Virginia Cooperative Extension

A partnership of Virginia Tech and Virginia State University

Virginia Tech College of Agriculture and Life Sciences

Virginia State

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Livestock Update

Beef - Horse - Poultry - Sheep - Swine

June-July 2012

This LIVESTOCK UPDATE contains timely subject matter on beef cattle, horses, poultry, sheep, swine, and related junior work. Use this material as you see fit for local newspapers, radio programs, newsletters, and for the formulation of recommendations.

IN THIS ISSUE:

Scott P. Greiner, Extension Project Leader
Department of Animal & Poultry Sciences

Dates to Remember

BEEF

AUGUST

6-7 Tri-State Beef Cattle Conference. Washington County Fairgrounds. Abingdon.
Contact: Scott Greiner (540) 231-9159; email: sgreiner@vt.edu

OCTOBER

11-14 VA Junior Livestock Expo. Rockingham Fairgrounds. Harrisonburg.
Contact: Paige Pratt, (540) 231-4732; email: pjpratt@vt.edu

HORSE

SEPTEMBER

13-16 VA State 4-H Horse and Pony Championship. Virginia Horse Center. Lexington.
Contact: Celeste Crisman, (540) 231-9162; email: ccrisman@vt.edu

SHEEP

AUGUST

25 Virginia Performance Tested Ram Lamb Sale. Shenandoah Valley AREC. Steeles Tavern. ***Contact:*** Scott Greiner, (540) 231-9159; email: sgreiner@vt.edu

SWINE

OCTOBER

26-27 Virginia Tech Small-Scale and Niche Market Pork Production Conference. Tidewater AREC. Suffolk. ***Contact:*** Mark Estienne, (757) 657-6450, ext. 408; email: mestienn@vt.edu

June-July Beef Management Calendars

Dr. Scott P. Greiner
Extension Animal Scientist, VA Tech

JUNE

Spring Calving Herds

- Finish AI; turn out clean-up bulls
- Check bulls regularly for performance and injury
- Manage first-calf heifers separately; give them best forage and supplement
- Use 48 hour calf removal for thin cows and first-calf heifers at beginning of breeding season
- Continue feeding high magnesium minerals to prevent grass tetany; may be able to switch to high Se
- Administer mid-summer deworming, and implant calves late in month or early next month
- Complete harvest of first cutting hay early in month
- Start grazing warm season grasses

Fall Calving Herds

- Body condition score cows; plan nutrition and grazing program based on BCS
- Administer mid-summer deworming on replacement heifers and pregnant heifers
- Plan marketing program for calves
- Finalize calf crop marketing program
- Vaccinate, wean, and certify calves to be marketed in late summer
- Switch to high selenium trace mineral salt
- Start grazing warm season grasses

JULY

Spring Calving Herds

- Check bulls regularly for performance and injury
- End breeding season; pull bulls
- Feed 1st calf heifers separately; provide highest quality forage and supplement
- Continue fly control program
- Continue feeding high Se trace salt
- Continue creep grazing
- Do mid-summer deworming and implanting early in month
- Start grazing warm season grasses

Fall Calving Herds

- Continue fly control program
- Do mid-summer deworming on replacement heifers, preg heifers (2yr olds) and 3yr-old cows
- Continue high Se trace mineral salt
- Vaccinate and certify calves for value-added feeder calf sales
- Wean calves if selling in weaned program (wean minimum of 45 days)

2012 Across-Breed EPD Table

Dr. Scott P. Greiner
Extension Animal Scientist, VA Tech

The table of adjustment factors to be used to estimate across-breed expected progeny differences (AB-EPDs) for eighteen breeds was released at the Beef Improvement Federation Annual Meeting in Houston, TX, on April 20 (see Table 1). Across-breed adjustment factors have been calculated for growth traits and maternal milk since 1993. Adjustment factors for carcass traits have been calculated since 2009; to be included, breeds must have carcass data in the U.S. Meat Animal Research Center (USMARC) database and report their carcass EPDs on an actual carcass basis using an age-adjusted endpoint. Bulls of different breeds can be compared on the same EPD scale by adding the appropriate adjustment factor to the EPDs produced in the most recent genetic evaluations for each of the sixteen breeds. The AB-EPDs are most useful to commercial producers purchasing bulls of more than one breed to use in cross-breeding programs. For example, in terminal cross-breed systems, AB-EPDs can be used to identify bulls in different breeds with high growth potential or favorable carcass characteristics.

As an example, suppose a Simmental bull has a yearling weight EPD of + 52.1 lb and a Gelbvieh bull has a yearling weight EPD of + 84.0 lb. The across-breed adjustment factors for yearling weight (see Table 1) are 22.4 lb for Simmental and -13.5 lb for Gelbvieh. The AB-EPD is 52.1 lb + 22.4 lb = 74.5 lb for the Simmmental bull and 84.0 - 13.5 = 70.5 lb for the Gelbvieh bull. The expected yearling weight difference when both are mated to cows of another breed (e.g., Angus) would be 74.5 lb – 70.5 lb = 4.0 lb.

Most breed associations publish EPDs at least on an annual basis. These EPDs predict differences expected in performance of future progeny of two or more bulls within the same breed for traits including birth weight, weaning weight, yearling weight, and maternal milking ability (as reflected in progeny weaning weights). Normally, the EPDs of bulls from different breeds cannot be compared because most breed associations compute their EPDs in separate analyses and each breed has a different base point. The across-breed adjustment factors allow producers to compare the EPDs for animals from different breeds for these traits; these factors reflect both the current breed difference (for animals born in 2010) and differences in the breed base point. They should only be used with EPDs current as of April 2012 because of potential changes in EPD calculations from year-to-year.

It is important to note that the table factors (Table 1) do not represent a direct comparison among the different breeds because of base differences between the breeds. They should only be used to compare the EPDs (AB-EPDs) of animals in different breeds. To reduce confusion, breed of sire means (i.e., when sires from two different breeds are mated to cows of a third, unrelated breed) between 2010 born animals under conditions at USMARC are presented in Table 2.

The adjustment factors in Table 1 were updated using EPDs from the most recent national cattle evaluations conducted by each of the eighteen breed associations (current as of March 2012). The breed differences used to calculate the factors are based on comparisons of progeny of sires from each of these breeds in the Germplasm Evaluation Program at USMARC in Clay Center, Nebraska. These analyses were conducted by USMARC geneticists Larry Kuehn (email: Larry.Kuehn@ars.usda.gov; ph: 402-762-4352) and Mark Thallman (email: Mark.Thallman@ars.usda.gov; ph: 402-762-4261).

TABLE 1. ADJUSTMENT FACTORS TO ADD TO EPDs OF EIGHTEEN DIFFERENT BREEDS TO ESTIMATE ACROSS BREED EPDs

Breed	Birth Wt.	Weaning Wt.	Yearling Wt.	Maternal Milk	Marbling Score[a]	Ribeye Area	Fat Thickness
Angus	0.0	0.0	0.0	0.0	0.00	0.00	0.000
Hereford	2.7	-2.8	-20.1	-16.7	-0.34	-0.11	-0.053
Red Angus	2.4	-0.6	-12.0	-3.1	0.03	-0.10	-0.034
Shorthorn	6.0	15.7	39.4	17.9	-0.14	0.17	-0.148
South Devon	4.2	3.2	-6.3	-2.3	0.05	0.15	-0.111
Beefmaster	6.7	35.3	32.5	7.8			
Brahman	11.1	42.5	4.8	22.4			
Brangus	3.7	13.0	13.5	6.8			
Santa Gertrudis	7.4	37.7	33.9		-0.67	-0.19	-0.115
Braunvieh	1.2	-19.2	-38.5	-0.4	-0.67	0.23	-0.095
Charolais	8.6	40.1	46.8	5.7	-0.46	0.92	-0.222
Chiangus	3.3	-14.9	-31.3		-0.42	0.40	-0.157
Gelbvieh	4.0	5.7	-13.5	13.6			
Limousin	3.8	-0.9	-34.7	-9.2	-0.70	1.07	
Maine-Anjou	4.1	-13.0	-34.5	-4.7	-0.79	0.88	-0.210
Salers	1.8	-3.1	-14.3	2.4	-0.11	0.75	-0.210
Simmental	5.2	24.9	22.4	19.8	-0.55	0.92	-0.215
Tarentaise	1.7	33.1	21.2	23.4			

[a]Marbling score units: 4.00 = Sl^{00}; 5.00 = Sm^{00}

TABLE 2. BREED OF SIRE MEANS FOR 2010 BORN ANIMALS UNDER CONDITIONS SIMILAR TO USMARC

Breed	Birth Wt.	Weaning Wt.	Yearling Wt.	Maternal Milk	Marbling Score[a]	Ribeye Area	Fat Thickness
Angus	89.8	582.0	1036.8	570.2	5.92	12.96	0.587
Hereford	94.3	576.2	1004.6	548.5	5.19	12.77	0.526
Red Angus	90.3	566.3	999.4	562.5	5.59	12.60	0.544
Shorthorn	96.3	565.7	1015.6	568.3	5.34	12.86	0.418
South Devon	94.8	578.7	1021.3	568.8	5.84	12.99	0.477
Beefmaster	95.0	578.3	997.3	558.0			
Brahman	100.8	592.2	980.0	576.9			
Brangus	92.4	571.0	1006.9	565.8			
Santa Gertrudis	96.0	577.7	992.7		4.82	12.46	0.463
Braunvieh	92.1	556.7	976.7	582.3	5.23	13.59	0.391
Charolais	97.2	599.3	1041.2	560.7	5.05	13.76	0.356
Chiangus	93.2	556.9	989.1		5.32	13.06	0.445
Gelbvieh	93.3	580.8	1012.7	578.5			
Limousin	93.3	579.5	1000.0	559.1	4.75	14.24	
Maine-Anjou	93.8	561.4	995.3	563.2	4.92	13.67	0.371
Salers	91.6	573.2	1016.8	570.7	5.58	13.40	0.368
Simmental	93.9	590.7	1030.5	571.4	5.11	13.75	0.375
Tarentaise	91.6	584.1	1001.6	572.2			

[a]Marbling score units: 4.00 = Sl^{00}; 5.00 = Sm^{00}

Details Announced for 2011-12 Virginia BCIA Central Bull Test Station Program

Joi D. Saville
Extension Associate, Beef, VA Tech

The Virginia Beef Cattle Improvement Association will begin its 55th year of sponsoring the Virginia's Central Bull Test Station Program. Rules and regulations for the upcoming test and sale season are now available through Virginia BCIA. A total of three test groups of bulls will be developed and sold from the two stations located at Culpeper and in Southwest Virginia.

The Culpeper Senior test is conducted at Glenmary Farm in Rapidan, VA owned and operated by Tom and Kim Nixon. The Southwest Bull Test Station is located at Hillwinds Farm owned by Tim Sutphin of Dublin, Virginia. At the Culpeper station, a set of fall-born Senior bulls will be developed. The Southwest Test Station will develop both a set of fall-born Senior bulls, as well as spring-born Junior bulls. In addition to the traditional tests, the opportunity exists for breeders to custom feed bulls through the BCIA program so that contemporary groups may be maintained. Additionally, provisions to the program allow breeders flexibility in developing both sale-eligible and custom tests bulls. The following table provides details of age requirements, entry deadlines and the test and sale schedule for each group of bulls.

	CULPEPER SENIOR BULLS
Birth Dates	August 15 – November 30, 2011
Entry Deadline	June 8, 2012
Delivery of Bulls	June 26, 2012
Start Test	July 10, 2012
Finish Test	October 30, 2012 (112 days)
Sale	Saturday, December 8, 2012

	SOUTHWEST SENIOR BULLS	SOUTHWEST JUNIOR BULLS
Birth Dates	September 15 – December 31, 2011	January 1 - March 31, 2011
Entry Deadline	September 7, 2012	September 7, 2012
Delivery of Bulls	October 2, 2012	October 2, 2012
Start Test	October 16, 2012	October 16, 2012
Finish Test	February 5, 2013 (112 days)	February 5, 2013 (112 days)
Sale	Saturday, March 23, 2013	Saturday, March 23, 2013

Again this year, we will feature the enhanced bull guarantee which covers fertility, structural soundness problems (including foot soundness) and other issues on all bulls sold through the program. To compliment this good-faith guarantee, fall-born senior bulls will be subject to a semen evaluation as part of breeding soundness exam required for sale eligibility. Volume discounts will be available to bull buyers purchasing three or more bulls at a BCIA bull sale.

Registered bulls of any recognized beef breed, or recorded percentage bulls of breeds which have an open herd book are eligible for the central tests. All bulls must be recorded in their respective breed association, and have a complete performance record (including EPDs). Bulls must also meet breed-specific minimum YW EPD requirements, individual performance specifications, as well as pre-delivery health and management protocol to be eligible for the tests.

Breeders in Virginia and bordering states who are members of Virginia BCIA are eligible to consign bulls. For details and copies of the rules and regulations as well as entry information regarding the central bull tests, contact the Virginia BCIA office at 540-231-9159 or visit http://www.bcia.apsc.vt.edu .

Tri-State Beef Conference

Dr. Scott P. Greiner

Extension Animal Scientist, VA Tech

The conference is presented by the University of Tennessee Extension, Virginia Cooperative Extension and North Carolina Cooperative Extension.

Co-sponsored by

E12-4115-00-008-12

Programs in agriculture and natural resources, 4-H youth development, family and consumer sciences, and resource development. University of Tennessee Institute of Agriculture, U.S. Department of Agriculture and county governments cooperating. UT Extension provides equal opportunities in programs and employment.

Conference Hotel

Comfort Suites
1093 Ole Berry Drive off I-81 exit 14
Abingdon, VA 24210
(276) 698-3040

Rate: $88 single or $99 double/night
Deadline for group rate: July 13
Group name: Tri-State Beef Conference

Directions to Fairgrounds

Take Exit 14 off I-81 to US 11
Turn left on US 11 at light
Go approximately 1/4 mile
Fairground Road is to the right

This year beef producers are experiencing record prices for feeder cattle, cull breeding animals and finished cattle. Even at these record levels, prices continue to be highly volatile and sensitive to news both on the domestic and international fronts. Stocker operators, especially because they are margin operators, must manage their risk for both cattle and purchased inputs. Cow calf producers are reaping the benefits of the high prices, yet are confronted by high cost for fertilizer, diesel fuel, etc. Capital requirements for stocker operators are 20 percent higher than a year ago. Lenders are increasingly interested in risk management plans for accounts in which they are supplying large amounts of capital. The cost to produce both grazed and mechanically harvested forage is very high. This year's conference will address topics of interest to both stocker and cow calf producers. Participants will hear from speakers on topics such as market outlook and planning, forage economics, cattle health, risk management, and nutrition. By popular demand, there will once again be a panel of successful stocker and cow calf operations for participants to hear and ask questions of about their operations. This year's conference will be one that should add dollars to your bottom line whether you run a stocker or a cow calf operation.

Beef Operations Tour — August 6

The conference will begin with an optional tour of two Virginia beef operations.

The tour will leave from the fairgrounds at 1:00 p.m.

During the tour there will be a demonstration of pinkeye treatment and BQA health management practices by Dr. Dee Whittier. The tour will be followed by a light meal and after-dinner talk by Dr. Gary Sides, Cattle Nutritionist with Pfizer Animal Health. The trade show will also be open for you to visit with our sponsors.

Conference — August 7

Registration begins at 7:45 a.m.

The program will begin at 8:30 a.m.

A trade show will be open during the day with many of the animal health, feed, and marketing organizations involved in the region's beef industry there for you to meet and learn more about their products and services.

A steak lunch will be provided for all participants.

Program Topics and Speakers

Beef Cattle Outlook and Market Planning
Dr. Derrell Peel
Professor and Extension Economist
Oklahoma State University

Managing Risk in the Beef Business
John Rakestraw
CEO, Agra Holdings, LP

Making the Most of the Big Dollar Cattle Treatments: Antibiotics and Dewormers
Dr. Dee Whittier
Professor
Virginia-Maryland Regional College of Veterinary Medicine

Making the Most of Your Forage Program
Kevin Ferguson
Farm Management Area Specialist
University of Tennessee Extension

Cow/Calf Producer Panel

Stocker Operator Panel

Wrap-up
Wes Ishmael
Editor, BEEF Magazine

Registration Form

Name: ____________________

Address: ____________________

City ____________ State ________ Zip ________

County: ____________________

Phone: (______) ____________

E-mail: ____________________

Attending tour on Monday, August 6? ☐ Yes ☐ No

Payment Information:
Enclose a check payable to:
Abingdon Feeder Cattle Association

Registration Fee
$20 — Before July 30
$25 — After July 30

Mail to:
Tri-State Beef Conference
c/o Phil Blevins
Abingdon Feeder Cattle Association
234 W. Valley Street, Suite B
Abingdon, VA 24210

Sheep Update

Dr. Scott P. Greiner
Extension Animal Scientist, VA Tech

2012 Virginia-North Carolina Wool Pool

Producers in Virginia and North Carolina interested in marketing their wool through local wool pools will have the opportunity to do so through Mid-States Wool Growers Cooperative Association based in Canal Winchester, Ohio. Producers are encouraged to package, handle and store their wool in an appropriate manner in order to maximize the value of their wool clip. Wool should be packaged by type and grade (ewe vs. lamb wool, long staple vs. short wools, fine vs. medium wools) in plastic bags, and be clean, dry, and have foreign material (straw, mud, manure) removed prior to packaging. Following is a list of local pool delivery dates, and locations where wool will be picked up:

July 12	Rice, VA
July 13	Orange, VA
July 16	Wytheville, VA
July 17	Christiansburg, VA
July 20	Clark Co., VA
July 20	Augusta Co., VA
July 24	Williamston & Albermarle, NC
July 25	Asheville & Sparta, NC
July 30	Russell Co., VA
July 31	Tazewell Co., VA

To confirm the above dates, and for more information regarding specific times and locations, contact your local Cooperative Extension Office.

Proper Wool Handling

Proper harvesting, packaging, and storage of the wool is important to realize the full value of the wool clip. Since wool sales represent a very small portion of the gross returns for most sheep enterprise, wholesale changes to the genetics of the flock to improve fiber diameter and fleece weight are likely not justified for most Mid-Atlantic producers. However, there are several important steps that should be considered to maximize the value of the wool clip:

A. Minimize Contamination:
   1. Keep shearing area clean and free of straw/hay and other potential sources of contamination.
   2. Avoid use of plastic baler twine in sheep operation that may contaminate fleeces (this contamination occurs throughout the year, not just at shearing time).

B. Use Proper Packaging Material:
   1. Do not use plastic feed sacks to store or package wool.
   2. Plastic film bags are available and preferred. Points to consider with plastic film bags:
      a. Sheep need to be dry when sheared. Plastic bags will not breathe as well as jute bags (more possibility for wool to mold and rot).
      b. Plastic film bags will tear easier when handled.
      c. Tie plastic film bags shut in similar manner to jute bags.
   3. Store wool in dry place, avoid cement or dirt floors to prevent moisture uptake.

C. Sort Wool at Shearing Time
1. Shear white-face sheep first, blackface sheep last to avoid contamination of white-faced wool with black fibers.
2. Package lamb and ewe wool separate.
3. Remove tags at shearing and discard.
4. Sort belly wool and bag separately. Also sort wool caps and leg wool out if justified.
5. Off-type fleeces (black, high vegetable matter, etc.) as well as belly wool should be packaged first in a small plastic garbage bag or paper sack. The small bag may then be added to the large polyethylene film bag. The small bag serves to keep these wools separate and prevents them from contaminating other fleeces already packaged, and results in a more uniform lot of wool.
6. Do not tie wool with paper twine.

Virginia Ram Lamb Performance Test Underway

A total of 66 rams were delivered May 1 to the Virginia Sheep Evaluation Station located at the Shenandoah Valley Agricultural Research and Extension Center near Steeles Tavern, VA. Consignment numbers and breeds of rams consigned include: 28 Winter Suffolk, 9 Fall Dorset, 10 Winter Dorset, 3 North Country Cheviot, 5 Suff x NC Crossbred, 9 Winter Katahdin, and 2 White Dorper. The rams began the 63-day test period on May 15, which will conclude July 17. At the completion of the test, rams will be evaluated for reproductive and structural soundness. Eligible rams will sell at the station on Saturday, August 25. Complete performance information will be available on all rams, including measures of growth performance, ultrasonic estimates of carcass merit, and scrapie resistance genotypes. For information please contact Dr. Scott Greiner, phone 540-231-9159 or email sgreiner@vt.edu .

Sheep Field Day and Ewe Lamb Sale to be Hosted at Shenandoah Valley AREC

An educational field day will be hosted at the Virginia Sheep Evaluation Station located on the Virginia Tech Shenandoah Valley AREC on Saturday, August 25. The field day will accompany the annual performance tested ram lamb sale. In addition, a consignment ewe lamb sale will be held in conjunction with the ram sale. Approximately 50 ewe lambs will be offered along with the performance tested rams. Producers interested in consigning ewe lambs or wanting further information on the field day or ram and ewe sale can contact Dr. Scott Greiner, phone 540-231-9159 or email sgreiner@vt.edu.

Proposed Increase to Assessment Rate for Lamb Checkoff Program

A proposed amendment to increase the assessment rate for the Lamb Promotion, Research and Information Order was published in the June 12 Federal Register. Interested parties are invited to make comments on this change through August 13.

The amendment would increase the assessment rate from $.005 to $.007 per pound for live sheep and lamb sold by producers, feeders and seedstock producers. For sheep and lamb purchased for slaughter by first handlers the rate would increase from 30 cents to 42 cents per head.

Funds collected under the Lamb Checkoff Program are used for promotion, information, research and advertising of American lamb.

This is the first proposed increase in assessment rates in the program's decade history. For more information about this proposed amendment, visit www.lambcheckoff.com or https://www.federalregister.gov.

Virginia Tech Sheep Center to Host 11th Annual Production Sale September1

The 13th Annual Virginia Tech Sheep Center Production Sale will be held Saturday, September 1st at the Alphin-Stuart Livestock Arena on the campus of Virginia Tech. The sale offering will include Suffolk and Dorset ram lambs, along with Suffolk and Dorset ewe lambs. Complete performance data including EPDs and carcass ultrasound records are available. Proceeds from the sale will be used to support the sheep teaching, extension, and research missions of the Department of Animal & Poultry Sciences. Sale details and catalog are available on the web at http://www.apsc.vt.edu/centers/sheepcenter/index_sheep.htm For additional information contact Dr. Scott Greiner, phone 540-231-9159 or email sgreiner@vt.edu .

Early-in-Life Experiences Impact Lifetime Reproductive Performance and Longevity in Sows

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Virginia Tech- Tidewater Agricultural Research and Extension Center
Suffolk, VA, USA

Introduction

On commercial farms in the U.S. annual culling rates often exceed 50% and many sows are replaced before their third or fourth parity, corresponding to potentially the most productive period in the life of a sow (Hoge and Bates, 2011). Indeed, it is estimated that gilts require a minimum of 3 parities to pay for their replacement cost (Stalder et al., 2003). Issues related to reproduction, such as failure to express estrus, conceive, or farrow (35%), and problems with foot and leg structure (22%), are the most common reasons for young sows leaving the herd (Mote et al., 2009). For pork producers to remain globally competitive, research and technological advances are needed to increase sow longevity and lifetime productivity. There is a critical need to develop and evaluate best management practices for gilt development that maximize future reproductive capacity.

Modern swine production has benefited from a large amount of research focused on management of replacement gilts during grow-finish and around the time of sexual maturity to capture reproductive efficiency. And while management during these phases of production may greatly influence lifetime reproductive performance, it is becoming more evident that management during the suckling and nursery periods may have profound effects as well. Moreover, a growing body of evidence supports the notion that the maternal environment in which a gilt fetus develops plays an important role in the development of the reproductive and other physiologic systems that becomes evident later in life- a phenomenon referred to as "fetal programming".

The objective of this paper is to provide the reader with a brief introduction to the concept of "fetal programming" and how management of the fetal, suckling, and nursery pig may ultimately influence reproduction and longevity in mature swine. Although this paper focuses mainly on the female, data in boars is also included if it exists.

Prenatal development in the pig and fetal programming

Fertilization of ovulated oocytes by sperm cells occurs in the oviduct a few hours after mating. Cell division begins soon after and the fertilized ova pass into the uterus by the third day post-mating. Cell specialization and rearrangement begins by the sixth day. Eleven day-old embryos begin to show initial signs of attachment to the uterine endometrium, and implantation and formation of the placenta occurs around day 18. By this time, the ectoderm, mesoderm, and entoderm are clearly formed within the embryo and cell specialization continues. From the ectoderm arise the skin, mammary and sweat glands, hair and hoofs, the intestinal epithelium, teeth enamel and the nervous system. From the entoderm arise components of the digestive tract, thyroid gland, trachea, and lungs. From the mesoderm arise the skeleton, skeletal muscle, connective tissue, blood vessels, blood cells, heart, smooth muscle, adrenal glands, reproductive organs, and the kidneys. Shown in Table 1 is a chronology of events in the prenatal growth of swine with emphasis on development of the reproductive system.

Table 1. Chronological events in prenatal development of pigs with emphasis on the reproductive system.

Event:	Day of gestation
Pass into uterus	2 to 3
Differentiation of germ layers into ectoderm, mesoderm, and entoderm	7 to 8
Initial attachment to endometrium	11 to 12
Implantation	18
Testes or ovaries differentiated	28
Formation of scrotum in boars and clitoris in gilts	44
Secretion of pituitary hormones begin	50
Formation of seminal vesicles, prostate and bulbourethral gland in boars and oviducts, uteri, and vagina in gilts	51
Testes enter inguinal canal in boars	95
Birth	114

Adapted from Pond et al., 1991

The concept of fetal programming was first put forth by Barker (1997) with the central premise of the "Barker Hypothesis" being that the exposure of a fetus *in utero* to various acute or chronic stimuli may elicit a permanent response that impacts physiologic function later in life. When reviewing the chronology of fetal development in the pig described above, it is intuitive that prenatal stressors can affect a variety of physiological systems later in life with the presence or magnitude of the effect dependent on the timing and duration of the prenatal experience (Lay, 2000). Reproductive consequences of fetal programming due to: 1) intrauterine growth retardation (**IUGR**), and 2) management of the sow, will now be discussed.

Intrauterine growth retardation and fetal programming

During the last two decades, management advances and selection for prolificacy have greatly increased litter size in swine, as evidenced in Figure 1. An unintended consequence of the increase in litter size, however, has been an increase in the proportion of low birth weight pigs due to IUGR. Intrauterine growth retardation is defined as impaired growth and development of the mammalian embryo or fetus or its organs during pregnancy. In reality, a number of factors, such as inadequate maternal nutrition or disease, can contribute to IUGR in domestic livestock (Wu et al., 2006). However, from a practical sense, the most important cause of IUGR in swine is probably insufficient uterine capacity, which limits the amount of placental attachment and as a consequence, nutrient exchange between the dam and fetuses (Foxcroft, 2010).

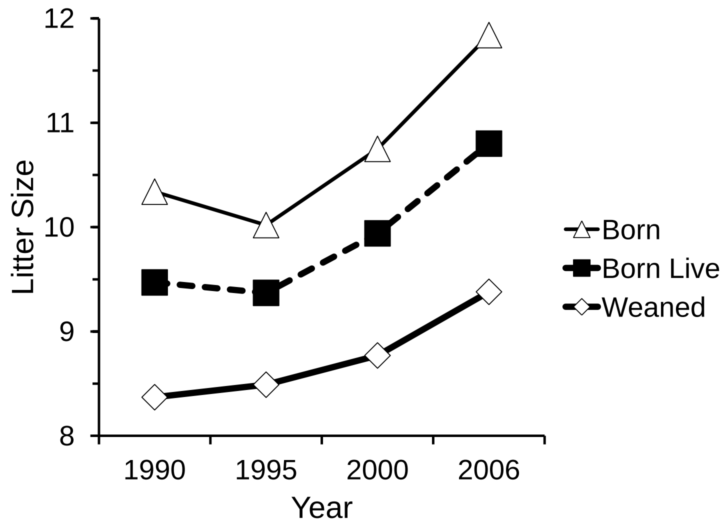

Figure 1. Total number of pigs born, pigs born live, and pigs weaned, per litter in the U.S. from 1990 to 2006 (data from National Animal Health Monitoring System, 2008).

Consequences of IUGR on postnatal growth performance in swine are well-documented. Compared with high birth weight offspring, IUGR newborn pigs have greater rates of pre-weaning mortality and lower postnatal growth rates; at slaughter, low birth weight pigs have less muscle, are fatter, and have poorer meat quality (for review, see Rehfeldt and Kuhn, 2006). The reproductive effects of IUGR have been less studied. Almeida et al. (2009) reported that at 7 days after farrowing, testes weight and the number of Sertoli cells and spermatogonia per testicular cord were lower in low-birth weight (mean weight = 1.17 kg) compared to high-birth weight (mean weight = 2.02 kg) boars. Because the number of Sertoli cells established before puberty determines adult sperm production, low-birth weight boars may have poorer reproductive performance at sexual maturity. Preliminary evidence from our laboratory supports this hypothesis.

In our study (Estienne and Harper, 2010b), the birth weights of boars successfully trained for semen collection (mean weight = 1.67 kg; n = 29) were significantly greater than birth weights of un-trainable boars (mean weight = 1.29 kg; n = 8), although body weights at training were similar between groups. Semen was collected from trained boars weekly for eight weeks and sperm concentration and total sperm per ejaculate were positively correlated with birth weight in these individuals. Moreover, a subset of boars classified as light weight (less than 1.36 kg; n = 7) had lower sperm concentrations and total sperm per ejaculate compared with boars classified as high-birth weight (greater than 1.86 kg; n = 9). Thus, our results are consistent with the concept that birth weight is a predetermining factor impacting reproductive potential in adult boars.

In gilts, Da Silva-Buttkus et al. (2003) reported that at birth, runt pigs (mean weight = 0.7 kg) had more primordial follicles, but fewer primary and secondary follicles than normal weight littermates (mean weight = 1.5 kg), indicating the IUGR delayed follicular development. We recently reported on a pilot study examining age at puberty in gilts farrowed in litters with various average birth weights (Estienne, 2012). Age at puberty, defined as the first standing estrus in the presence of a mature boar, was determined for two to seven gilts from each of 33 litters that had a range of average pig birth weight of 1.13 to 1.98 kg. Age at puberty was negatively correlated (r = - 0.43; $P < 0.01$) with average pig birth weight. Foxcroft (2010) suggested that differences among litters is the major source of variation in pig birth weight in populations of mature sows producing between 10 and 15 pigs per litter, and the low birth weight phenotype was repeatable.

Management of the fetal pig and future reproduction

Relatively little research has been conducted to determine the effects of sow management and husbandry on fetal programming. Most studies conducted to date have examined the effects of experimentally subjecting pregnant sows to "stress" conditions on the future performance of offspring, with a postulate being that at least some fetal programming occurs as a consequence of enhanced secretion of maternal cortisol. Haussmann et al. (2000) demonstrated that stress caused by restraint or injection of adrenocorticotropin (**ACTH**) to stimulate cortisol secretion in the pregnant sow, resulted in offspring with altered endocrine profiles and adrenal gland morphology, enhanced cortisol secretion in response to stress, and a decreased ability to heal a wound. There was a tendency for control pigs to have greater birth weights than pigs farrowed by sows treated with ACTH.

In terms of reproduction, boars born to dams that received ACTH during gestation, had similar birth weights but smaller anogenital distances than boars farrowed by control sows (Lay et al., 2008). O'Gorman et al. (2007) conducted a study during which sows were allocated to one of two treatment groups: control or stressed. Stressed sows were subjected to daily restraint for five minutes during weeks 12 to 16 of gestation. Female offspring were checked for estrus twice daily beginning at 122 days of age. Age at first estrus was significantly delayed in gilts farrowed by stressed sows (~ 172 days) compared to gilts farrowed by control females (~ 158 days). Potential involvement of the adipocyte-produced hormone leptin was suggested by the finding that leptin receptor mRNA in the choroid plexus was greater in pubertal gilts from control sows compared to gilts from stressed sows.

A recent experiment from our laboratory compared growth performance and reproductive characteristics of gilts farrowed by sows that were kept in individual crates throughout gestation, group pens throughout gestation, or individual crates for the first thirty days post-mating and then group pens for the remainder of pregnancy (Estienne and Harper, 2010a). Pig birth weights, and growth performance prior to weaning and during the nursery phase of production were similar among treatments, but during the last four weeks of the grow-finish period, body weights of gilts farrowed by females housed in crates throughout gestation were greater than body weights of gilts in the other two groups. Also, the efficiency of feed conversion was greatest, and the amount of ultrasonically determined last-rib backfat the least, in gilts farrowed by females housed in crates throughout gestation. Consistent with these findings, Foxcroft et al. (2006) reviewed the scientific literature and concluded that environmental influences on embryonic and fetal development most often express themselves in the late grower or finisher stages of production. Interestingly, in our study, fewer gilts farrowed by females kept in crates throughout gestation reached puberty by 165 days of age compared with the other two groups. Although the mechanisms responsible for these effects were not addressed, maternal cortisol secretion could be involved. Circulating cortisol levels were greater for gilts kept in individual gestation crates compared with group-penned individuals (Estienne et al., 2006).

Management of the suckling pig and future reproduction

Nelson and Robison (1976), reported that at day 25 post-mating, gilts that were raised in litters of six pigs prior to weaning, had more corpora lutea (an indication of ovulation rate) and embryos, than did gilts raised in litters of 12 pigs. Moreover, through three parities, sows raised in litters of seven pigs or less were less likely to be culled and had higher farrowing rates and larger litters than sows raised in litters of 10 or more pigs; boars raised in litters of six pigs or less reached puberty sooner and produced more sperm cells per ejaculate compared with boars raised in litters of nine pigs or more (Flowers, 2008). This suggests that lactation litter size can impose some type of stress that negatively impacts future reproduction of the suckling pigs.

Management of the nursery pig and future reproduction

There are many potential environmental stressors in intensively-managed swine operations and clinical signs of these stressors are often easily detected. For example, temperatures below the thermo-neutral zone cause pigs to huddle and shiver. Inadequately ventilated barns may cause coughing indicative of respiratory distress and animals housed in pens with poor flooring may display lameness. A stressor that is often operative, but which may not have easily discernible consequences, is stress due to inadequate floor space. For example, the percentage of gilts reaching puberty at less than 285 days of age tended to be greater for females allowed adequate floor space during the grower and finisher phases of production (0.56 and 0.72 m^2, respectively), compared to gilts allowed less floor space (0.28 and 0.56 m^2, respectively) (Lindemann et al., 1988). Kuhlers et al. (1985) placed grower gilts in pens of 8 or 16 animals each and the females reared in the smaller groups ultimately farrowed one more pig per litter than did gilts reared in the larger groups. More recently, Young et al. (2008) conducted an experiment during which 1,257 gilts at 75 days of age and 38 kg body weight were each given 0.76 or 1.12 m^2 of floor space during rearing. Space allowance in rearing did not affect total pigs produced over three parities or removal rate, however, a greater percentage of gilts attained puberty and attained puberty at a younger age, when given the greater amount.

It is reasonable to speculate that the immediate post-weaning environment (i.e., nursery phase of production) in which gilts are raised can ultimately influence reproduction as well. Floor space allowance during the nursery phase of production impacts growth performance, as demonstrated by Cho et al. (2010) who allotted weaned barrows and gilts to three treatments: I. 6 pigs/nursery pen and 0.5 m^2 floor space/pig, II. 12 pigs/pen and 0.25 m^2/pig, and III. 6 pigs/pen and 0.25 m^2/pig. Crowding significantly reduced average daily gain in both sexes during the 6-week trial.

Effects of nursery floor space allowance and stocking density on subsequent reproduction in gilts has not been adequately studied. However, gilts kept in pens of 16 during a 5-week nursery period subsequently farrowed 1.25 live pigs less during parity 1 and 3.5 live pigs less during parity 2, compared to gilts kept in pens of 8 in the nursery (Figure 2). In a study by Kim et al. (2008), 68 weaned gilts were allotted to: I. 6 pigs/nursery pen with 0.5 m^2 floor space/pig, II. 9 pigs/pen with 0.33 m^2/pig, III. 12 pigs with 0.25 m^2/pig, and IV. 6 pigs with 0.25 m^2/pig. In the first parity, litter size was largely unaffected by treatments. However, in the second parity, total litter size (10.86, 10.38, 8.79, and 8.67; linear effect for treatments I to III, $P = 0.24$) and pigs born live (8.43, 9.38, 7.79, and 7.67; quadratic effect for treatments I to III, $P = 0.30$) were numerically decreased by crowding stress. These studies were limited in terms of the number of animals employed, but nevertheless provide solid preliminary evidence consistent with the concept that space allocation during the nursery phase of production affects future gilt reproductive performance. Further, they demonstrate that the potential detriment increases in Parity 2 after the female has experienced the normal rigors of the Parity 1 lactation. These effects, however, must be substantiated in a commercial setting, using large numbers of experimental animals.

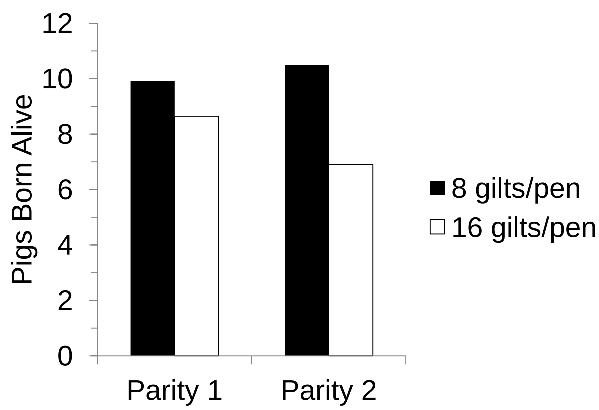

Figure 2. ***First and second litter size for sows that were kept in pens of 8 or 16 gilts each during the nursery phase of production. For both parities, the number of pigs born alive was greater (P < 0.01) for females previously housed in the less crowded conditions (M.D. Lindemann, personal communication).***

Summary and Conclusions

The research summarized herein provides evidence that stimuli to which gilts are exposed *in utero* and early-in-life may result in developmental adaptations that have lifelong physiologic consequences. The current trend of increasing litter size in swine has concomitantly increased the proportion of low-birth weight pigs due to inadequate uterine capacity. Pigs born with the IUGR phenotype have poorer reproductive performance compared to normal body weight pigs.

Currently, there is a need for the development of strategies and techniques to “rescue” low-birth weight pigs. For example, treatment of gilts with porcine growth hormone from day 10 to day 27 of gestation increased total fiber number in semitendinosus muscle in low-birth weight pigs that were ultimately farrowed (Rehfeldt and Kuhn, 2006). Foxcroft (2010) suggested two strategies to address variation in litter average birth weight and postnatal performance including: 1)segregated management of litters based on birth weight phenotype, and 2) nutritional strategies in gestation and lactation and interventions in the farrowing house targeted at low birth weight phenotypes. Subjecting sows to treatments that result in stimulation of the hypothalamic-pituitary-adrenal axis and the attendant increase in cortisol secretion may have long-term consequences on the fetus. Although the mechanism for these effects must be ascertained, it is not, in all likelihood, due solely to changes in pig birth weight. Given the evidence that experimentally induced hyper-secretion of cortisol in gestating sows may have negative effects on postnatal performance of pigs, producers should strive to minimize factors that result in stress to the breeding herd.

Finally, stress experienced by gilts in large litters during the suckling period or in crowded conditions during the nursery phase of production can not only impact growth performance immediately but may also have long-term consequences. Research will continue to identify prenatal or early-in-life stressors and to develop management strategies for mitigating adverse effects on reproduction and increasing sow longevity.

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