USDA Agricultural Research Service

Volume 1
Edition 1

Pig Pen

USDA ARS Swine Industry Stakeholder Update

Calendar

March 9-11: National Pork Industry Forum

April 6-7: Spring LAC

June 8-10: World Pork Expo

July 10-13: National Pork Industry Conference

July 20: Nebraska Pork Expo

In This Issue:

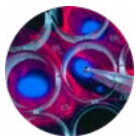
Welcome from the USMARC Director

Dr. Boggess with an update on Center. Swine research programs and plan for the future.

Meet the USMARC Swine Manager

Troy McCain manages the swine facility used in the research efforts at USMARC.

USDA ARS Research Reports



Research summaries or abstracts for current ARS research at USMARC and our partner ARS locations.

U.S. Meat Animal Research Center
Phone: (402) 762-4100

Alexa Johnson
Communication Specialist
Email: alexa.johnson@usda.gov
Phone: (402) 762-4129

USMARC Director's Pen!

Hello from the Pig Pen!

To kick off this edition, we have five outstanding research reports for your review from our USMARC research team and from our ARS partners in Beltsville, MD. We are excited about our swine programs and our collaborations with ARS and other research partners! At USMARC, we are aggressively building partnerships in ARS, with academia, and with industry stakeholders to best utilize our resources and expertise. We greatly value the stakeholder support we receive, and we rely on our critical producer stakeholders to help us develop our research and swine programs and to represent our common interests with industry influencers. Your support is critical to our continued success!

Our research is centered on the lifetime productivity of the sow as part of a systems approach to swine production. The systems approach is best illustrated by the relationships between genetics (including the pig and related microbiomes), the environment, management approaches, and socio-economic factors. Specific research priorities include gilt development, litter size and piglet viability, feed efficiency, structural soundness, and precision management. We work closely with many industry and academic partners, and we have tremendous support from the swine industry and the National Pork Board.

Of course, our research would not be possible without the swine production unit and the excellent care and management provided from manager Troy McCain and his team. You will read an overview of the unit from Troy in this update. You will find that we have consistent and excellent performance, even with numerous ongoing research trials and buildings that are now 50+ years old! It is important that our research be conducted with industry relevant production metrics and Troy's team makes sure that our pigs receive optimal care and that our research programs have maximum impact while representing the industry to the best of our abilities.

However, even with great management we are always striving to improve. For example, we recently developed a "Blue Ribbon Panel" (BRP) of industry experts to provide us with a comprehensive swine program review. Our BRP includes producers and industry leaders, scientists, animal care staff, and other USMARC stakeholders. The BRP meets periodically on the Center, with an eye on improving overall animal husbandry, animal care and well-being, herd and individual performance, and overall management. The BRP recommends improvements in all programs and facilities, and monitors progress and implementation. We also contrast USMARC program performance with industry benchmarks to identify areas needing focused improvement, and to monitor progress over time. We have not been able to meet as often as we had hoped, due to the pandemic, but plan to return the swine BRP to a more active role in 2022. Please let us know if you would like to participate in this effort or if you would like more information.

To say that the BRP program has been successful would be a gross understatement. The panel meetings have provided valuable and revealing guidance and we are using them to promote continuous improvements in animal care, management, and research programs. I am certain that this effort will continue to yield benefits into the future.

Our management team and BRP efforts have supported an evolving and proactive relationship with

our colleagues at APHIS, who have been charged with providing annual inspections for the Center. These interactions with APHIS are considered opportunities to strengthen our already strong programs for animal care and animal husbandry, and APHIS is a partner in our ongoing success.

Lastly, we are looking to expand our research programs and impact through new and expanded research collaborations. We are working with our leadership in ARS and with our sister locations to describe best ways to develop systems-based research programs and collaborations that focus on real industry needs and on swine industry sustainability. These collaborations will include many land grant university partners as well and we look forward to seeing where these evolving program ideas take us for the swine industry.

So, as I hope you can see, we are excited and optimistic and looking to the future! Please join us on our journey forward and let us know how we can make our programs even better. We need your support for our research programs, for our producers and stakeholders, and in WDC. Help us to help you!

All the best from the Pig Pen!

Mark Boggess

USMARC Swine Progress Update

Troy McCain

Looking back at the past two years, I think 2020 was a year that everyone would like to forget. We were very concerned about what 2021 had in store for us. With most of 2021 in the rear-view mirror now, this year was a welcome sight considering all the challenges we have faced. Below are the quarterly numbers for our research herd for the past two years.

As you look through these production numbers, there are some points to be made. Our average parity is low because we do not keep any sows past the fourth

	2020				2021				Industry Average
Time Period	1st Q	2nd Q	3rd Q	4th Q	1st Q	2nd Q	3rd Q	4th Q	1st Q 2021
Average Parity							2.12		2.75
Weaned sows bred < 7 days (%)	88.8%	85.1%	89.8%	84.1%	91.0%	90.9%	90.4%	89.8%	89.4%
Wean to first service interval	4.3	4.3	4.2	4.2	4.2	4.3	4.3	4.3	6.4 days
Farrowing rate	82.6%	80.5%	81.7%	81.2%	83.5%	82.8%	85.8%	80.8%	85.4%
Average total born	13.9	14.2	13.9	13.3	13.7	14.1	14.5	14.2	14.8
Average live born	12.9	13.1	13.9	12.3	12.5	13.1	13.3	12.9	13.3
Mummy %	2.4%	2.4%	1.7%	2.2%	2.4%	2.5%	2.1%	2.0%	2.3%
Stillborn %	4.7%	6.3%	4.9%	5.6%	6.3%	5.1%	6.5%	7.1%	7.2%
Prewean mortality %	13.9%	11.5%	11.5%	11.4%	11.2%	14.5%	14.3%	15.8%	13.5%
Pigs weaned / sow	11.1	11.6	11.5	10.9	11.1	11.2	11.4	10.8	11.2
Pigs/sow/year	26.64	27.84	27.6	26.16	26.64	26.88	27.36	26.01	29.7
Average wean age	25.5	25.4	25.5	25.5	25.4	25.5	25.5	25.7	21
Sow death loss %	0.9%	2.0%	2.2%	1.8%	1.5%	1.7%	1.9%	1.2%	13.8%
Total sows								428	

parity. We do not have the ability to staff our farrowing barns with help 24/7 like most operations. We are also weaning at four weeks of age rather than the industry standard of 3 weeks. Although our emphasis is on research, we try to run the farm as close to the industry as we can so our discoveries are more relevant.

I recently attended the International Conference on Swine Survivability in Omaha, NE. The attendance was excellent, and the discussions were very relevant to what we are working on at the USMARC. Here are a few of some of the key points that were topics of discussion:

1. Between 30-35% of pigs that are born never make it to market.
2. The current sow mortality is 12-14%.
3. In the sow mortality 40% of that happens in the first two parities.
4. Of that death loss 30% of that happens between day 115-123 of gestation.
5. One of the biggest factors in sow longevity is feet and leg structure.

USDA ARS Pig Pen

What are we doing here to address these challenges and to help to improve survivability? Let's start in the finishing area where the gilts are being developed for replacements into the herd. Studies have taken place with pressure mats, cameras, and visual notations of all the gilts being selected for our herd. As they progress through the herd, they are monitored at various stages. Before they enter the farrowing barn, additional observations are taken. Females showing signs of mobility concerns are noted and a blood sample is taken. When they are in their farrowing pen, photos document the foot and pad structure when they are lying down. Additional observations are made when they return to gestation at weaning time. Some of the animals in the study will undergo further analysis to help to best understand how we can improve both structural soundness and animal wellbeing in the sow herd.

In the farrowing crate we are again using recording devices to study the female and her litter 24/7 to help us to understand precisely where mortalities are occurring and how to prevent these occurrences in the future.

To the right is a summary of the number of animals that have been produced each year for the past eight years. In December of 2017, we did have a PRRS challenge which affected our production the following year.

ALL HOGS		
YEAR	NUMBER OF HEAD	WEIGHT
2014	6734	705,386
2015	7385	830,129
2016	9144	1,042,903
2017	9286	1,072,822
2018	8622	1,013,048
2019	8646	982,565
2020	10052	1,126,397
2021	11418	1,331,982

Week	Number of Litters	Total Pigs Born	Pigs Born Live	Number Weaned	Average Number Born	Average Number of Mummies	Average Number of Stillbirths	Average Number Born Live	Average Number Weaned	Birth Weight Total	Weaning Weight Total
23	22	345	306	265.	15.68	0.64	1.14	13.91	12.05	43.2	192.2
24	19	295	274	240.	15.53	0.47	0.63	14.42	12.63	43.8	210.5
25	23	312	290	270.	13.57	0.43	0.52	12.61	11.74	43.6	193.6
26	20	274	253	223.	13.70	0.15	0.90	12.65	11.15	39.6	188.4
27	21	335	312	256.	15.95	0.38	0.71	14.86	12.19	42.0	204.0
28	21	317	290	244.	15.10	0.24	1.05	13.81	11.62	43.1	201.9
29	15	219	201	173.	14.60	0.20	1.00	13.40	11.53	43.1	198.7
30	20	290	258	230.	14.50	0.60	1.00	12.90	11.50	42.5	194.7
31	24	355	331	284.	14.79	0.38	0.63	13.79	11.83	43.2	200.0
32	21	306	285	255.	14.57	0.24	0.76	13.57	12.14	43.8	207.0
33	22	301	258	222.	13.68	0.18	1.77	11.73	10.09	36.8	183.7
34	19	291	268	217.	15.32	0.42	0.79	14.11	11.42	45.5	214.5
35	18	263	250	208.	14.61	0.28	0.44	13.89	11.56	41.8	194.9
36	21	321	297	243.	15.29	0.14	1.00	14.14	11.57	42.6	207.1
Total	286	4224	3873	3,330.	14.78	0.34	0.88	13.56	11.64	42.5	199.4

The chart above reflects a 14-week period in 2021. Again, the pigs are weaned on a 4-week rotation which is reflected in the weaning weight.

There have been continued upgrades to the ventilation in the finishing barns which were built in the 1980's. My hope is to eventually be able to add more modern finishers into our facility. There is a plan to add a walkway between our two farrowing barns but that has been put on hold with the current pandemic challenges that are occurring.

Recent Swine Publications

Fine mapping genetic variants associated with age at puberty and sow fertility using Sowpro90 genotyping array

Hiruni Wijesena - U.S. Meat Animal Research Center

Contributors: Steve Kachman - University of Nebraska, Clay Lents - U.S. Meat Animal Research Center, Jean-Jack Riethoven - University of Nebraska, Melanie Trenhaile-Grannemann - Univeristy of Nebraska, Tim Safranski - University of Missouri, Matt Spangler - University of Nebraska -Lincoln, and Daniel Ciobanu - University of Nebraska -Lincoln

Citation: Wijesena, H.R., Kachman, S.D., Lents, C.A., Riethoven, J.J., Trenhaile-Grannemann, M.D., Safranski, T.J., Spangler, M.L., Ciobanu, D.C. 2020. Fine mapping genetic variants associated with age at puberty and sow fertility using Sowpro90 genotyping array. Journal of Animal Science. 98(10):1-12. https://doi.org/10.1093/jas/skaa293.

Improving reproductive traits of sows, such as litter size and reproductive longevity, via traditional breeding and genetic approaches is challenging for pork producers because reproductive traits are lowly heritable and expressed late in life. With the aim of improving accuracy of genomic prediction for sow reproductive and fertility traits, ARS scientists at Clay Center, Nebraska, in collaboration with researchers from the University of Nebraska developed a custom genotyping array called SowPro90 that contains novel single nucleotide polymorphisms (SNP) predicted to affect the level of gene expression or cause loss of gene function. Researchers used the SowPro90 to determine if SNP located in genomic regions controlling age at puberty are also related to litter size and reproductive longevity. They discovered several SNP associated with all three of the traits and further confirmed the genetic association with litter size in sows from commercial swine production. Results from this study provide producers with critical information about genetic markers on the commercially available SowPro90 genotyping platform that are useful for selecting replacement sows and improving reproductive traits.

Effects of farrowing stall layout and number of heat lamps on sow and piglet behavior

Suzanne Leonard - North Carolina State University

Contributors: Hongwei Xin - University of Tennessee, Tami Brown-Brandl - University of Nebraska, Brett Ramirez - Iowa State University, Anna Johnson - Iowa State University, Somak Dutta - Iowa State University, and Gary Rohrer - U.S. Meat Animal Research Center

Citation: Leonard, S.M., Xin, H., Brown-Brandl, T.M., Ramirez, B.C., Johnson, A.K., Dutta, S., Rohrer, G.A. 2021. Effects of farrowing stall layout and number of heat lamps on sow and piglet behavior. Applied Animal Behaviour Science. 239. Article 105334. https://doi.org/10.1016/j.applanim.2021.105334.

Farrowing stalls are used in the swine industry to reduce pre-weaning piglet mortality and enable individual animal management. The quantity and quality of space provided for sows and piglets in farrowing stalls is an important welfare consideration. To further explore the impacts of farrowing stall space allocation, a field study was conducted to compare sow and piglet behavior when housed in three farrowing stall layouts: 1) a layout typically used in commercial production (T – traditional), 2) an expanded layout where the additional space is allocated for the piglets (EC – expanded creep area), and 3) an expanded layout where additional space is allocated to the sow (ES – expanded sow area). In addition, the use of one versus two heat lamps (1HL and 2HL, respectively) was tested across all three stall layouts. A computer vision system classified sow posture, sow behavior and piglet location for 325 sows and their litters. Results show sows spent more time lying and less time sitting when provided more space in the ES stall layout compared to T and EC stall layouts. In addition, 2 heat lamps resulted in greater percentage lying compared to only 1 heat lamp. Number of piglets, parity, and farrowing group also influenced postural behavior of sows. Sow postures and behaviors were significantly influenced by day of lactation. Piglets with 2 heat lamps spent more time in the heated zone and less time in the creep and sow zones for all stall layouts on all days of lactation observed. In the ES stall layout, piglets spent a greater percentage of time in the sow zone compared to EC stall layout. This study emphasizes that sow and piglet behavior can be significantly influenced by the farrowing environment. Results can be used to guide farrowing stall designs to better meet the behavioral needs of sows by providing wider sow stalls and the behavioral needs of piglets by providing greater heated areas.

Breed differences in placental development during late gestation between Chinese Meishan and White crossbred gilts in response to intrauterine crowding

Jeremy Miles - U.S. Meat Animal Research Center

Contributor: Jeff Vallet - Associate Area Director Midwest Area

Citation: Miles, J.R., Vallet, J.L. 2021. Breed differences in placental development during late gestation between Chinese Meishan and White crossbred gilts in response to intrauterine crowding. Animal Production Science. 226:106711. https://doi.org/10.1016/j.anireprosci.2021.106711.

As litter size has increased in commercial swine production, there has been a consequential increase in preweaning piglet mortality as the result of greater within-litter birth weight variation and the production of smaller piglets due to limitations in uterine capacity and fetal crowding. Meishan pigs have large litter size and produce piglets that weigh significantly

less than contemporary Western pig breeds but have reduced preweaning piglet mortality. The placenta has direct implications on uterine capacity, fetal growth, and survival as well as postnatal piglet growth and survival. To evaluate genotypic differences in placental development during late gestation following intrauterine crowding, this study performed unilateral hysterectomy ovariectomy in Meishan and White crossbred gilts to induce intrauterine crowding and evaluated both gross (histotrophic via glandular exchange) and microscopic (hemotrophic via capillary exchange) development of the subsequent placentas. Meishan placentas had greater density and improved development of placental areolae that regulate histotrophic exchange compared to White crossbred pregnancies, thereby demonstrating greater glandular exchange in Meishan pigs. In contrast, Meishan pregnancies had reduced influence of altered hemotrophic exchange (i.e. folded bilayer and placental stromal widths) between the smallest and largest littermate placentas compared to White crossbred indicating greater uniformity of blood exchange across the placentas of Meishan pigs. These alterations in placental development of Meishan pregnancies corresponded to decreased within-litter fetal weight variation compared to White crossbred pregnancies and provide potential mechanisms for reduced sensitivity of fetal growth in response to intrauterine crowding.

Manipulation of these mechanisms may result in more uniform, vigorous piglets born in large litters and reduce preweaning mortality.

Temporal Dynamics of the Gut Bacteriome and Mycobiome in the Weanling Piglet

Katie Summers - Beltsville Agricultural Research Center

Contributors: Ann Arfken - Beltsville Agricultural Research Center, and Juli Foster Frey - Beltsville Agricultural Research Center

Citation: Arfken AM, Foster Frey J, and Summers KL. Temporal Dynamics of the Gut Bacteriome and Mycobiome in the Weanling Piglet. Microorganisms, 2020. doi: 10.3390/microorganisms8060868.

The environmental changes and stress associated with the weaning transition in piglets can lead to poor growth performance and a predisposition to disease. Interactions between the bacteriome and mycobiome can result in altered host nutrition, development, and disease response, but these interactions remain poorly understood in swine. Scientists at the Agricultural Research Service, Beltsville, Maryland analyzed the bacteriome and mycobiome in the feces of piglets from birth through 2 weeks post-weaning (35 days of age). USDA scientists demonstrated that the interactions between bacterial and fungal populations are changed by piglet development. The bacteriome had a predictable pattern of colonization with increased diversity over time while the mycobiome demonstrated reduced diversity over time. Further, fungal populations were more effected by environmental effects such as feed, showing them to be a more transient

population than the bacteriome. These data together suggest that the mycobiome may be an effective target for microbial interventions due to its tractability and ability to alter the bacteriome during the weaning transition in piglets. This data provides insights into microbial interactions in the piglet fecal ecosystem during weaning and future studies will investigate its role in piglet growth performance.

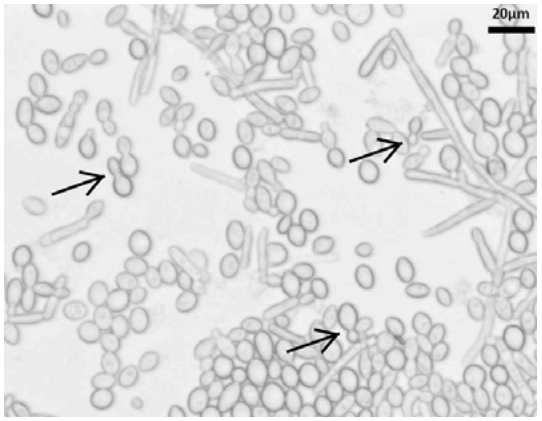


Photo to the Right: Budding yeast from Kazachstania slooffiae.

Genes associated with chromatin modification within the swine placenta are differentially expressed due to factors associated with season

Lea Rempel – U.S. Meat Animal Research Center

Contributors: John Parrish - University of Wisconsin and Jeremy Miles – U.S. Meat Animal Research Center,

Citation: Rempel, L.A., Parrish, J.J., Miles, J.R. 2020. Genes associated with chromatin modification within the swine placenta are differentially expressed due to factors associated with season. Frontiers in Genetics. 11:1019. https://doi.org/10.3389/fgene.2020.01019.

Epigenetics is the result of environmental factors altering the DNA output, without altering the DNA sequence. Environmental factors, such as season, have been shown to impact reproductive performance in swine. ARS scientists along with the University of Wisconsin, evaluated the difference in known epigenetic-associated genes in placenta that were derived from semen collected during warm or cool periods, semen that was stored as cooled-extended or cryopreserved, and breeding females in summer or winter. The season in which the females were bred, summer or winter, elicited the greatest number of genes that were different within the placenta. Three genes were influenced by the interaction of semen collection season, semen storage, and breeding season. Although the swine industry regulates environmental influence of summer by using climate-controlled housing, these data suggest season, or time of the year, can still influence placental development. These subtle changes likely occur to improve survivability of the developing fetuses under different environmental conditions. These data are novel findings and support future studies investigating the influences season has on placental development

Authors

Contact	Name	Email	Office Phone
U.S. Meat Animal Research Center	Dr. Mark Boggess	mark.boggess@usda.gov	(402) 762-4109
U.S. Meat Animal Research Center	Hiruni Wijesena	hiruni.wijesena@usda.gov	(402) 762-4184
U.S. Meat Animal Research Center	Dr. Jeremy Miles	jeremy.miles@usda.gov	(402) 762-4182
Beltsville Agriculture Research Center	Dr. Katie Summers	katie.summers@usda.gov	(301) 504-8760
U.S. Meat Animal Research Center	Dr. Lea Rempel	lea.rempel@usda.gov	(402) 762-4185
North Carolina State University	Dr. Suzanne Leonard	smleona4@ncsu.edu	(919) 513-3680
U.S. Meat Animal Research Center	Troy McCain	troy.mccain@usda.gov	(402) 762-4139

U.S. Meat Animal Research Center
Phone: (402) 762-4100

Alexa Johnson
Communication Specialist
Email: alexa.johnson@usda.gov
Phone: (402) 762-4129