight) market swine is about 12 mm *(Pig Pocketbook*). The pigs in this trial were slightly fatter than that (13.42 mm), but data from hoop pigs raised in other countries also indicates that they are often slightly fatter than confinement pigs *(Honeyman and Harmon, Magolski and Onan, Payne)*. British data also indicates that for swine in a carcass weight range of 80 – 90 kg, about 98% grade into S or E *(Pig Pocketbook).* In the present trial 97% graded S or E.

Data from the United States indicates that average carcass weight for all pigs slaughtered is about 91 kg and these carcasses have 17 mm fat depth and 58 mm loin depth at the 10th rib *(National Daily Direct Hog).* Typically, at the 10th rib carcasses are slightly fatter and have slightly less loin depth than at the last rib, but these differences are only of a magnitude of 1-2 mm *(Leach et al.).* Again, the pigs in the present trial produced carcasses that carried somewhat less fat with an average combined P_2 fat depth of 13.42 mm, but also somewhat less loin depth with an average combined loin depth of 56.18 mm. Overall percent lean for the trial pig carcasses was 59.30%. The current United States average is 52.31%, although this value uses a different regression equation than the Romanian equation, which likely accounts for much of this difference. Overall, it appears that the carcass parameters from hoop raised pigs will be similar to those from confinement management systems, although there is consistent evidence that hoop hogs may be slightly fatter under some environments *(Honeyman and Harmon, Magolski & Onan, Payne).*

Scan data for fat depth indicates that barrows develop greater amounts of fat tissue earlier in their growth than do gilts. This is consistent previous research results *(Hamilton et al., Latorre et al., Leach et al.).* The carcass measurements for fat depth from this trial also show a significant difference with barrows having greater fat depth, again in agreement with previous results. This clearly indicates that barrows deposit fat tissue earlier in their growth period to a greater degree than gilts do, and that this added fat tissue accumulation continues on to slaughter weight. Typically this would result in lower percent lean for barrows *(Leach et al.),* which however was not the case in the present trial. This likely occurred because the barrows in this trial exhibited greater loin muscle depth, compensating for the added fat in the percent lean equation. The fact that the barrows displayed greater loin muscle depth both with the scan data and the final carcass data is anomalous relative to other reports. Both Hamilton et al. and Leach et al. report greater loin muscle depth and area for gilts. Had the current pigs been fed to a heavier weight (for example 130 – 135 kg), the gilts might have made up some of the difference in loin depth as they would have supposedly continued to produce lean tissue growth to a greater degree than the barrows.

It is unlikely however, that they would have made up their deficiency in loin depth, much less exceeded the barrows, even at heavier weights. There is no immediate explanation for why the gilts lagged in loin development. One conjecture would be that the hoop management system somehow played a role in this anomaly, but that seems unlikely as none of the other growth parameters (see companion paper) or carcass parameters between barrows and gilts differed from expected norms.

Conclusions and implications

Hoop raised pigs will produce carcasses with similar weights, fat depths, loin depths and percent lean as conventionally raised pigs. Furthermore, the growth patterns of barrows and gilts are not substantially altered from the differences seen in conventional systems when they are raised in hoop systems. Hoop structures are a viable low cost management system for Romanian swine farmers.

Acknowledgments

The activities and materials was sponsored in a frame of *Smithfield Romania University Program* and the research was carried out with in a *Swine Experimental Unit*, a part of *Horia Cernescu Research Unit* from *Banat University of Agricultural Science and Veterinary Medicine "King Michael I",* infrastructure established by POSCCE project - *Development of research, education and services infrastructure in the fields of veterinary medicine and innovative technologies for West Region* - contract no 18/1st March, 2009 and 2669 SMIS code.

References

1. Hamilton, D. N., M. Ellis, K. D. Miller, F. K. McKeith, and D. F. Parret. 2000. *The effect of the Halothane and Rendement Napole genes on carcass and meat quality characteristics of pigs.* J. Anim. Sci. 78:2862–2867.
2. Honeyman, M.S. and J.D. Harmon. 2003*. Performance of finishing pigs in hoop structures and confinement during winter and summer*. J. Anim. Sci. 81:1663-1670.
3. Honeyman, M.S., J.D. Harmon, J.B. Kliebenstein and T.L. Richard. 2001*. Feasibility of hoop structures for market swine in Iowa: pig performance, pig environment, and budget analysis*. App. Eng. in Ag. 17: 869–874.
4. Huțu I., Onan W.G., 2008, *Alternative Swine Management Systems – Hoop Structures for Swine, TVT Publishing - River Falls, WI, Mirton - Timişoara, RO.*
5. Latorre, M. A., R. Lazaro, D. G. Valencia, P. Medel, and G. G. Mateos. 2004. *The effects of gender and slaughter weight on the growth performance, carcass traits, and meat quality characteristics of heavy pigs.* J. Anim. Sci. 82: 526-533.
6. Leach, L. M., M. Ellis, D. S. Sutton, F. K. McKeith, and E. R. Wilson. 1996. *The growth performance, carcass characteristics, and meat quality of Halothane carrier and negative pigs.* J. Anim. Sci. 74:934–943.
7. Magolski, J. and G. Onan. 2007. *Growth and carcass parameters of hogs finished in a deep-bedded hoop structure vs. a confinement structure*. American Society of Animal Science Midwestern Branch (Abstr.) pg. 105.
8. Maltman, J. *A review of pig production in hoop shelters on the Canadian prairies (Abstract).* Hoop Barns & Bedded Systems for Livestock Production Conference. Ames, IA, 14 September, 2004.
9. Payne, H. *Deep litter housing systems, an Australian perspective* (Abstract). Hoop Barns & Bedded Systems for Livestock Production Conference. Ames, IA, 14 September, 2004.
10. *Pig Pocketbook*. 2013. Agricultural and Horticultural Development Board. Stoneleigh Park, Kenilworth Warwickshire CV8 2TL. www.pork.ahdb.org.uk/media/2425/pig_pocketbook_2013.pdf
11. Whittemore, C. T. 2003. The science and practice of pig production. 2nd ed. Blackwell Science Ltd., Osney Mead, Oxford, UK.
12. ****National daily direct afternoon hog report*. Agricultural Marketing Service, United States Department of Agriculture. https://www.ams.usda.gov/mnreports/lm_hg203.txt. Accessed 18 September, 2016.