

BEEF IMPROVEMENT FEDERATION RESEARCH SYMPOSIUM & CONVENTION



ANNUAL CONVENTION 2019
Brookings, South Dakota

JUNE 18-21, 2019

CO-HOSTED BY:



SOUTH DAKOTA
STATE UNIVERSITY



WELCOME TO SOUTH DAKOTA STATE UNIVERSITY

51ST BEEF IMPROVEMENT FEDERATION MEETING



South Dakota State University and the South Dakota Beef Breeds Council are proud to host the Beef Improvement Federation Annual Meeting and Research Symposium.

The meeting is being held, for the first time ever, in Brookings, SD. We are excited to have you visit our community. Brookings has 24,000 residents, it is the fourth largest community in the state of South Dakota, and is the home of the South Dakota State University Jackrabbits. We hope you will find time to visit some of the interesting venues in our town. For families that may be looking for activities during the day, Brookings has a waterpark and excellent children's museum. Adults may choose to take in the South Dakota Art Museum, South Dakota Agricultural Heritage Museum, or McCrory Gardens on the campus of South Dakota State University. Others will enjoy the antique stores found on Main Street or the Dakota Nature

Park on the south edge of Brookings. Event staffers will be happy to answer any questions you may have regarding activities in Brookings.

The meeting kicks off with a reception on Tuesday afternoon followed by a symposium organized by the National Association of Animal Breeders. This is a continuation of the longstanding relationship between BIF and NAAB. In odd numbered years, NAAB plans the opening symposium. This year's symposium begins with SDSU's own Dr. George Perry discussing the use of sexed semen. Wednesday morning starts with a welcome from South Dakota State University President Dr. Barry Dunn. Dr. Dunn is a former rancher and faculty member who often attended and was, on occasion, a presenter at BIF conferences. I know he is excited to join us again this year. The Wednesday morning session is looking toward the future with advances in assisted reproductive techniques that have the potential to change generation interval in cattle and gene editing techniques that could revolutionize our strategies for beef improvement. New technologies have created the opportunity for beef producers to collect vast amounts of data. Thursday morning we will hear from speakers who are working on ways to best utilize the data for management and genetic improvement. The afternoon breakout sessions offer something for everyone covering a wide range of topics affecting our industry.

The meetings and events would not be possible without the support of our sponsors listed in the back of the program. Please thank our sponsors and enjoy your visit to Brookings, SD.

A handwritten signature in black ink, reading 'Joseph Cassady'. The signature is fluid and cursive, with a long, sweeping underline that extends to the right.

Dr. Joseph Cassady
Animal Science Department Head, South Dakota State University
BIF 2019 Organizing Committee Chair



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SCHEDULE OF EVENTS

TUESDAY, JUNE 18:

1:00 p.m.	Young Producer Symposium
1:00 p.m.	Introduction to BIF - Lee Leachman, President of BIF
1:15 p.m.	Drafting Your Team - Alan Hojer
2:00 p.m.	Building a Ranch Using Data - Trey Patterson
2:45 p.m.	Thinking Outside the Box – Dr. Tom Field
3:30 p.m.	Question and Answer Roundtable
5:30 p.m.	Opening Reception
7:00 p.m. - 8:30 p.m.	National Association of Animal Breeders Symposium moderated by Dr. Kenneth Odde
	7:00 p.m. – Welcome and Presentation of Sexed Semen Research by Dr. George Perry
	7:25 p.m. – Timed AI with Sex-Sorted Semen: Research and Application in Commercial Beef Herds by Dr. Jordan Thomas & Brent Mason
	8:00 p.m. – Panel Discussion and Audience Questions

WEDNESDAY, JUNE 19:

Theme: Applications of Technology

7:45 a.m.	Welcome from Dr. Barry Dunn, President of South Dakota State University
8:00 a.m.	New Technologies in Cattle Reproduction and the Correlated Acceleration of Genetic Gain – Dr. Mark Allan, Trans Ova Genetics, Sioux Center, IA
8:45 a.m.	Update on Gene Editing – Dr. Alison Van Eenennaam, UC Davis Extension Specialist: Animal Biotechnology and Genomics, Department of Animal Science
9:30 a.m.	30-minute Q&A
10:00 a.m.	Break
10:30 a.m.	Elite Commercial Producers - John Moes – Moes Feedlot, Trey Patterson - Padlock Ranch, Tylor Braden - King Ranch, John Maddux - Maddux Cattle Company
11:30 a.m.	What I Heard – Kevin Schultz, Sandhill Farms
12:00 - 2:00 p.m.	Lunch
	Presentation of BIF Commercial Producer, Continuing Service and Ambassador Awards, Roy Wallace Scholarship
2:00 - 5:30 p.m.	Breakout sessions

Advancements in genomics and genetic prediction - Chair, Dr. Mark Thallman

2:00 p.m.	Introduction – Dr. Mark Thallman, U.S. Meat Animal Research Center
2:05 p.m.	BIF Guidelines Update – Dr. Lauren Hyde, American Simmental Association
2:20 p.m.	Would You Drive a Race Car Without Steering? - Lee Leachman, Leachman Cattle of Colorado
3:00 p.m.	Decision Support Using Customizable Indices Across Breeds – Dr. Matt Spangler, University of Nebraska
3:40 p.m.	Break
4:00 p.m.	Detection and Treatment of Various Birth Weight Contemporary Group Recording Methods in the IGS Evaluation – Dr. Bruce Golden, Theta Solutions
4:40 p.m.	Low-pass Sequencing to Genotype Cattle: Promises & Problems – Dr. Warren Snelling, U.S. Meat Animal Research Center

Advancements in producer applications - Chair, Dr. Darrh Bullock

2:00 p.m.	Introduction – Dr. Darrh Bullock, University of Kentucky
2:10 p.m.	BIF Guidelines Update – Dr. Megan Rolf, Kansas State University
2:20 p.m.	Can we select for structure? Foot Score EPD – Dr. Kelli Retallick, Angus Genetics Inc
2:40 p.m.	Beyond Milk EPD: Udder Scores - Shane Bedwell, American Hereford Association
3:00 p.m.	Fertility Traits: Where we are and opportunities for advancement – Dr. Bob Weaver, Kansas State University
3:30 p.m.	Break
3:45 p.m.	Getting the most from our selection tools: Decision Support – Dr. Matt Spangler, University of Nebraska
4:30 p.m.	Developing DNA tests for improved fertility and reduced embryonic loss in US cattle breeds – Dr. Jerry Taylor, University of Missouri

Advancements in efficiency and adaptability - Chair, Dr. Mark Enns

- 2:00 p.m. Introductions – Dr. Mark Enns, Colorado State University
- 2:05 p.m. Improving thermotolerance in beef cattle: a genomic approach – Dr. Raluca Mateescu, University of Florida
- 2:50 p.m. The BIF Guidelines Wiki - BIF Guidelines Drafting Team
- 3:05 p.m. Genetic Control of Cattle Feet and Leg Structure – Dr. Jennifer Borman, Kansas State University
- 3:45 p.m. PAP, HMD, and FHD: alphabet soup of what we know, and don't know, about genetics of pulmonary hypertension in cattle – Dr. M. G. Thomas, Colorado State University
- 4:30 p.m. PAP EPD: A new tool to improve adaptability – Dr. Kelli Retallick, Angus Genetics Inc
- 6:30 p.m. Evening social and dinner at Club 71, SDSU campus

THURSDAY, JUNE 20:

Theme: Utilization of Big Data

- 7:45 a.m. Welcome from Dr. John Killefer, Dean of the College of Agriculture, Food and Environmental Sciences, South Dakota State University
- 8:00 a.m. The Next Generation of Genetic Tools – John Genho, Neogen senior director technical services
- 8:40 a.m. An Update on the Latest Agri-tech Emerging in the Australian Grazing Industries – Dr. Mark Trotter, Central Queensland University
- 9:20 a.m. Break
- 9:50 a.m. The use of 'Big Data' in a modern swine breeding program now and in the future – Dr. Jeremy Howard, Smithfield Premium Genetics
- 10:30 a.m. 30-minute Q&A
- 11:00 a.m. Wrap-up, Matt Perrier, Dalebanks Angus
- 11:15 a.m. Caucuses and elections
- 12:30 - 2:00 p.m. Lunch
- Presentation of BIF Pioneer and Seedstock Producer Awards, Frank Baker and Larry Cundiff
- Scholarships, Introduction of newly elected BIF Board of Directors, Invitation to BIF 2020
- 2:00 - 5:30 p.m. Breakout sessions

Advancements in emerging technology - Chair, Dr. Megan Rolf

- 2:00 p.m. Update on the BIF Guidelines Wiki – Dr. Darrh Bullock, University of Kentucky
- 2:15 p.m. Development of a web-based sire selection tool – Dr. Matt Spangler, University of Nebraska
- 3:00 p.m. Past, Present and Future of Genetic Embryo Testing in Cattle – Dr. Mark Allan, Trans Ova Genetics
- 3:45 p.m. Break
- 4:00 p.m. ROH and Genomic Inbreeding in Angus - Duc Lu, American Angus Association
- 4:45 p.m. Individual Animal Supplementation using SmartFeeds – Dr. Timothy DelCurto, Montana State University

Advancements in end product improvement - Chair, Dr. Tommy Perkins

- 2:00 p.m. BIF Guidelines Web Version Update - BIF Wiki Team Members
- 2:10 p.m. Using Genomics to Improve Meat Quality in Bos Indicus Influenced Cattle – Dr. Raluca Mateescu, University of Florida
- 2:45 p.m. From Label to Table: Understanding Consumer Preferences for Beef –Dr. Amanda Blair, South Dakota State University
- 3:30 p.m. Use of Cloning in Beef Production - the WTAMU PrimeOne Project – Dr. David Lust, West Texas A&M University
- 4:15 p.m. Consumer Perceptions of Beef and Beef Production - Rick Husted, NCBA, Vice President Strategic Planning & Market Research
- 4:45 p.m. Ultrasound Guidelines Council Update - Patrick Wall, UGC Executive Director

Advancements in selection decisions - Chair, Dr. Bob Weaver

- 2:00 p.m. Bovine respiratory disease (BRD) research at US-MARC - Larry Kuehn and Dr. Tara McDanel, U.S. Meat Animal Research Center
- 2:45 p.m. Economic-based index selection: an example in pigs – Dr. Scott Newman, Genus - ABS .
- 3:00 p.m. Break
- 3:45 p.m. New \$Value indexes at AAA – Dr. Stephen Miller, Angus Genetics Inc
- 4:30 p.m. Utilization of Beef Cattle Genetic Technology by Producers – Dr. Bob Weaver, Kansas State University
- 6:30 p.m. Evening social and BBQ, SDSU Cow/Calf Education and Research Facility

SCHEDULE OF EVENTS

FRIDAY, JUNE 21: POST-CONFERENCE TOUR

7:30 a.m.	Load the bus at University Comfort Suites 7:45 a.m. - Leave for Millborn Seeds
8:00 a.m.	Millborn Seeds, Brookings – Catered Breakfast, tour 9:30 a.m. – Load the bus
9:40 a.m.	Leave for Oines Farms LLC, Brookings
9:45 a.m.	Arrive at Oines Farms LLC, Brookings
11:45 p.m.	Load the bus
12:00 p.m.	Leave for Wienk Charolais Ranch, Lake Preston, SD
12:45 p.m.	Wienk Charolais Ranch, Lake Preston, SD – lunch, talk, tour
2:15 p.m.	Load the bus
2:30 p.m.	Leave for Schadé Winery
3:00 p.m.	Schadé Winery, Volga, SD – Wine tasting, appetizers, tour
4:30 p.m.	Load the bus
4:45 p.m.	Leave for Brookings
5:00 p.m.	Arrive at University Comfort Suites, Brookings

Millborn Seeds

Opened in 1987. Specializing in: forage, cover crops, conservation, wildlife, turf & custom formulated mixes.

Oines Farms LLC

Feeding for the future/ Our Responsible Beef

Wienk Charolais

Founded in 1958 by Arnold & Carol Wienk, the operation is an internationally recognized herd of purebred Charolais cattle located on the rolling plains of eastern South Dakota. The operation consists of roughly 450 registered Charolais cows and is owned and operated by three generations of the Eschenbaum family. Celebrating 60 years in the Charolais business. Wienk Charolais is a proven leader in the cattle industry because of their relentless commitment to the genetic improvement of the Charolais breed and industry leading customer service.

Schadé Winery

Founded 1999. Schadé Vineyard & Winery is the third bonded farm winery in South Dakota. Owned and operated by Jim & Nancy Schadé in Volga, SD. Their goal is to produce a wine that is made from SD grown products. We believe in Good Wines and Good Times.



GENERAL SESSION SPEAKERS

YOUNG PRODUCERS SYMPOSIUM - TUESDAY, JUNE 18TH

ALAN HOJER



Alan Hojer is manager and legacy consultant of Keep Farmers Farming, a division of First Dakota National Bank. Alan joined First Dakota National Bank in April of 2014 and was given the opportunity to work extensively with farm/ranch estate planning, transition/succession planning and other areas such as marketing & risk management through the Keep Farmers Farming program. Most recently, Alan became a certified estate planner. This has been the most challenging and rewarding experience of his professional career, but Alan feels blessed to be part of this great effort.

Alan and his wife Pam are the proud parents of three children and 10 grandchildren. He looks forward to the day that he and Pam will get to work day-by-day next to their children and grandchildren at their family operations. Alan is a proud alum of South Dakota Ag and Rural Leadership (SDARL) Class VII.

TOM FIELD, PH.D.



Tom Field, Ph.D. serves the people of Nebraska as the director of the Engler Agribusiness Entrepreneurship Program and holder of the Engler Chair in Entrepreneurship at the University of Nebraska – Lincoln. An enthusiastic advocate for free enterprise, the potential of young people and opportunities in both agriculture and rural communities, Tom is an internationally recognized educator and innovator with the ability to connect the dots between people, industries, and ideas.

Tom is a fifth-generation cattleman who has partnership in a family cow-calf business in western Colorado. He also authors the “Out of the Box” column and consults and advises a number of enterprises and organizations. Additionally, Tom is a sought-after speaker who challenges and inspires audiences to lead their organizations to excellence by asking the right questions, seeking solutions beyond conventional wisdom and unleashing the power of focused creativity. Tom is a native of Colorado and earned his bachelor's, master's and Ph.D. degrees at Colorado State University. He, his wife Laura and their family now reside near Raymond, Neb.

TREY PATTERSON, PH.D.



Dr. Trey Patterson received a bachelor's and master's degree in animal science from Colorado State University and his Ph.D. in ruminant nutrition from the University of Nebraska.

Trey served as an SDSU Extension beef specialist for five years. In this role, he led state-wide Extension and research programs in beef cattle nutrition and management.

Since 2005, Trey has been with Padlock Ranch Company based out of Ranchester, Wyo. Padlock is a large family-owned integrated cow/calf, feedlot, and farming operation. Trey now holds the position of President and CEO.

WEDNESDAY, JUNE 19TH

MARK ALLAN, PH.D.



Mark Allan, Ph.D., currently serves as the director of genetic technology for Trans Ova Genetics in Sioux Center, Iowa. In this role, he oversees R&D for genetics, genetic marketing opportunities and new product development activities.

From 2003 to 2008, Mark served as a research geneticist for the USDA's Agricultural Research Service at the U.S. Meat Animal Research Center in Clay Center, Neb. From 2008 to 2011, he served as the associate director of global technical services for Pfizer Animal Health-Genetics. Additionally, from 2006-2011 he served as an adjunct faculty member at the University of Nebraska Animal Science Department.

Mark has delivered numerous invited symposium talks across North America and abroad. He has received multiple industry awards, including the Trail Blazers Teachers and Researchers honor from the American Angus Association and was named one of the “Top Ten Industry Leaders Under 40” by Cattle Business Weekly.

GENERAL SESSION SPEAKERS

ALISON VAN EENENNAAM, PH.D.



Dr. Alison Van Eenennaam is a cooperative Extension specialist in the field of animal genomics and biotechnology in the Department of Animal Science at University of California, Davis. She received a bachelor's degree in agricultural science from the University of Melbourne in Australia, as well as a master's degree in animal science and her Ph.D. in Genetics from UC Davis.

Alison's publicly funded research and outreach program focuses on the use of animal genomics and biotechnology in livestock production systems. Her current research projects include the development of genome editing approaches for cattle. She has given over 600 invited presentations to audiences globally, and uses a variety of media to inform general public audiences about science and technology.

Dr. Van Eenennaam was the recipient of the 2014 Council for Agricultural Science and Technology (CAST) Borlaug Communication Award, and in 2017 was elected as a Fellow of the American Association for the Advancement of Science (AAAS).

JOHN MOES



John Moes grew up on a dairy farm near Kranzburg, S.D. John's operation started out in 1987 as a herd of 20 cows grazing on rented land and has since grown exponentially. Around 2005, John expanded his operation to include a feedlot and added the first ag-waste pond in 2006 to improve water quality and catch runoff water from the feedlot. In 2011, John expanded his feedlot to accommodate 1,999 head of cattle and continues to work with his son, Bryan, raising quality beef cattle and operating the feedlot.

Over the years, John has been proactive in the area of waste management and an excellent steward of the land. He is able to re-use manure from his feedlot operation to enhance and fertilize his crops, with about 10% of his cropped acres being strictly no-till. Additionally, organic matter in the soil has increased because of these practices.

John serves as a Director for the East Dakota Water Development District. He has served as a past director and president of the Coteau Hills Cattlemen, is a member of the South Dakota Cattlemen's Association, and serves as chairman of the Codington County 4-H organization. John has received numerous awards including Eminent Farmer, CAB Progressive Feedlot of the year in 2014, and was the regional winner in 2018 of Environmental Stewardship.

TYLOR BRADEN, M.S.



Mr. Braden currently oversees the cattle operations for King Ranch, Inc., consisting of: a 1,500+/-head purebred herd of Santa Gertrudis to serve as the seedstock herd to produce Super Cruz (1/2 SG x 1/2 Red Angus) bulls for their 20,000 commercial cow herd on 825,000 deeded acres in South Texas in addition to a 16,000 head feed & background yard. King Ranch operates in one of the most difficult environments in the nation but recognizes that their cattle compete against an ever improving national supply and thus cannot compromise in fertility, efficiency, or carcass quality. To that end, in the early 2000's King Ranch developed their own within-herd EPD data base and after employing the single-step model in-house, led Santa Gertrudis Breeders International, to be the first beef breed in the nation to do so. King Ranch only markets 100+/-bulls annually, as most are produced for intercompany use; however, King Ranch is a quite yet progressive genetic improvement and data management leader within the industry.

Braden has a M.S. in Ranch Management from Texas A&M -Kingsville's King Ranch Institute for Ranch Management, a Certificate of Ranch Management from Texas Christian University, and a B.S. in Animal Science from New Mexico State University. Raised in the industry and originally from New Mexico, Braden has managed/worked for operations in TX, NM, CO, WY, MT, NE, OR, WA, & FL including the Padlock, 6666's, the Bell Ranch, Swenson Land & Cattle, and the Stirrup Ranch. Prior to King Ranch, Braden was at Beef Northwest, LLC, a vertically integrated feeding company based in Oregon; serving in various capacities overseeing genetic, cow-calf, stocker, & feedyard operations in the Pacific Northwest.

JOHN MADDUX



John currently owns and manages the family ranch operations, which includes 45,000 deeded and leased acres, 2,500 mother cows, and 5,000 yearlings. In addition to his daily ranch duties, he is also a member of the Nebraska Grazing Lands Association; Nebraska Investment Council, which is responsible for managing the state's pension assets; and a member of the State Bank Board of Directors.

Prior to running the ranch, John was employed by Goldman Sachs of New York, and worked with Elanco selling herbicides.

GENERAL SESSION SPEAKERS

THURSDAY, JUNE 20TH

JOHN GENHO



John Genho, M.S., MBA, is a geneticist and beef producer based in Sperryville, Virginia. His company, Livestock Genetic Services, runs genetic evaluations for multiple breed associations including commercial ranches and other commercial entities.

He has a Masters of Science in Animal Breeding and Genetics from Cornell University, a Master of Business Administration from Duke University, and a Bachelors of Science in Animal Science from Brigham Young University. In addition to his education, he has spent his life in commercial beef production.

JEREMY HOWARD, PH.D.



Jeremy Howard grew up Webster City, located in north central Iowa. Throughout high school and college, he worked in various sectors of swine production.

He received degrees from Iowa State University (B.S.; 2010), University of Nebraska (M.S.; 2012) and North Carolina State University (Ph.D.; 2017) and is currently a Geneticist at Smithfield Premium Genetics (SPG).

MARK TROTTER, PH.D.



Mark Trotter is an Associate Professor in Precision Livestock at CQUniversity Australia. Marks research focusses on developing and evaluating digital technologies that help drive production efficiency and sustainability in grazing livestock systems. Growing up on a dairy farm, Mark developed an understanding of the complexities of livestock production and a passion for agriculture in general.

He undertook his undergraduate and postgraduate degrees at the University of New England (Australia) and worked there for over a decade as a lead precision agriculture academic. Marks' research has involved the development and evaluation of pasture biomass sensors to enable producers to improved fodder budgeting and understanding spatial variability in soil nutrients in grazing systems to enable development of site specific fertiliser strategies. He has spent a significant proportion of his career developing GPS tracking technologies and working with numerous commercial start-ups to make this technology available to livestock managers.

Mark has also led the development of the GPScows program which sees high school students from across Australia (and some in the USA) learning about using GPS tracking technologies to monitor livestock. This program is developing the next generation of tech savvy growers as well as exposing students from a non-agriculture background to the new way of farming. In 2019 Mark will be undertaking a Fulbright Scholarship program with New Mexico State University and The Ohio State University.



SEEDSTOCK PRODUCER OF THE YEAR

NOMINEES

HAGER CATTLE COMPANY

Owners/Managers: Austin & Leah Hager
Karlsruhe, North Dakota

Hager Cattle Company is a fourth-generation farming and ranching operation headquartered in Karlsruhe, North Dakota. The crops and cattle, both registered and commercial, pay their bills. HCC runs more than 775 cows with half of the cattle producing registered seedstock and the remainder commercial cattle. They also background feeder cattle at the home ranch and sell approximately 400 feeder cattle on an annual basis. The Hager program is the quintessential professional family ranching operation that makes a living in solely production agriculture.

The North Dakota winters are long and hard, which means their cattle are built tough so they can thrive in their harsh North Dakota environment. HCC has worked diligently to breed more rib shape, fleshing ability and marbling into their Limousin & Lim-Flex cattle. At the same time, they work hard to increase performance levels, while holding birth weights modest and keeping maternal traits high. The Hager Cattle Company heavily utilizes genomic testing and is a strong supporter of single-step EPD utilization with the switch to the IGS BOLT NCE cattle evaluations.

HCC will host its 13th annual bull sale this year in Mandan, North Dakota, selling approximately 110 head of Limousin and Lim-Flex bulls to commercial customers throughout the North Central region of the United States. The Hager Cattle Company's goal is to provide its customers with genetics that will allow them to be profitable in the mainstream commercial cattle business. HCC is a family cattle operation as Austin as Leah are both actively working the operation along with their four kids — Bailee, Pitch, Tripp and Remmi.

Hager Cattle Company is proudly nominated by the North American Limousin Foundation.



HINKSON ANGUS RANCH

Owners/Managers: Frank J. & Trey Hinkson
Cottonwood Falls, Kansas

Hinkson Angus Ranch is located in the Flint Hills region of east central Kansas, 12 miles southeast of Cottonwood Falls. This region is the largest portion of the last tallgrass prairie left in North America. The ranch was purchased in March 1984, when Frank Jr., wife, Marilyn, and children — Trey and Tyla — moved from West Texas with 90 head of registered Angus cows. These cows stemmed from the original registered herd started by Frank Sr. in 1959 near Lazbuddie, Texas.

Today, Hinkson Angus Ranch is owned by Frank Jr. and his son, Trey, who is the fourth generation on the ranch and manages the daily operation. Hinkson Angus consists of 5,500 acres of owned and leased land; 200 fall- and 175 spring-calving registered Angus cows. An additional 1,000 commercial heifers are purchased each year, with the majority coming from Hinkson bull customers.

The focus of the Hinkson family is to produce practical, balanced-trait seedstock that will work at an optimum level in all phases of the beef industry in a real-world environment. Over the years, the Hinksons have been early to adopt new advances and technology within the livestock industry. A small herd of registered Charolais cows was added in 2017, in response to the needs of some of their commercial customers to add terminal genetics.

The Kansas Livestock Association is proud to nominate Hinkson Angus Ranch.



SEEDSTOCK PRODUCER OF THE YEAR

NOMINEES

JUNGELS SHORTHORN FARMS

Owners/Managers: Derek & Brock Jungels

Kathryn, North Dakota

Jungels Shorthorn Farm (JSF) was established in 1953 with the purchase of a registered Shorthorn heifer. She was added to a herd of commercial cows as a 4-H project for Derek's uncle, LeRoy. From there, the herd grew to a base of 50 registered Shorthorn cows. Top bulls were purchased throughout the years from National Sales and the family was one of the first in the area to employ performance testing. In 1974, Dennis and Rita Jungels purchased the farm and cow herd of longtime North Dakota Shorthorn breeder Melvin Dronen.

The 50-head cow herd was maintained for the next 25 years with performance testing at the core of selection. Expansion began in 2000 when Dennis and Rita's son, Derek, graduated from college and began to aggressively seek the best real-world, industry-driven genetics available in the Shorthorn breed to enhance their existing core cow herd. In 2002, Derek purchased a farmstead along the banks of the Sheyenne River Valley south of Valley City, North Dakota. What started with a couple pole buildings and two pens has evolved into a bustling ranch headquarters where the females and bulls for their production sales are housed, as well as display pens and a sale facility.

In 2007, Derek took a risk that would later become a boom to the operation. In an effort to reintroduce Shorthorns to the industry, Derek took as many as 50 bulls to the National Western Stock Show in Denver, Colorado, not only displaying them but auctioning them off after. This later grew into a fixture at the National Western and effectively put JSF on the map with commercially focused Shorthorn genetics on a national stage. Today, the operation runs a state of the art 999head capacity backgrounding feedlot along with barns for calving and staging new pairs, as well as working facilities. This, coupled with 1,050 acres of owned tillable, pasture, and irrigated land, all within a three-mile radius of headquarters, is utilized for feed production and supports residual and winter grazing of 225 head of registered Shorthorn and Shorthorn Plus cows, plus the development of 100 purebred and composite Shorthorn heifers. In addition to the core Shorthorn herd, JSF also maintains separate herds of 50 Angus, 50 Red Angus and 50 Simmental cows. These females are mated exclusively to JSF Shorthorn bulls for the development of unique composite cattle, marketed with the commercial producer at the forefront of their mind.

In addition to the cowcalf operation, JSF acquires heifer calves from its bull customers. These females are developed and then mated to Shorthorn or Red Angus bulls via artificial insemination. These bred heifers are marketed in groups, based on calving date, at its annual bull sale. At any one time, Jungels Shorthorn Farm supports 400 registered cows from four breeds, and up to 1,000 registered or commercial females, and backgrounded steers.

The operation spans over 3,300 acres, on a combination of owned and rented land. JSF currently hosts two sales annually, "Durham Nation" the first Saturday in November and "Durhams in the Dakotas" the first Tuesday in February.

Jungels Shorthorn Farms is proudly nominated by the American Shorthorn Association.



PAST BIF SEEDSTOCK PRODUCERS OF THE YEAR

2018 BIF SEEDSTOCK PRODUCER OF THE YEAR

Van Newkirk Herefords | Oshkosh, Nebraska



Van Newkirk, Oshkosh, Nebraska, was named the 2018 Beef Improvement Federation Seedstock Producer of the Year during an awards ceremony June 22 in Loveland, Colorado. Pictured are (from left) Steve May, BEEF magazine, award sponsor; Sara, Kolby, Joe and Cyndi Van Newkirk; and Donnell Brown, 2017-2018 BIF president.

2018	Van Newkirk Herefords, Nebraska	1995	Tom & Carolyn Perrier, Kansas
2017	Hunt Limousin Ranch, Nebraska	1994	Richard Janssen, Kansas
2016	Shaw Cattle Company, Idaho	1993	R.A. "Rob" Brown, Texas
2015	McCurry Angus Ranch, Kansas	1993	J. David Nichols, Iowa
2014	Schuler Red Angus, Nebraska	1992	Leonard Wulf & Sons, Minnesota
2013	Bradley 3 Ranch, Texas	1991	Summitcrest Farms, Ohio
2012	V8 Ranch, Texas	1990	Douglas & Molly Hoff, South Dakota
2011	Mushrush Red Angus, Kansas	1989	Glynn Debter, Alabama
2010	Sandhill Farms, Kansas	1988	W.T. "Bill" Bennett, Washington
2009	Harrell Hereford Ranch, Oregon	1987	Henry Gardiner, Kansas
2009	Champion Hill, Ohio	1986	Leonard Lodoen, North Dakota
2008	TC Ranch, Nebraska	1985	Ric Hoyt, Oregon
2007	Pelton Simmental Red Angus, Kansas	1984	Lee Nichols, Iowa
2006	Sauk Valley Angus, Illinois	1983	Bill Borrer, California
2005	Rishel Angus, Nebraska	1982	A.F. "Frankie" Flint, New Mexico
2004	Camp Cooley Ranch, Texas	1981	Bob Dickinson, Kansas
2003	Moser Ranch, Kansas	1980	Bill Wolfe, Oregon
2002	Circle A Ranch, Missouri	1979	Jim Wolf, Nebraska
2001	Sydenstricker Genetics, Missouri	1978	James D. Bennett, Virginia
2000	Fink Beef Genetics, Kansas	1977	Glenn Burrows, New Mexico
1999	Morven Farms, Virginia	1976	Jorgenson Brothers, South Dakota
1998	Knoll Crest Farms, Virginia	1975	Leslie J. Holden, Montana
1998	Flying H Genetics, Nebraska	1975	Jack Cooper, Montana
1997	Wehrmann Angus Ranch, Virginia	1974	Carlton Corbin, Oklahoma
1997	Bob & Gloria Thomas, Oregon	1973	Mrs. R. W. Jones, Jr., Georgia
1996	Frank Felton, Missouri	1972	John Crowe, California

COMMERCIAL PRODUCER OF THE YEAR

NOMINEES

CRYSTAL RIVER RANCH

Owner: Sue Anschutz-Rodgers

Manager: Tom Harrington

Carbondale, Colorado

The Crystal River Ranch is located on Colorado's Western Slope in the Roaring Fork Valley, Thompson Creek Drainage and the Cottonwood Pass areas southeast of Glenwood Springs, near Carbondale. The ranch has been solely owned by Sue Anschutz-Rodgers since 1987 and owned by her family since 1958. The ranch raises Hereford- and Angus-cross cattle, selling spring-born commercial feeder calves every fall. The area is considered high mountain, 6,500-10,000 elevation, with harsh winters starting in October and deep snow until mid-April.

Cattle are wintered on the hay meadows on native grass/alfalfa hay, salt and mineral and start calving March 1. Spring grazing on the lower elevation pastures starts in early May after branding the calves. The cows are moved to high mountain summer pastures in early June until the pairs are then trailed home in the fall to pre-condition the calves and sort for sale, grazing the forage grown at the lower elevations all summer before the snow returns in late October.

The Colorado Cattlemen's Association is proud to nominate Crystal River Ranch.



BLEW PARTNERSHIP

Owners/Managers: CJ & Beckie Blew; Russel Blew
Hutchinson, Kansas

The Blew Partnership is a cow-calf operation in south central Kansas operated by fifth generation ranchers CJ and Beckie Blew and Russell Blew. Although Blew Partnership is an integrated beef production enterprise with cow-calf, backgrounding and finishing components, the Blews describe their primary business as agricultural land/range rehabilitation – where beef cows are the primary stewardship vehicles. The Blew Partnership breeds more than 1,700 females and operates on approximately 19,000 leased and/or owned acres of native range, irrigated perennial grasses and annual cover crops.

Additionally, the Blew Partnership is a strategic partner with two progressive seedstock operations for the purpose of conducting large scale, structured progeny testing. The Blews expect their cows to survive on dormant grass, so the ranch, which operates in Barber and Reno counties, makes efficiency and conservation a top priority. About 50% of the cows never leave the range; the only supplement they receive is a 20% protein, all-natural cube from late fall through winter. When the other cows and heifers are brought in to calve, they receive a TMR, which is mixed based on their nutritionist's advice. The Blews calve in March/April, wean in August/September and background their steers and feeder heifers for 120-150 days on the ranch before being finished at two feedyards and marketed through added-value programs.

The Blews pride themselves on their progressive mindset when it comes to adopting technology. CJ Blew attests that technology has made their operation more sustainable and because they've been quick to adapt, they've been able to grow and expand.

Blew Partnership is proudly nominated by the Red Angus Association of America.



COMMERCIAL PRODUCER OF THE YEAR

NOMINEES

LARSON FARMS

Owners/Managers: Raymond & Andy Larson
Green, Kansas

Larson Farms' headquarters is located in the Flint Hills region of northwestern Riley County, Kansas. Raymond Larson and his son, Andy, represent the fifth and sixth generations to own and manage the operation, which encompasses about 7,000 acres of farmland and native or improved grassland in Riley and Clay counties.

The Larson family maintains a herd of about 500 Angus-based cows, with approximately three-quarters calving in the fall beginning August 15 and one-quarter calving in the spring beginning February 15. All calving takes place on native bluestem pasture. Cows are rotated throughout the year on 35 pasture units based on an established grazing plan, forage type and availability. Corn stalks and interseeded cover crops are used to extend the grazing season. Horses are regularly utilized in handling cattle to encourage a low-stress environment.

Larson Farms also maintains a feedyard in which breeding bulls are custom-fed. In addition, all raised calves are backgrounded in the yard and either finished onsite or sent to a western Kansas feedyard. Ownership is retained on all steers through the finishing phase, with marketing typically done through U.S. Premium Beef.

Heifers are artificially inseminated (AI) at Larson Farms' 300-head breeding/feeding facility. Both embryo transfer and AI are used on the ranch to create marketing opportunities and improve the genetic base of the cowherd. The Larson family is dedicated to improvement and progress. By utilizing both technology and genetics, Raymond and Andy strive to maintain a top-producing cow herd and livestock operation that can be passed on to future generations.

Larson Farms is proudly nominated by the Kansas Livestock Association.



LONE CREEK CATTLE COMPANY

Owner/Manager: Shane Peed
Lincoln, Nebraska

While relatively young for the cattle industry, Lone Creek Cattle Company was founded in 2006. With headquarters in Lincoln, Nebraska, this family owned business is the driving force behind the expansion of the Piedmontese breed in the United States, primarily through their vertically integrated branded beef program, Certified Piedmontese Beef. In the 1970s, a group of progressive ranchers imported the first Piedmontese cattle to North America over a five-year process that consisted of 15 live animals. Today, the breed remains rare, representing less than 1% of all cattle in North America. The Piedmontese are unique in that they carry a particular version of an inactive myostatin gene, with profound effects on retail product yield and beef tenderness at the genetic level.

Lone Creek Cattle Company has several locations throughout Nebraska and South Dakota comprised of some 30,000-plus acres with 5,000-plus breeding animals, of which 3,000 are commercial cows. Each location specializes in contributing to the development of Lone Creek's Piedmontese terminal bull battery for use on commercial cow herds.

Lone Creek Cattle Company maintains and grows the supply of Certified Piedmontese Beef in line with the ongoing growth of the brand and the rising demand for lean and tender beef. The mission is to expand the Piedmontese cattle breed through bull development, a qualified bull lease program (currently 1,000 bulls annually) and contracted premiums on Piedmontese crossbred offspring, verified procurement of feeder calves, and support for their network of ranchers. Lone Creek's focus is on raising healthy Piedmontese cattle through responsible stockmanship and animal husbandry, effective resource management, and farm-to-fork traceability. The program is designed to merge Piedmontese cattle with the finest ranching practices to produce a generous supply of gourmet beef.

The North American Piedmontese Association is proud to nominate Lone Creek Cattle Company.



COMMERCIAL PRODUCER OF THE YEAR

NOMINEES

MERSHON CATTLE LLC

Owners/Managers: Bruce & Tracey Mershon
Buckner, Missouri

Mershon Cattle LLC is a diversified crop and livestock operation headquartered on a Century Farm in Buckner, Missouri, northeast of Kansas City. The Mershon family has deep roots in Missouri agriculture. In 1865, Bruce's great-great-grandfather, Eli Mershon, settled in the Fort Osage area of Jackson County and purchased 160 acres shortly thereafter. The family has farmed there ever since.

Bruce and Tracey Mershon have owned cattle since 1993 and launched Mershon Cattle LLC in 2012. They purchased Sunny Acres Farm in Appleton City, Missouri, in 2013 to expand the operation. The Mershon cow herd consists of 1,600 Angus-based, crossbred cows, which are bred to Hereford, Simmental and Charolais sires. This complementary breeding program allows the operation to produce efficient, high-performing offspring, and is paired with a sustainable grass management program to maximize environmental stewardship.

Bruce and Tracey have built their award-winning cattle operation while working full time as a commodity trader and marketing communications professional, respectively. A key to their success is gathering complete phenotypic records on each calf crop from birth to harvest. In conjunction with utilizing cutting-edge reproductive technologies, this phenotypic data is used to implement strategic improvements in building accuracy for their cow herd.

The Mershons are passionate about growing their community and bettering the beef industry. Bruce and Tracey hold leadership roles with multiple livestock organizations and other national agricultural groups. Through leadership and involvement, the Mershons endeavor to improve their operation, their land, their community and the beef industry every day.

Mershon Cattle LLC is proudly nominated by the American Hereford Association.



NEWMAN FARMS

Owners/Managers: Cyril & Linda Newman
Banks, Alabama

Newman Farms is located in southeast Alabama, near Banks, and consists of 485 total acres. It is home to a commercial cattle operation comprised of Angus, Simmental and Sim-Angus genetics with approximately 90 breeding females. A total of 250-acres contain permanent Bahiagrass and hybrid Bermudagrass pastures and hayfields and 200-acres in forestry.

The cow herd originated in 1975 and operates as a closed herd. The two-breed combination has proven in this environment to provide mothering ability, growth performance and phenotype for high-demand feeder calves. The operation is firmly committed to quality genetics. Newman Farms has been active in Alabama BCIA since 2000 and utilizes the BCIA Commercial Record Keeping Program for performance records. Only high-quality, performance-documented bulls are selected. All feeder heifers and steers are marketed annually in the Southeast Alabama Feeder Cattle Marketing Association Feeder Calf Sale each August.

Newman Farms is an Alabama Department of Agriculture and Industries "Century Farm," recognized for being continuously operated by the same family for a minimum of 100 years and currently engaged in agriculture. It is also eligible for "Heritage Farm" status being a family farm with 100 years of continuous operation, consisting of forty or more acres and possessing important historical and agricultural aspects.

Both Cyril and Linda Newman have served the beef industry in many leadership capacities. Cyril is a past president of the Southeast Alabama Feeder Cattle Marketing Association Inc. Linda is a past president of the Alabama BCIA and currently serves as a board member of the Alabama Beef Cattle Improvement Foundation.

The Alabama Beef Cattle Improvement Association is proud to nominate Newman Farms.



COMMERCIAL PRODUCER OF THE YEAR

NOMINEES

SCHENE ENTERPRISES, INC.

Owner/Manager: Tom Schene

Dixon, California

The Schene Family started in the livestock business with Grandpa Schene working for Washburn and Condon in Los Angeles around 1915, he then moved to San Francisco after he married and continued with the firm. Tom's father along with his uncles started Schene Livestock Commission Firm in San Francisco and eventually moved to Stockton opening the Stockton Livestock Market.

In the late 1960s, the Stockton Market was closed and the family moved to Dixon where they opened the Dixon Livestock Market. Through the years, land was leased in the Farmington area for clover, which maintained feeder cows and feeder lambs from throughout the United States. In 1975, these pastures were closed and the operation was moved to Dixon where they have been for the past 42 years.

The family has never owned property but has leased numerous ranches of irrigated pasture and native grasses to sustain cattle and sheep. For the past 18 years, Tom has worked hard to create a reputable cow herd calving both in the fall and spring with 1,200 cows respectively in each season.

The Schene's keep a bull inventory averaging 55-65 head. The bulls are tested two times per year and are on a four-year rotation. Bulls are selected for growth, feed efficiency on dry feed intake and residual feed intake basis. The switch to an all Byrd Cattle Co base began about 8 years ago as they found that these bulls fit what they wish to strive for and that is carcass and feed efficiency in the end product that they sell. All bulls go through the Snyder Livestock GrowSafe Program.

Schene Enterprises Inc. is proudly nominated by the California Beef Cattle Improvement Association.



PAST BIF COMMERCIAL PRODUCERS OF THE YEAR

2018 BIF COMMERCIAL PRODUCER OF THE YEAR

Woolfolk Ranch | Protection, Kansas



Woolfolk Ranch, Protection, Kansas, was named the 2018 Beef Improvement Federation Commercial Producer of the Year during an awards ceremony June 21 in Loveland, Colorado. Pictured (l to r) are: Donnell Brown, 2017-2018 BIF president; Kent and Stephanie Woolfolk of Woolfolk Ranch; and Burt Rutherford of BEEF magazine, award sponsor.

2018	Woolfolk Ranch, Kansas	1996	Virgil & Mary Jo Huseman, Kansas
2017	Mundhenke Beef, Kansas	1995	Joe & Susan Thielen, Kansas
2016	Plum Thicket Farms, Nebraska	1994	Fran & Beth Dobitz, South Dakota
2015	Woodbury Farms, Kansas	1993	Jon Ferguson, Kansas
2014	CB Farms Family Partnership, Kansas	1992	Kopp Family, Oregon
2013	Darnall Ranch, Inc., Nebraska	1991	Dave & Sandy Umbarger, Oregon
2012	Maddux Cattle Company, Nebraska	1990	Mike & Diana Hopper, Oregon
2011	Quinn Cow Company, Nebraska	1989	Jerry Adamson, Nebraska
2010	Downey Ranch, Kansas	1988	Gary Johnson, Kansas
2009	JHL Ranch, Nebraska	1987	Rodney G. Oliphant, Kansas
2008	Kniebel Farms and Cattle Company, Kansas	1986	Charles Fariss, Virginia
2007	Broseco Ranch, Colorado	1985	Glenn Harvey, Oregon
2006	Pitchfork Ranch, Illinois	1984	Bob & Sharon Beck, Oregon
2005	Prather Ranch, California	1983	Al Smith, Virginia
2004	Olsen Ranches, Inc., Nebraska	1982	Sam Hands, Kansas
2003	Tailgate Ranch, Kansas	1981	Henry Gardiner, Kansas
2002	Griffith Seedstock, Kansas	1980	Jess Kilgore, Montana
2001	Maxey Farms, Virginia	1979	Bert Hawkins, Oregon
2000	Bill & Claudia Tucker, Virginia	1978	Mose Tucker, Alabama
1999	Mossy Creek Farm, Virginia	1977	Mary & Stephen Garst, Iowa
1999	Giles Family, Kansas	1976	Ron Baker, Oregon
1998	Mike & Priscilla Kasten, Missouri	1975	Gene Gates, Kansas
1998	Randy & Judy Mills, Kansas	1974	Lloyd Nygard, North Dakota
1997	Merlin & Bonnie Anderson, Kansas	1973	Pat Wilson, Florida
		1972	Chan Cooper, Montana

PAST BIF PIONEER AWARD RECIPIENTS

The Pioneer Award recognizes individuals who have made lasting contributions to the improvement of beef cattle, honoring those who have had a major role in acceptance of performance reporting and documentation as the primary means to make genetic change in beef cattle.

2018

Tim Holt, Colorado
Craig Huffhines, Texas
Mark Thallman, U.S. Meat Animal
Research Center

2017

Harvey Lemmon (posthumously),
Lemmon Angus
Dorian Garrick, Iowa State University

2016

Doug Hixon, University of Wyoming
Ronnie Green, University of Nebraska
Bill Rishel, Rishel Angus

2015

Paul Genho, Florida
Tom Woodward, Texas

2014

Merlyn Nielsen, Nebraska Gary Bennett,
Nebraska Steve Radakovich, Iowa

2013

Keith Bertrand, Georgia
Ignacy Misztal, Georgia
Glenn Selk, Oklahoma

2012

Sally Buxkemper, Texas
Donald Franke, Louisiana
Leo McDonnell, Montana

2011

Mike Tess, Montana
Mike MacNeil, Montana
Jerry Lipsey, Montana

2010

Richard McClung, Virginia
John and Bettie Rotert, Missouri
Daryl Strohbehn, Iowa
Glen Klippenstein, Missouri

2009

Bruce Golden, California Bruce Orvis,
California
Roy McPhee (posthumously), California

2008

Donald Vaniman, Montana
Louis Latimer, Canada
Harry Haney, Canada
Bob Church, Canada

2007

Rob Brown, Texas
David and Emma Danciger, Colorado
Jim Gosey, Nebraska

2006

John Brethour, Kansas
Harlan & Dorotheann Rogers,
Mississippi
Dave Pingrey, Mississippi

2005

Jack and Gini Chase, Wyoming
Jack Cooper, Montana
Dale Davis, Montana
Les Holden, Montana
Don Kress, Montana

2004

Frank Felton, Missouri
Tom Jenkins, Nebraska
Joe Minyard, South Dakota

2003

George Chiga, Oklahoma
Burke Healey, Oklahoma
Keith Zoellner, Kansas

2002

H.H. "Hop" Dickenson, Kansas
Martin & Mary Jorgensen, South Dakota
L. Dale Van Vleck, Nebraska

2001

Larry Benyshek, Georgia
Minnie Lou Bradley, Texas
Tom Cartwright, Texas

2000

J. David Nichols, Iowa
Harlan Ritchie, Michigan
Robert R. Schalles, Kansas

1999

Joseph Graham, Virginia
John Pollak, New York
Richard Quaas, New York

1998

John Crouch, Missouri
Bob Dickinson, Kansas
Douglas MacKenzie Fraser, Canada

1997

Larry V. Cundiff, Nebraska

Henry Gardiner, Kansas
Jim Leachman, Montana

1996

A.L. "Ike" Eller, Virginia
Glynn Debter, Alabama

1995

James S. Brinks, Colorado
Robert E. Taylor, Colorado

1994

Tom Chrystal, Iowa
Robert C. DeBaca, Iowa
Roy A. Wallace, Ohio

1993

James D. Bennett, Virginia
M.K. "Curly" Cook, Georgia
O'Dell G. Daniel, Georgia
Hayes Gregory, North Carolina
Dixon Hubbard, Virginia
James W. "Pete" Patterson, North
Dakota
Richard Willham, Iowa

1992

Frank Baker, Arkansas
Ron Baker, Oregon
Bill Borrer, California
Walter Rowden, Arkansas

1991

Robert A. "Bob" Long, Texas
Bill Turner, Texas

1990

Donn & Sylvia Mitchell, Canada
Hoon Song, Canada
Jim Wilton, Canada

1989

Roy Beeby, Oklahoma
Will Butts, Tennessee
John W. Massey, Missouri

1988

Christian A. Dinkle, South Dakota
George F. & Mattie Ellis, New Mexico
A.F. "Frankie" Flint, New Mexico

1987

Glenn Burrows, New Mexico
Carlton Corbin, Oklahoma
Murray Corbin, Oklahoma

PAST BIF PIONEER AWARD RECIPIENTS

Max Deets, Kansas

1986

Charles R. Henderson, New York
Everett J. Warwick, Maryland

1985

Mick Crandell, South Dakota
Mel Kirkiede, North Dakota

1984

Bill Graham, Georgia
Max Hammond, Florida
Thomas J. Marlowe, Virginia

1983

Jim Elings, California
W. Dean Frischknecht, Oregon
Ben Kettle, Colorado
Jim Sanders, Nevada
Carroll O. Schoonover, Wyoming

1982

Gordon Dickerson, Nebraska
Mr. & Mrs. Percy Powers, Texas

1981

F.R. "Ferry" Carpenter, Colorado
Otha Grimes, Oklahoma
Milton England, Texas
L.A. Maddox, Jr., Texas
Charles Pratt, Oklahoma
Clyde Reed, Oklahoma

1980

Richard T. "Scotty" Clark, Colorado
Bryon L. Southwell, Georgia

1979

Robert Koch, Nebraska
Mr. & Mrs. Carl Roubicek, Arizona
Joseph J. Urick, Montana

1978

James B. Lingle, Maryland
R. Henry Mathiessen, Virginia
Bob Priode, Virginia

1977

Ralph Bogart, Oregon
Henry Holsman, South Dakota
Marvin Koger, Florida
John Lasley, Missouri

W. L. McCormick, Georgia
Paul Orcutt, Montana
J.P. Smith, Missouri
H.H. Stonaker, Colorado

1976

Forrest Bassford, Colorado
Doyle Chambers, Louisiana
Mrs. Waldo Emerson Forbes, Wyoming
C. Curtis Mast, Virginia

1975

Glenn Butts, Missouri
Keith Gregory, Nebraska
Braford Knapp, Jr., Montana

1974

Reuben Albaugh, California
Charles E. Bell, Jr., Virginia
John H. Knox, New Mexico
Paul Pattengale, Colorado
Fred Wilson, Montana
Ray Woodward, Montana

1973

Jay L. Lush, Iowa

PAST BIF CONTINUING SERVICE AWARD RECIPIENTS

Continuing Service Award winners have made major contributions to the BIF organization. This includes serving on the board of directors, speaking at BIF conventions, working on BIF guidelines and other behind-the-scenes activities. As BIF is a volunteer organization, it is this contribution of time and passion for the beef cattle industry that moves BIF forward.

2018

Dan Moser, American Angus Assoc.
Lynn Pelton, Burdett, Kansas
Scott Speidel, Colorado State University

2017

Michelle Elmore, Alabama BCIA
Shauna Hermel, Angus Journal
Matthew Spangler, University of Nebraska - Lincoln
Kevin & Lydia Yon, South Carolina

2016

John Pollak, U.S. Meat Animal Research Center
Alison Van Eenennaam, University of California, Davis
Alison Sunstrum, GrowSafe
Steve Kachman, University of Nebraska-Lincoln

2015

Joe Cassady, South Dakota State University
Andy Boston, Indiana
Lois Schreiner, Kansas State University
Chris Shivers, American Brahman Breeders Association

2014

Larry Kuehn, U.S. Meat Animal Research Center
Wade Shafer, American Simmental Association
Warren Snelling, U.S. Meat Animal Research Center
Susan Willmon, American Gelbvieh Association

2013

Ben Eggers, Sydenstricker Genetics
Brian House, Select Sires

Lauren Hyde, American Simmental Assoc.
Jerry Taylor, University of Missouri
Jack Ward, American Hereford Assoc.

2012

Tom Field, Nebraska
Stephen Hammack, Texas
Brian McCulloh, Wisconsin
Larry Olson, South Carolina

2011

Tommy Brown, Alabama
Mark Enns, Colorado
Joe Paschal, Texas
Marty Ropp, Montana
Bob Weaver, Missouri

2010

Bill Bowman, Missouri
Twig Marston, Nebraska
David Patterson, Missouri

PAST BIF CONTINUING SERVICE AWARD RECIPIENTS

Mike Tess, Montana

2009

Darrh Bullock, Kentucky
Dave Daley, California
Renee Lloyd, Iowa
Mark Thallman, Nebraska

2008

Doug Fee, Canada
Dale Kelly, Canada
Duncan Porteous, Canada

2007

Craig Huffhines, Missouri
Sally Northcutt, Missouri

2006

Jimmy Holliman, Alabama
Lisa Kriese-Anderson, Alabama
Dave Notter, Ohio

2005

Jerry Lipsey, Montana
Micheal MacNeil, Montana
Terry O'Neill, Montana
Robert Williams, Missouri

2004

Chris Christensen, South Dakota
Robert "Bob" Hough, Texas
Steven M. Kappes, Nebraska
Richard McClung, Virginia

2003

Sherry Doubet, Colorado
Ronnie Green, Virginia
Connee Quinn, Nebraska
Ronnie Silcox, Georgia

2002

S.R. Evans, Mississippi
Galen Fink, Kansas
Bill Hohenboken, Virginia

2001

William Altenburg, Colorado
Kent Andersen, Colorado
Don Boggs, South Dakota

2000

Ron Bolze, Kansas
Jed Dillard, Florida

1999

Bruce Golden, Colorado
John Hough, Georgia
Gary Johnson, Kansas
Norman Vincil, Virginia

1998

Keith Bertrand, Georgia
Richard Gilbert, Texas
Burke Healey, Oklahoma

1997

Glenn Brinkman, Texas
Russell Danielson, North Dakota
Gene Rouse, Iowa

1996

Doug L. Hixon, Wyoming
Harlan D. Ritchie, Michigan

1995

Paul Bennett, Virginia
Pat Goggins, Montana
Brian Pogue, Canada

1994

Bruce E. Cunningham, Montana
Loren Jackson, Texas
Marvin D. Nichols, Iowa
Steve Radakovich, Iowa
Doyle Wilson, Iowa

1993

Robert McGuire, Alabama
Charles McPeake, Georgia
Henry W. Webster, South Carolina

1992

Jack Chase, Wyoming
Leonard Wulf, Minnesota

1991

John Crouch, Missouri

1990

Robert Dickinson, Kansas

1989

Roger McCraw, North Carolina

1988

Bruce Howard, Canada

1987

Bill Borrer, California
Jim Gibb, Missouri
Daryl Strohbehn, Iowa

1986

Larry Benyshek, Georgia
Ken W. Ellis, California
Earl Peterson, Montana

1985

Jim Glenn, IBIA

Dick Spader, Missouri
Roy Wallace, Ohio

1984

James Bennett, Virginia
M.K. Cook, Georgia
Craig Ludwig, Missouri
1983
Art Linton, Montana

1982

J.D. Mankin, Idaho

1981

Mark Keffeler, South Dakota

1980

Glenn Butts, PRI
Jim Gosey, Nebraska

1979

C.K. Allen, Missouri
William Durfey, NAAB

1978

James S. Brinks, Colorado
Martin Jorgensen, South Dakota
Paul D. Miller, Wisconsin

1977

Lloyd Schmitt, Montana
Don Vaniman, Montana

1976

A.L. Eller, Jr., Virginia
Ray Meyer, South Dakota

1975

Larry V. Cundiff, Nebraska
Dixon D. Hubbard, Washington, D.C.
J. David Nichols, Iowa

1974

Frank H. Baker, Oklahoma
D.D. Bennett, Oregon
Richard Willham, Iowa

1973

F. R. Carpenter, Colorado
Robert DeBaca, Iowa
E.J. Warwick, Washington, D.C.

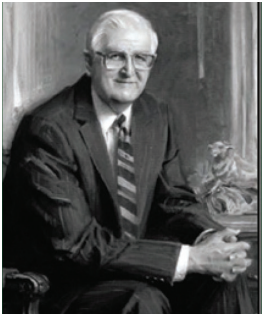
1972

Clarence Burch, Oklahoma

PAST BIF AMBASSADOR AWARD RECIPIENTS

The BIF Ambassador Award is given annually by BIF to a member of the media for his or her efforts in spreading the news of BIF and its principles to a larger audience.

2018 Pete Crow, Colorado • Western Livestock Journal	2005 Steve Suther, Kansas • Certified Angus Beef LLC	Robert C. DeBaca, Iowa • The Ideal Beef Memo
2017 Kevin Ochsner, Colorado • NCBA Cattlemen to Cattlemen	2004 Kindra Gordon, South Dakota • Freelance Writer	1989 Forrest Bassford, Colorado • Western Livestock Journal
2016 Bob Hough, Colorado • Freelance writer	2003 Troy Marshall, Missouri • Seedstock Digest	1988 Fred Knop, Kansas • Drovers Journal
2015 E. C. Larkin, Texas • Gulf Coast Cattlemen	2002 Joe Roybal, Minnesota • BEEF Magazine	1987 Chester Peterson, Kansas • Simmental Shield
2014 John Maday, Colorado • Drovers CattleNetwork	2001 Greg Hendersen, Kansas • Drovers	1986 Warren Kester, Minnesota • BEEF Magazine
2013 A.J. Smith, Oklahoma • Oklahoma Cowman Magazine	2000 Wes Ishmael, Texas • Clear Point Communications	
2012 Burt Rutherford, Texas • BEEF Magazine	1999 Shauna Rose Hermel, Missouri • Angus Journal & BEEF Magazine	
2011 Jay Carlson, Kansas • BEEF Magazine	1998 Keith Evans, Missouri • American Angus Association	
2010 Larry Atzenweiler and Andy Atzenweiler, Missouri • Missouri Beef Cattlemen	1997 Bill Miller, Kansas • Beef Today	
2009 Kelli Toldeo, California • Cornerpost Publications	1996 Ed Bible, Missouri • Hereford World	
2008 Gren Winslow and Larry Thomas, Canada • Canadian Cattleman Magazine	1995 Nita Effertz, Idaho • Beef Today	
2007 Angie Denton, Missouri • Hereford World	1994 Hayes Walker III, Kansas • America's Beef Cattleman	
2006 Belinda Ary, Alabama • Cattle Today	1993 J.T. "Johnny" Jenkins, Georgia • Livestock Breeder Journal	
	1991 Dick Crow, Colorado • Western Livestock Journal	
	1990	



(Photograph of portrait in Saddle and Sirloin Club Gallery; Everett Raymond Kinstler, artist)

FRANK H. BAKER, PH.D., is widely recognized as the “Founding Father” of the Beef Improvement Federation (BIF). Frank played a key leadership role in helping establish BIF in 1968, while he was Animal Science Department Chairman at the University of Nebraska, Lincoln, 1966-74. The Frank Baker Memorial Scholarship Award Essay competition for graduate students provides an opportunity to recognize outstanding student research and competitive writing in honor of Dr. Baker.

Frank H. Baker was born May 2, 1923, at Stroud, Oklahoma, and was reared on a farm in northeastern Oklahoma. He received his B.S. degree, with distinction, in Animal Husbandry from Oklahoma State University (OSU) in 1947, after two and a half years of military service with the US Army as a paratrooper in Europe, for which he was awarded the Purple Heart. After serving three years as county extension agent and veterans agriculture instructor in Oklahoma, Frank returned to OSU to complete his M.S. and Ph.D. degrees in Animal Nutrition. Frank’s professional positions included teaching and research positions at Kansas State University, 1953-55; the University of Kentucky, 1955-58; Extension Livestock Specialist at OSU, 1958-62; and Extension Animal Science Programs Coordinator, USDA, Washington, D.C., 1962-66. Frank left Nebraska in 1974 to become Dean of Agriculture at Oklahoma State University, a position he held until 1979, when he began service as International Agricultural Programs Officer and Professor of Animal Science at OSU. Frank joined Winrock International, Morrilton, Arkansas, in 1981, as Senior Program Officer and Director of the International Stockmen’s School, where he remained until his retirement. Frank served on advisory committees for Angus, Hereford, and Polled Hereford beef breed associations, the National Cattlemen’s Association, Performance Registry International, and the Livestock Conservation, Inc.

His service and leadership to the American Society of Animal Science (ASAS) included many committees, election as vice president and as president, 1973-74. Frank was elected an ASAS Honorary Fellow in 1977, he was a Fellow of the American Association for the Advancement of Science, and served the Council for Agricultural Science and Technology (CAST) as president in 1979. Frank Baker received many awards in his career, crowned by having his portrait hung in the Saddle and Sirloin Club Gallery at the International Livestock Exposition, Louisville, Kentucky, on Nov. 16, 1986. His ability as a statesman and diplomat earned him many awards in his career, crowned by having his portrait hung

in the Saddle and Sirloin Club Gallery at the International Livestock Exposition, Louisville, Kentucky, on November 16, 1986. His ability as a statesman and diplomat for the livestock industry was to use his vision to call forth the collective best from all those around him. Frank was a “mover and shaker” who was skillful in turning “Ideas into Action” in the beef cattle performance movement. His unique leadership abilities earned him great respect among breeders and scientists alike. Frank died Feb. 15, 1993, in Little Rock, Arkansas.



(Photograph taken at BIF 2014, by Angus Journal)

LARRY CUNDIFF, PH.D., retired in January 2007 after 40 years of service as a research geneticist with the U.S. Department of Agriculture, Agricultural Research Service. He was research leader of the Genetics and Breeding Research Unit at the U.S. Meat Animal Research Center from 1976 until 2005, when he accepted an interim eight-month appointment as acting center director.

Larry Cundiff was born in Kansas in 1939, received his B.S. from Kansas State University in 1961, and his M.S. and Ph.D. from Oklahoma State in 1964 and 1966. He married his wife, Laura, in 1960. They have three children. He was on the faculty at the University of Kentucky from 1965 to 1967, before working as a research geneticist in the USDA.

Cundiff has not only designed, conducted and published some of the most important beef breeding research of the 20th century, but also has led the transfer of new technology to the beef industry through his continued work in BIF and his presentations made across the nation and around the world.

His research efforts have involved evaluation and utilization of diverse breeds, effects and utilization of heterosis through alternative crossbreeding systems, and evaluation and effectiveness of selection for traits of economic importance in beef production. Since his retirement, he has continued service as a collaborator at the U.S. Meat Animal Research Center, assisting with preparation of research reports and speaking at beef industry meetings and conferences. Cundiff has served as chairman of the Beef Improvement Federation (BIF) Committee on Genetic Prediction from 1973 until 2007, and as the Agricultural Research Service, USDA representative on the BIF Board of Directors from 1981 until 2007. He has served as editor of the Beef Improvement Federation’s 9th Edition of Guidelines for Uniform Beef Improvement Programs.

PAST BIF BAKER/CUNDIFF AWARD RECIPIENTS

The annual Frank Baker/Larry Cundiff Beef Improvement Essay Contest for graduate students provides an opportunity to recognize outstanding student research and competitive writing in honor of Frank Baker and Larry Cundiff.

2018 Miranda Culbertson, Colorado State University Jose Delgadillo Liberona, Texas A&M University	2010 Kent A. Gray, North Carolina State University	2001 Khathutshelo A. Nephawe, University of Nebraska Janice M. Rumph, University of Nebraska
2017 Cashley Ahlberg, Kansas State University Lindsay Upperman, University of California-Davis	2009 Lance Leachman, Virginia Polytechnic Institute and State University Scott Speidel, Colorado State University	2000 Paul L. Charteris, Colorado State University Katherine A. Donoghue, University of Georgia
2016 Kathleen Ochsner, University of Nebraska-Lincoln Kashly Schweer, University of Nebraska-Lincoln (2015 and earlier. this was known as the Frank Baker Scholarship)	2008 Devori W. Beckman, Iowa State University Kasey L. DeAtley, New Mexico State University	1999 Janice M. Rumph, University of Nebraska Bruce C. Shanks, Montana State University
2015 Justin Buchanan, Oklahoma State University Jamie Parham, South Dakota State University	2007 Gabriela C. Márquez Betz, Colorado State University Yuri Regis Montanholi, University of Guelph	1998 Patrick Doyle, Colorado State University Shannon M. Schafer, Cornell University
2014 Heather Bradford, Kansas State University Xi Zeng, Colorado State University	2006 Amy Kelley, Montana State University Jamie L. Williams, Colorado State University	1997 Rebecca K. Splan, University of Nebraska Robert Williams, University of Georgia
2013 Heather Bradford, Kansas State University Erika Downey, Texas A&M University	2005 Matthew A. Cleveland, Colorado State University David P. Kirschten, Cornell University	1996 D.H. "Denny" Crews, Jr., Louisiana State University Lowell S. Gould, University of Nebraska
2012 Jeremy Howard, University of Nebraska-Lincoln Kristina Weber, University of California-Davis	2004 Reynold Bergen, University of Guelph Angel Rios-Utrera, University of Nebraska	1995 D. H. "Denny" Crews, Jr., Louisiana State University Dan Moser, University of Georgia
2011 Brian Brigham, Colorado State University Megan Rolf, University of Missouri	2003 Fernando F. Cardoso, Michigan State University Charles Andrew McPeake, Michigan State University	1994 Kelly W. Bruns, Michigan State University William Herring, University of Georgia
	2002 Katherina A. Donoghue, University of Georgia Khathutshelo A. Nephawe, University of Nebraska	

ROY A. WALLACE MEMORIAL SCHOLARSHIP



THE ROY A. WALLACE BIF MEMORIAL FUND

was established to honor the life and career of Roy A. Wallace. Mr. Wallace worked for Select Sires for 40 years, serving as vice president of beef programs, and devoted his life to beef cattle improvement. He became involved with BIF in its infancy and was the only person to

attend each of the first 40 BIF conventions.

Roy loved what BIF stood for – an organization that brings together purebred and commercial cattle breeders, academia and breed associations, all committed to improving beef cattle.

Wallace was honored with both the BIF Pioneer Award and BIF Continuing Service Award and co-authored the BIF 25-year history, *Ideas into Action*.

This scholarship was established to encourage young men and women interested in beef cattle improvement to pursue those interests as Mr. Wallace did, with dedication and passion. Proceeds from the Roy A. Wallace Beef Improvement Federation Memorial Fund will be used to award scholarships to graduate and undergraduate students currently enrolled as fulltime students in pursuit of a degree related to the beef cattle industry. Criteria for selection will include demonstrated commitment and service to the beef cattle industry.

Preference will be given to students who have demonstrated a passion for the areas of beef breeding, genetics and reproduction. Additional considerations will include academic performance, personal character and service to the beef cattle industry.

Two scholarships will be offered in the amount of \$1,250 each. One will be awarded to a student currently enrolled as an undergraduate and one will be awarded to a student currently enrolled in a master of science or doctoral program.

PAST ROY A. WALLACE SCHOLARSHIP RECIPIENTS

2018

Johnna Baller (graduate), University of Nebraska-Lincoln
Madison Butler (undergraduate), Oklahoma State University

2017

Dustin Aherin (graduate), Kansas State University
Tanner Aherin (undergraduate), Kansas State University

2016

Will Shaffer (graduate), Oklahoma State University
Ryan Boldt (undergraduate), Colorado State University

2015

Joshua Hasty (graduate), Colorado State University
Matthew McIntosh (undergraduate), University of Connecticut

2014

Heather Bradford (graduate), Kansas State University
Maci Lienemann (undergraduate), University of Nebraska- Lincoln

2013

Loni Woolley (graduate), Texas Tech
Tyler Schultz (undergraduate), Kansas State University

2012

Ky Polher (graduate), University of Missouri
Natalie Laubner (undergraduate), Kansas State University

2011

Jessica Bussard (graduate), University of Kentucky
Cassandra Kniebel (undergraduate), Kansas State University

2010

Paige Johnson (graduate), Texas Tech University
Sally Ruth Yon (undergraduate), Clemson University

NEW TECHNOLOGIES IN CATTLE REPRODUCTION AND THE CORRELATED ACCELERATION OF GENETIC GAIN

Mark F. Allan, Ph.D. | Trans Ova Genetics

INTRODUCTION

Over the last 50 years, the cattle industries, both beef and dairy, have dramatically increased the rate of genetic change for economically important traits by harnessing the power of quantitative population genetics theory coupled with the development and implementation of advanced reproductive technologies (ART). These technologies have increased the impact of genetically superior individuals in cattle populations for both sexes. Breakthroughs in the ART tool box continue to decrease generation interval, while at the same time, becoming more efficient in the production of animals. Such breakthroughs include in vitro fertilization (IVF) embryo production that equals or is greater than in vivo embryo production. Current technology advancements continue to accelerate genetic gain, not just in elite germplasm, the power of these technologies is beginning to be harnessed in the commercial production sectors as well. This discussion will review the current status of ART and the impact it has on genetic improvement in all sectors of the cattle industry.

ARTIFICIAL INSEMINATION

Without a doubt, the largest impact of a single technology affecting bovine genetic improvement in cattle over the last 50 years was the commercialization of artificial insemination, followed with the development of cryopreserved semen. These advancements greatly enhanced the widespread use of artificial insemination (Pickett and Berndtson, 1978; Foote, 2002). The ability to produce large numbers of progeny from a single sire across many geographical regions and multiple management practices was the cornerstone in making estimation of additive genetic merit in individual animals possible. Artificial insemination resulted in and continues to enable widespread dissemination of superior sires to all sizes of producers. Additionally, artificial insemination facilitates progeny testing, and is often a key component in cross breeding programs. This technology has accelerated the distribution of superior genetics worldwide through exportation, and is essential in the success of estrus synchronization programs when done on large groups of cattle.

Estimations of the use of artificial insemination in the beef and dairy industries, and its impact of genetic progress can be assessed from the current 2018 National Association of Animal Breeders (NAAB) reports of units semen sold domestically and exported in the United States, when compared with historic reports from 1980

(www.naab-css.org). In 1980, 13.3 million units were sold in the dairy industry, domestic, compared to 24.6 million units of semen sold in 2018. Beef domestic sales of semen increased 1980, with 1.0 million units semen sold compared with 4 million units of semen sold in 2018. Differences in the percent of domestic sales in beef and dairy can be attributed to the changes in management in the dairy industry observed over the last 50 years. This change resulted from the consolidation of dairy operations and a continued decreased use of natural service. Development of artificial insemination in beef has been considerably slower in the United States, when compared to dairy and its implantation in beef production in other countries. Range conditions create added hurdles to overcome for heat detection and insemination. However, the industry has seen steady growth over the last ten years (www.naab-css.org). One should note a portion of the increase in beef units sold over the last ten years is the use of beef semen to create beef dairy cross calves in the dairy industry. Presently, artificial insemination is a worldwide business, with an estimated greater than 100 million cattle inseminated annually (Verma et al., 2012).

Genetic change, resulting from AI, has been well documented over the last sixty years (Van Vleck, 1986; Wiggins 1991; Johnson and Jones 2008). During this same time, commercialization of artificial insemination has resulted in the growth of numerous companies on a global scale participating in the leasing/ownership of sires, collection, processing, distribution of semen, and insemination of females.

The acceptance and adoption of artificial insemination was the cornerstone making the development of other advanced reproductive technologies, such as sexing of sperm, estrus regulation, embryo harvesting, freezing, culture, transfer, and cloning possible. Without this game changing development, the rate of genetic improvement in beef and dairy would be a fraction of the present success.

EMBRYO TRANSFER

In vivo embryo transfer (ET) is the process of changing the normal ovulation of the bovine female from ovulating one ovum every 21-day estrus cycle, to having many (multiple) ovulations allowing for the production of multiple embryos produced that can be transferred to surrogate females, often referred to as recipient dams, to gestate, and if needed, raise the calf. Donor females can begin a superovulation program between 8-13 days of the estrus cycle if a corpus luteum (CL) is present. Donors are given

scheduled injections of follicle stimulating hormone (FSH) over three to four days, every twelve hours. Upon the final dose of FSH, an injection of prostaglandin f2 alpha is administered to initiate ovulation. Donors are bred by natural service or artificial insemination; embryos are allowed to develop for 7 days in utero, at which time they are non-surgically flushed from the uterus. At this time; they are either transferred to a recipient female that was synchronized to ovulate on the same schedule as the superovulated donor, or frozen for later transfer to recipient females.

The commercialization of embryo transfer in cattle had a huge impact in the ability of the producer to leverage the contribution of genetics from the superior female. The ability to produce upwards of 20-40 progeny from a female in a given year -compared to 6 or 7 in a lifetime- resulted in much of the cattle seedstock industry adopting ET technology into genetic selection programs over the past 3 decades. Embryo transfer allows the producer to mate superior parents to produce multiple full-sibs per procedure, resulting in increased rates of genetic gain. By enhancing selection intensity in the female population and harnessing the power of sampling many more individuals from a single mating. This enhances the probability of identifying superior progeny for the next generation (Land and Hill, 1975). This has resulted in genetic gain by improving reproductive rates in bovine females, increased selection intensity, shorter generation intervals (Church et al., 1977), and with the incorporation of genomics in genetic evaluation, enhanced accuracy of selection in younger animals.

The first reported successful bovine embryo transfer was reported by Willet et al. in 1951. Another key event includes the first commercial embryo company, Alberta Livestock Transplants, Ltd., in 1971. This was followed by key scientific advancements in this field: 1) the production of offspring from frozen embryos (Wilmut and Rowson, 1973); and 2) the development of non- surgical transfer (Greve and Lehn-Jensen, 1979). The ability to cryopreserve embryos like semen created a vehicle to make on farm embryo transfer extremely manageable. Additionally, the producer has an additional genetic product to generate revenue and facilitate greater numbers of progeny from superior parents. Estrus synchronization programs evolved and developed in conjunction with the in vivo embryo transfer, which added to the success and adaption of ET worldwide.

In vivo embryo transfer technology became common throughout the world in the 1980's and 90's. About 17,000 bovine pregnancies were produced by superovulation and embryo transfer in North America in 1979 (Seidel, 1981). It has been estimated that greater than 500,000 ET embryos are produced world-wide annually from super ovulated cows (Mapletoft and Hasler, 2005).

The impact of ET has been dramatic in enhancing the rate of genetic gain in cattle world- wide. The theoretical modeling of genetic change estimated that twice the rate of improvement would be achievable for moderately heritable traits when harnessing the power of ET, when compared to a traditional conventional performance testing program (Land and Hill, 1975). Additionally, it was estimated that the impact on generation interval would also enhance genetic improvement even though the accuracy of selection in unproven females is less than adult females (Nicolas and Smith, 1983). Since these early publications, the impact of ET on genetic advancements has become a reality. For dairy and beef seedstock sectors, ET has become an integral part of the world's industry leading companies.

IN VITRO EMBRYO PRODUCTION

In vitro embryo production (IVP) is the process of creating embryos from oocytes (unfertilized female gametes) by fertilization and early development outside of the uterus in a laboratory setting. Oocytes are either collected (aspirated) from slaughter house ovaries, surgical collection or the through the use of ultrasound-guided transvaginal follicular aspiration on the donor female. Oocytes go through a maturation period and are fertilized the following maturation with conventional or sexed-sorted semen. After fertilization, they are allowed to develop in an incubator for seven additional days, and the resulting viable embryos are transferred into recipient dams or frozen for future transfers.

This evolution of in vitro embryo production technology has been under development for three decades. Early key pieces of IVP science that allowed scientists to begin to take oocyte maturation, fertilization and embryo development to the blastocyst stage in the lab for bovine occurred in the 1980's (Freis and Ruvinsky, 1999). A very important development for IVP adoption that occurred in the early 1990's was a procedure/technique that was less invasive than earlier surgical procedures, allowing oocyte retrieval from live cows at a much more efficient rate (Merton et al., 2009). Transvaginal, ultrasound-guided oocyte recovery, often referred to as Ovum Pick Up (OPU) (Kruip et al., 1991)- is used in a commercial setting to recover oocytes from antral follicles that will be matured, fertilized and cultured to the blastocyst stage using in vitro procedures (Hasler et al., 1995). The procedure, which is minimally invasive, can be used with super-ovulation every two weeks or done without superovulation twice a week on a single donor (Kruip et al., 1994; Hasler et al., 1995).

The benefits of IVP, like ET, allow for the increased number of progeny from valuable cows, production of progeny from females no longer able to produce naturally or through in vivo embryo transfer, ability to produce

embryos from pregnant donors from days 40-100 of pregnancy, and with the advent of sorted semen, the ability to produce large numbers of calves of a desired sex (Hasler et al., 1995). The ability to produce embryos weekly, or every other week, from a donor female allows for a greater number of progeny to be produced in a shorter period of time when contrasted to ET. These gains in efficiency of IVP in time will lead to the development of the technology being used beyond the nucleus seedstock sector to the commercial production portion of the industry. First, it will likely impact the commercial dairy female replacement programs for both purebred and cross breeding programs. Such programs allow producers to further capture greater portion of the gains made in genetic improvement programs. Additionally, the value of heterosis through the crossing complementary breeds to create f1 progeny maternally designed to match production environment will likely evolve in the dairy and beef commercial industries.

SEXED SEMEN

The use of sexed semen in the dairy and beef industries has increased dramatically over the last 10 years. In 2008 very few, if any, commercially available AI beef bulls had gender sorted semen available for use in AI programs (Garner and Seidel, 2008). By 2011 greater than 70 commercially available AI beef sires had gender sorted semen available, which brought about a dramatic increase. In dairy, the number of units of commercially available semen increased dramatically from 2006 with 18,000 to 170,000 units of semen in the U.S. in 2008. The estimated number of females produced from sexed semen that entered the U. S. dairy herd in 2008, 2009, 2010, 2011, and 2012 is 8,000, 63,000, 156,000, 258,000 and 237,000, respectively (De Vries, 2010). This trend has continued to increase dramatically, over the last ten years, in numbers of dairy replacement female production. Currently, dairy genetic companies have begun to only sell X bearing semen on the highest genetic merit young genomic enhanced sires.

Simulation studies have shown the impact of sexed semen on the selection intensity, resulting in a future genetic impact on production traits when used in cows and heifers compared with conventional semen programs (Weigel, 2004). It should be noted that a negative effect on reproductive performance of dairy cows was found. Suggesting the appropriate use of sexed semen maybe in the dairy heifer to limit the negative impact of overall herd reproductive performance when used on lactating cows (Khalajzadeh et al., 2012). Sexed semen has the ability to greatly impact genetic gain in both the nucleus selection and commercial populations in both the beef and dairy industries.

CLONING

Since the first announcement of cloning Dolly the sheep (Wilmut et al., 1997), somatic nuclear transfer technology (SCNT) has led to a wide variety of mammals being cloned, including cattle. Over the last decade, the number of cattle created using SCNT technology has increased from a handful to thousands. Academic groups across the world have successfully cloned cattle and continue to study the biology and ways to improve efficiency (Wells et al., 2003). In the beef, dairy and bio-pharma industries commercialization of the SCNT cloning has become an additional tool in the ART toolbox across many regions of the globe.

The principal application of cloning in cattle can be separated into three main categories. First, some of the early models that were discussed were based on the principle of mass production of cloned animals that had more desirable genetic characteristics for traits well suited for commercial livestock production. The benefit for such a program would be the dissemination of superior genetic material on a large scale with a great reduction in variation final product (Bousquet and Blondin, 2004). One example discussed would be a two-line cloning system. Terminal clones would be produced based on superior output qualities of a genetic donor(s). These clones would gestate in female clones that were derived from a superior maternal genetic donor(s) (Smith, 1989). This type of production, although attractive in theory, has some major shortcomings associated with risk, including proper identification of correct target traits and profit models, possible bottle necks in genetic variability (Van Vleck, 1999). In addition, the present costs of cloning and other ART technologies make the possibility of such systems production by cloning developing in the short term very unlikely. Second, is the use of cloning to produce genetic superior individuals. These are individuals that are identified as being superior for genotype. The producer may use cloning because of the need to propagate greater numbers of progeny from these individuals or use the technology as a type of insurance for elite genetics. Coupling cloning of superior females with other ART allows for increased selection intensity in a population from the contribution of the elite genetic donor. Additional examples include, superior cattle that become injured, reproductive inactivity due to age, and/or die unexpectedly. Cloning is a viable option to capture potential genetics that may be lost. Third is the use of cloning in the bio-pharma industry. Cloning technology has greatly impacted the ability to produce genetic engineered cattle to be used as medical models and production of pharma products through milk and blood in genetic engineered cattle.

GENETIC SELECTION FOR TRAITS ASSOCIATED WITH ART

Genetic selection for traits that enhance reproductive performance in cattle has been slow to almost non-existent in production populations, with very little research done on traits that impact ART. Church et al., 1977 discussed the impact that embryo transfer would have with the development of nonsurgical techniques and cryopreservation of bovine embryos. Interestingly, discussion in the article was extremely optimistic that the advancements covered in management and protocols would lead to the possibility of understanding genetic variation for traits impacting in vivo embryo transfer technology. Over the last 30 plus years, very little improvement was made in understanding the genetic contribution or implementing the selection of traits impacting superovulation. Like many traits related to reproduction in bovine, the progress and understanding has been slow. Much of this slow progress results from low heritability of reproductive traits and the multi-trait nature of so many of the measurable reproductive traits recorded (Cushman et al., 2007). Because environment is greatly influenced by management, the antagonistic relationships between the selection of traits have resulted in increased outputs of production. This has led to a negative genetic trend for traits related to reproduction in many selection programs. Genetic improvement for increased milk yield in Holstein cattle in the US has led to a dramatic reduction in fertility, as measured by open daughter pregnancy rate (VanRaden et al., 2004). One of the primary reasons for these negative trends is the low, narrow sense heritability of reproductive and correlated traits (Cushman et al., 2007). Much of this reduction can also be attributed to the lack of inclusion of traits measuring fertility in selection models. For these reasons, genetic selection for animals that perform well in ART programs has been limited to none.

Limited work has been done on the estimation of genetic parameter associated with ART in cattle. One of the earliest studies, looking at the repeatability and heritability of response the superovulation in Holsteins, (analyzed using Multiple Trait Derivative-Free Restricted Maximum Likelihood (MTDFREML) repeatability animal model), found the repeatability of the number of transferable embryos to be low, with an extremely low heritability of 0.03. The conclusion by the authors was that little evidence existed in predicting future, superovulation responses based previous treatment(s) and that superovulation may not be a heritable trait that can be selected for (Tonhati et al., 1999). Historically, investigations in understanding the genetic parameters of traits associated with multiple ovulations have shown that it may be possible to enhance embryo transfer production through maternal selection of traits associated with superovulation in cattle. In Nellore cattle, heritability

estimates for palpable corpora lutea (CL) ranged from .47 to .57 viable embryos from .20 to .65 (Peixoto et al., 2004). In Holstein, dairy heritability's was estimated to be .23 for number of flushed ova and .1 for transferable viable embryos. The number of flushed ova was also found to have a positive correlation with transferable embryos of .74. The authors concluded that selection for number of ova flushed would have an indirect positive increase of 22% transferable viable embryos, a key profit driver in embryo transfer programs (Konig, et al., 2007). Heritability estimates of .25 for number of oocytes collected and .16 for number of transferable embryos at day 7 were found in Holstein Friesian cattle. In that study, sires estimated breeding values for oocyte number and transferable embryos showed no correlation to the sires breeding index for female fertility in this population. Genetic parameter estimates for oocyte number and embryo production using in vitro embryo production systems support the possibility of introducing such traits into breeding programs to enhance the number of off-spring produced from a superior dam. And, as an important result, an improvement in cost per progeny produced in IVP (Merton, et al., 2009). The genetic components of direct and correlated traits for embryo production in the female give evidence that efficiency of ART programs can be improved through donor selection. From these studies, it would be useful to have genetic breeding value estimates for: 1) the traits number of ova produced; and 2) numbers of viable embryos. This will provide important data and enhance the efficiencies of in vivo embryo transfer and in vitro embryo production. The reality of such data making its way into genetic evaluation is hindered by the difficulty of collecting large numbers of phenotypic data. Because of these hurdles, the first impact of such data will likely be in those genetic evaluation programs that exist within breeding companies.

INCORPORATION OF ART THE FUTURE

Incorporation of ART will be extremely important as the world continues to see an increased need for high quality animal protein production. The manipulation of gametes and embryos in farm animals will become increasingly important. It will help meet the growing demand of agricultural products in emerging economies world-wide and impact in the biomedical field.

In the early years of ET, sources of variation in donor females and recipient dams were observed and discussion included such factors as genetics that may not respond to management practices (Church and Shea, 1977). This observation has been confirmed with the large amounts of documented individual female phenotypic variability both in vivo and in vitro embryo production resulting in the estimation of genetic components for traits associated ART (Merton et al., 2009; König, et al., 2007). No matter

how excellent the management of donor females and the excellence execution of ART protocols, poor production of embryos in many cases cannot be overcome. In order to enhance efficiency of ART in the production of embryos selection programs, cattlemen will have to incorporate genetic selection for traits that are impacting embryo production. This will affect female selection first, but holds great potential to impact selection of males used in ART programs, as the world begins to understand the impact of male fertility in the successful formation of the bovine zygote. In the future, it will be important to take high genetic index females for traits and correlated traits that indicate females that will excel in production of embryos. One specialized phenotype that holds promise is the use of ultrasonography of the ovaries in assessing antral follicle count. This use of antral follicle count has been shown to be associated with a females' response to superovulation protocols and embryo production (Ireland et al., 2009; Mossa et al., 2012). With a heritability estimated of .44 (Snelling et al., 2012), antral follicle count would definitely respond to genetic selection, making it a good candidate for enhancing embryo production in MOET programs.

The desire to shorten generation interval has been greatly enhanced by the accuracy of genomic enhanced evaluations in young animals. The next logical step is selecting the next generation of parents by using embryo selection to increase selection intensity, resulting in another jump in genetic progress. It should be noted that mistakes will also be magnified and that continued phenotypic data in the genetic evaluations will be critical for the success of these types of programs.

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NOTES

APPLICATION OF GENOME EDITING IN FARM ANIMALS: CATTLE

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ABSTRACT

Milk and meat from cattle and buffaloes contribute 45% of the global animal protein supply, followed by chickens (31%), and pigs (20%). In 2016, the global cattle population of 1.5 billion head produced 6.5 billion tons of cows' milk, and 66 million tons of beef. In the past century, cattle breeding programs have greatly increased the yield per animal with a resultant decrease in the emissions intensity per unit of milk or beef, but this has not been true in all regions. Genome editing research in cattle to date has focused on disease resistance (e.g. tuberculosis), production (e.g. myostatin knockout; production of all-male offspring), elimination of allergens (e.g. beta-lactoglobulin knockout) and welfare (e.g. polled or hornlessness) traits. Modeling has revealed how the use of genome editing to introduce beneficial alleles into cattle breeds could maintain or even accelerate the rate of genetic gain accomplished by conventional breeding programs, and is a superior approach to the lengthy process of introgressing those same alleles from distant breeds. Genome editing could be used to precisely introduce useful alleles (e.g. heat tolerance, disease resistance) and haplotypes into native locally-adapted cattle breeds, thereby helping to improve their productivity. As with earlier genetic engineering approaches, whether breeders will be able to employ genome editing in cattle genetic improvement programs will very much depend upon global decisions around the regulatory framework and governance of genome editing for food animals.

INTRODUCTION

Animal products, namely milk, meat and eggs, provide approximately 13% of the energy and 28% of the protein consumed globally. In developed countries, these numbers increase to 20% and 48%, respectively (FAO, 2009). Milk and meat from cattle and buffaloes contribute 45% of the global animal protein supply, followed by chickens (31%), and pigs (20%) (Mottet et al., 2017). Despite impressive advances in animal protein production over the past 50 years, projections suggest demand for pork could increase by up to 43% and demand for beef by as much as 66% to feed the predicted global population of 9 billion by 2050 (Figure 1). The greatest increase is expected for poultry products, with demand for poultry meat increasing by as much as 121% and eggs by 65% (Mottet and Tempio, 2017).

In 2016, the global cattle population of 1.5 billion head, including 270 million dairy cows, produced 6.5 billion tons of cows' milk and 66 million tons of beef (FAO, 2018). In the past century, cattle breeding programs have greatly

increased the yield per animal with a resultant decrease in the emissions intensity per unit of milk or beef, but this has not been true in all regions (Capper and Bowman, 2013). Many countries with the lowest production per cow are also those with the most cows (Figure 2). A similar trend can be seen for beef cattle (Figure 3), and the selection for improvement in beef yield that has been occurring in the United States since 1980 is evident as total beef production has been rising despite a falling cattle inventory. It is likely that future growth in meat and dairy production will be accomplished through larger herds and higher output per animal (Britt et al. 2018), with global meat production expected to expand by almost 40 million tons (Mt) and world milk production by 178 Mt by 2026 (OECD/FAO, 2012). In order to meet increased demands, it will be necessary to accelerate the rate of genetic gain in global breeding programs for both dairy and beef cattle.

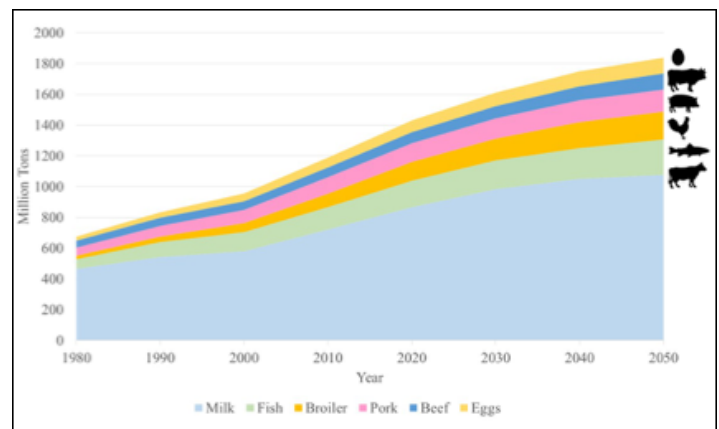


Figure 1. Egg, beef, pork, chicken, fish and milk production since 1980 and projected to 2050 (FAO 2018; Alexandratos and Bruinsma, 2012).

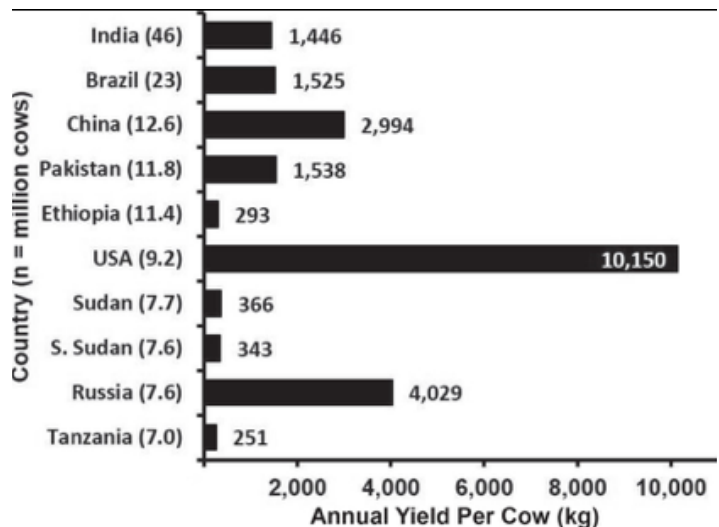


Figure 2. Number of cows (n, millions) and average annual yield (kg) per cow for the 10 countries with the greatest number of milk cows in 2014. These countries comprise 150 million milk cows, about 46% of the world's inventory (Britt et al., 2018).

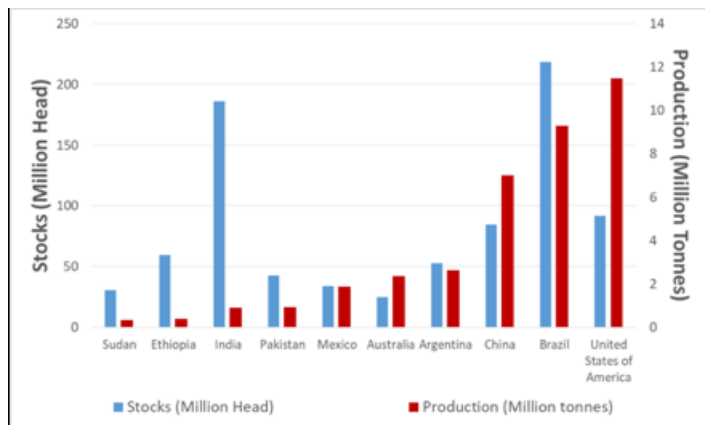


Figure 3. 2016 global beef production: cattle numbers (Million Head; blue, left) versus beef production (Million Tonnes; red, right). (FAO, 2018).

The United States is the world's largest producer of beef in part because of selection for higher yielding carcasses since the 1980s. Figure 4 show that despite a falling cattle inventory, total beef production has been rising due to the increased beef yield per carcass.

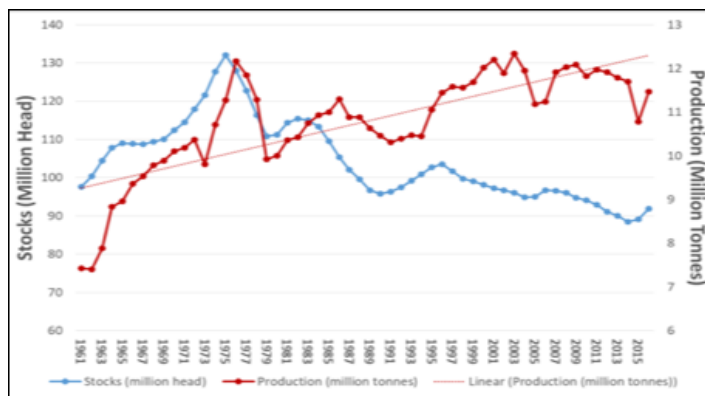


Figure 4. US cattle inventory 1961 – 2015. Cattle numbers (Million head; blue, left axis) versus beef production (Million Tonnes; red, right axis). (FAO, 2018).

In order to achieve such progress, producers breed animals that contribute to their breeding objective, or overall goal of the breeding program, which is traditionally focused on production traits such as milk or meat yield or growth rate. Animal breeders work to maximize the response to selection towards their breeding objective. The rate of genetic gain depends on the four components of the breeders' equation:

$$\text{Genetic change per year} =$$

$$(\text{Reliability} \times \text{Intensity} \times \sqrt{(\text{Genetic Variation}) / (\text{Generation Interval})})$$

Approaches or technologies that can improve one of these components can accelerate the rate of genetic progress towards the breeding objective. A number of advanced reproductive technologies and breeding methods are being routinely combined to accelerate the rate of genetic improvement in the cattle breeding sector. The image below shows how in vitro fertilization (IVF), genomic selection, and somatic cell nuclear transfer can work together to increase the intensity of selection, the

reliability of the genetic merit estimate, and decrease the generation interval.

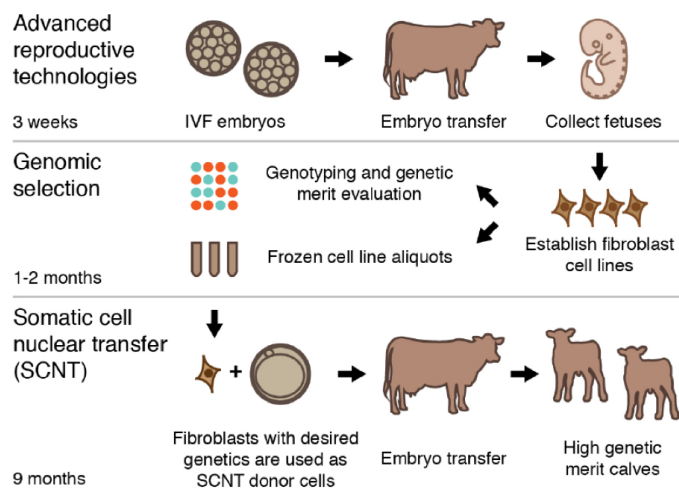


Figure 5. Production of high genetic merit calves. Image from Kasinathan et al. (2015).

GENOME EDITING IN CATTLE GENETIC IMPROVEMENT

Genome editing could be integrated into genomic selection programs to alter the genetic variation and/or generation interval in order to accelerate the rate of genetic gain. Figure 6 shows how genome editing could seamlessly integrate into existing breeding programs. To date, genome editing research in cattle has focused primarily on disease resistance (e.g. tuberculosis (Wu et al., 2015; Gao et al., 2017)), production (e.g. myostatin knockout (Proudfoot et al., 2015); generation of all-male offspring (Van Eenennaam, unpublished data)), elimination of allergens (e.g. beta-lactoglobulin knockout (Yu et al., 2011)) and welfare traits (e.g. polled or hornlessness (Carlson et al., 2016)) (Table 1). Genome editing could be used to precisely introduce useful alleles (e.g. heat tolerance, disease resistance) and haplotypes into native locally-adapted cattle breeds, thereby helping to improve their productivity (Dikmen et al. 2014).

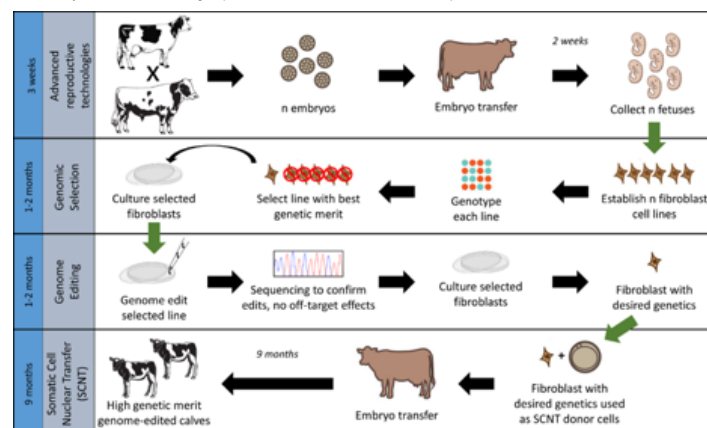


Figure 6. Production of high genetic merit calves using a range of biotechnologies and showing where genome editing might fit into the process. Image from Van Eenennaam (2017).

TARGET	TARGETED TRAIT/GOAL	REFERENCE
Intraspecies <i>POLLED</i> allele substitution	No horns/welfare trait	Carlson et al., 2016
Intraspecies <i>SLICK</i> allele substitution	Heat tolerance	Sonstegard et al., 2017
Myostatin (<i>MSTN</i>) gene knockout	Increased lean muscle yield	Proudfoot et al., 2014
Beta-lactoglobulin gene knockout	Elimination of milk allergen	Yu et al., 2011
Prion protein (<i>PRNP</i>) knockout	Elimination of prion protein	Bevacqua et al., 2016
Intraspecies <i>CALPAIN</i> & <i>CAPASTATIN</i> allele substitution	Improved meat tenderness	Casas et al., 2006 (not reduced to practice)
Insertion of lysostaphin/lysozyme transgene	Resistance to mastitis	Liu et al., 2013 & 2014
CD18 gene edit	Resistance to bovine respiratory disease	Shanthalingam et al., 2016
Insertion of SP110, NRAMP1	Resistance to tuberculosis	Wu et al., 2015; Gao et al., 2017
Intraspecies SRY translocation onto X chromosome	All male offspring	Owen et al., 2018
NANOS gene knockout	Infertile males (for gonial cell transfer)	Ideta et al., 2016

Table 1. Examples of proposed and actual targets for genome editing in cattle.

Computer modeling has revealed how the use of genome editing to introduce 1-20 beneficial edits impacting a quantitative trait could maintain or even accelerate the rate of genetic gain accomplished by conventional breeding programs. The data shows that it is a superior approach to the lengthy process of introgressing those same alleles from distant breeds (Figure 7; Jenko et al., 2015).

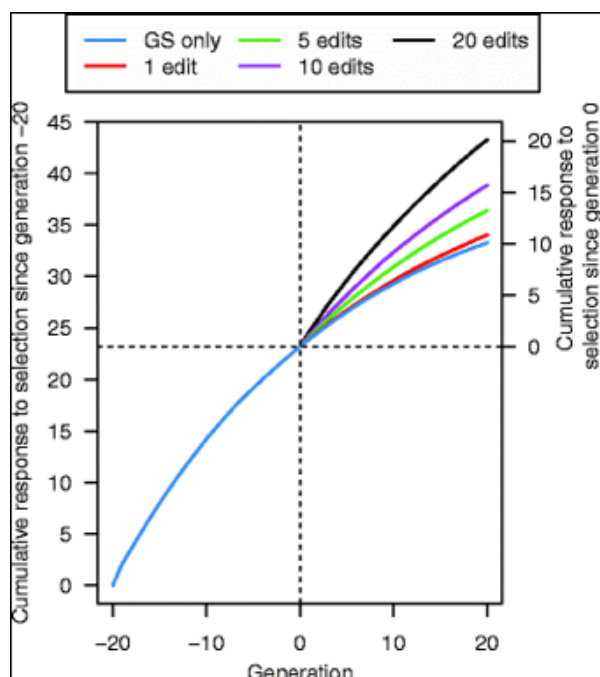


Figure 7. Cumulative response to selection across 21 generations of recent historical breeding based on genomic selection only (GS only) and 20 generations of future breeding based on GS only or GS plus the promotion of alleles by genome editing when different numbers of quantitative trait nucleotides were edited. Image from Jenko et al. (2015).

It should be noted, however, that the scenario modeled in Figure 7 simulated editing a quantitative trait that had 10,000 known quantitative trait nucleotides (QTN). In reality, breeders do not currently have a comprehensive understanding of which edits would be impactful on

quantitative traits, i.e. those controlled by many genes. Genome editing is particularly suited to addressing qualitative traits that are controlled by a single gene like *POLLED* (hornlessness). In the short term, therefore, it is likely that editing will be focused on large effect loci and known targets to correct genetic defects or decrease disease susceptibility, and conventional selection will continue to make progress in selecting for all of the many small effect loci that impact the complex traits that contribute to the breeding objective. In this regard, genome editing can be represented as a cherry on top of the ice cream sundae of an existing breeding program, synergistically allowing the precise introgression of beneficial genetic variants, while still building on the genetic progress that is achieved every generation using traditional breeding methods (Figure 8).

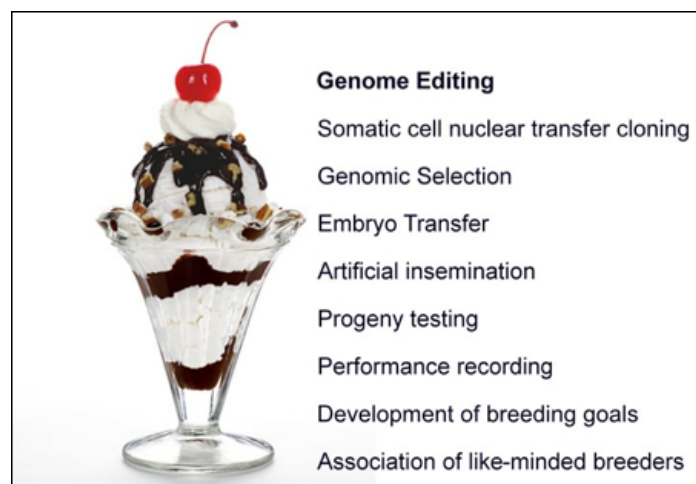


Figure 8. Genome editing can be envisioned as the cherry on top of the ice cream sundae of progress made using traditional breeding techniques and programs.

REGULATIONS

As with earlier genetic engineering approaches, whether breeders will be able to employ genome editing in cattle genetic improvement programs will very much depend upon global decisions around the regulatory framework and governance of genome editing for food animals. On January 18, 2017, the United States Food and Drug Administration came out with a draft guidance on the regulation of genome edited animals entitled, "Regulation of Intentionally Altered Genomic DNA in Animals." The new guidance removes the presence of a recombinant DNA (rDNA) construct as the regulated article that meets the definition of a drug, replacing it instead with "intentional genomic alterations" produced using modern molecular technologies. It is proposed that the presence of any "intentionally altered genomic DNA" produced using genome-editing tools would trigger mandatory, premarket new animal drug evaluation, irrespective of product risk or novelty of the genomic alteration.

One procedural problem with the proposed guidance

is differentiating between “intentional genomic alterations”, off-target genome-editing alterations, and de novo mutations (Van Eenennaam, 2018). In one analysis of whole-genome sequence data from 234 taurine cattle representing three breeds, more than 28 million variants were observed, comprising insertions, deletions, and single-nucleotide variants (Daetwyler et al., 2014). Another recent study found that on average every new animal will have around 65 de novo mutations, of which approximately five will be small insertion/deletions and the remaining 60 will be single-nucleotide substitutions (Harland et al., 2017).

In contrast, Argentina’s proposed regulatory approach is to ask the same question of edited plants and animals, “Is there a new combination of genetic material in the final product?” If not, then they do not trigger the GE regulatory approval process that was initially put in place for plants and animals containing rDNA constructs containing new combinations of DNA that could potentially present a hazard in the form of a new food allergen or toxin (Whelan and Lema, 2015).

From a risk perspective, it does not make a lot of sense to regulate genome edited polled calves differently than naturally-occurring polled calves carrying exactly the same allelic DNA sequence at the POLLED gene. Animal breeders need certainty that if they use genome editing to develop products that are no different from those that could have been obtained using conventional breeding, they will not be faced with additional layers of regulatory scrutiny. This would require proportionate regulations based on any novel risks inherent in the product, rather than arbitrary regulation of products based solely on human intent being the basis for the modification, or the processes that were used to create them (Carroll et al. 2016).

CONCLUSIONS

Significant improvements in the efficiency of milk and beef production have historically been accomplished through conventional breeding of superior individuals with an eye towards specific breeding objectives. Genome editing is a tool that is well-suited for modifying qualitative, single-gene traits at comparatively rapid rates and could be used in conjunction with conventional selection approaches to address issues such as disease resistance and improved welfare traits. The availability of this technology for use by animal breeders hinges on the regulatory framework imposed, which will likely vary by country. From a risk-based perspective, it makes little sense to regulate genome edited animals differently than conventionally-produced animals carrying the same allelic DNA at the targeted locus simply because they were produced using genome editing. Regulations should be fit-

for-purpose, proportional, and based upon novel product risks, if any, rather than being triggered by the use of an arbitrary set of breeding methods.

ACKNOWLEDGEMENTS

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NOTES

GENOMIC INDICATORS OF HETEROSIS

John Genho | Neogen

CONCLUSIONS

The most basic idea of genetic evaluation is parsing phenotypic variation (σ_P^2) into environmental variation (σ_E^2) versus genetic variation (σ_G^2). Heritability is calculated as the portion of the phenotypic variation that is explained by genetic variation. The basic model can be written as follows:

$$\sigma_P^2 = \sigma_G^2 + \sigma_E^2$$

As animal breeders, we usually only include additive genetic variation (σ_A^2), or the variation that is heritable and can be selected for. This makes sense in selection programs. However, two additional genetic factors could be considered. We could include dominance variation (σ_D^2), which is interaction of different alleles at the same locus, or epistasis (σ_I^2), which is interaction between genes at different loci. Both are very real genetic factors, but neither are heritable and hence cannot be selected for. Dominance and epistasis are the working effects that cause heterosis or hybrid vigor. A full expression of this more advanced model can be written as follows:

$$\sigma_P^2 = \sigma_A^2 + \sigma_D^2 + \sigma_I^2 + \sigma_E^2$$

In general, when we've included dominance and/or epistasis in our genetic prediction models, they have not allowed us to better predict breeding values or expected progeny differences (EPDs), which are the additive genetic portion. The added level of complexity and the lack of better predicting breeding values, have prevented them from being added to our models.

Our work in beef genomics has been no exception to the above. We've spent years trying to find the genes that will be transmitted to the next generation to improve the quality of animals. In the process, we've virtually ignored the non-additive genetic effects. Our reasons have been identical to the above. The additive genetic portion of genomic prediction has been sufficiently complicated to completely absorb our time and resources without adding the complexity of the non-additive effects of dominance and epistasis.

At the same time, we've watched several other phenomena in our industry. First, we've watched the loss of crossbreeding and an increase in the relationship among all animals to a select number of sires. This has led to improvement in certain traits, but a decrease in genetic variation among commercial animals. We've also seen a dramatic increase in feedlot health issues and deaths,

which likely have many causes but could be partially due to this lack of genetic variation. And finally, we've seen a dramatic decrease in genotyping costs over the past several years. These factors have created both the need and the ability to create genomic tests for non-additive effects.

Developing a genomic test for heterosis would be very complicated if done completely. If we only considered the dominance portion of the non-additive genetics, it would mean calculating the value of a heterozygote versus the average of the two heterozygotes for every SNP. This would have to be done simultaneously with the estimation of additive genetic values to ensure we're not double counting any effects. We would then have to think about the gene frequencies in different breeds and decide whether we want to focus on genomic heterosis or genomic dominance. Epistasis would be a separate effect to estimate, further complicating the issue. Clearly these would be difficult tasks given our current datasets.

Basarab, et. al (2018) proposed an alternative, easier approach to genomic indicators of heterosis in their paper "Genomic retained heterosis effects on fertility and lifetime productivity in beef heifers". In this paper, they considered several indicators of heterosis. The two discussed here are H, which is the percentage heterozygosity calculated by dividing the number of heterozygotes for a given panel by the number of SNPs considered; and RHET, which can be defined by the following equation:

$$RHET = 1 - \sum_{i=1}^n p_i^2$$

where p is the fraction of the n contributing breeds.

In addition, access heterozygosity (aH) was also considered, which assessed the frequency at each SNP and hence the expected amount of heterozygosity. The equation for this is as follows:

$$aH = \left(\sum_{i=1}^n \frac{x_i - 2q_i(1 - q_i)}{2q_i(1 - q_i)} \right) / n$$

where q is the minor allele frequency of the i th SNP, x_i is a heterozygosity indicator at the i th SNP and is equal to 1 for a heterozygote and 0 for a homozygote, and n is the number of SNPs. Note that $2q_i(1 - q_i)$ is the expected frequency (percent) of the heterozygote, assuming Hardy Weinberg equilibrium. As the minor allele gene frequency at a particular SNP goes down, the likelihood of seeing a heterozygote goes down as well, and heterozygotes receive a larger value added to the aH value.

A dataset with 2,080 pregnancy records on crossbred and purebred animals was tested for the above indicators of heterosis. Phenotypes were available for pregnancy through 5 years of age. For this dataset, the value H (as defined above) ranged from 25 to 55 percent heterozygosity, with 95% of the population ranging from 35 to 45 percent heterozygosity. Linear regression and binomial logistic regression were used to determine the effect of H on pregnancy at each age as well as stayability, defined as success or failure at each age given previous successes. The linear regression and binomial logistic regression models gave nearly identical results due to H values being centered at a point in the logistic regression curve which is nearly linear. For stayability at age 3 and age 4, a one percentage point increase in H was associated with a 1.23 and 1.48 percentage increase in the probability of staying in the herd, respectively.

It's important to remember that the above values are only indicators of genomic heterosis, not actual measurements of heterosis. In addition, these values, while genetic in nature, are not passed on to the next generation and hence aren't valuable in a selection program for offspring. Despite these shortcomings, these values could be very beneficial in a commercial heifer selection program to identify animals that are more likely to remain in the herd to an older age. Information of this nature could prove very valuable to a commercial operator developing a long-term asset. It could also be possible to develop these values for feeder calf programs to identify animals that are more at risk for health problems given a lack of heterozygosity.

NOTES

APPLICATIONS OF PRECISION AGRICULTURE TO CATTLE: IS IT ALL JUST HYPE AND WILL DIGITAL TECHNOLOGIES EVER DELIVER VALUE TO THE BEEF INDUSTRY?

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INTRODUCTION

Precision Agriculture (PA) is synonymous with the cropping industries. Most people think of a farmer driving a GPS enabled combine across the field with yield map data being collected to enable improved efficiency through innovations such as variable rate fertiliser application. Whilst the plant industries are in no doubt leading the field in understanding and managing landscape variability, there is a similar revolution occurring in the grazing livestock sector. GPS enabled monitoring systems along with a range of other sensors and data management platforms are providing livestock managers with insights never before possible. Furthermore, technologies such as virtual fencing are enabling a complete re-think of the way in which animals are managed in extensive grazing landscapes.

This paper and presentation will review some of the currently available, and emerging technologies in the livestock industries. The focus will be on monitoring and managing animals in extensive grazing environments. This is a far greater challenge than in the intensive beef industries. The complexities of balancing variation in landscapes, feedbase, animal requirements and sustainability provide challenges but also opportunities.

One key challenges facing the livestock industries is the hype surrounding many of the technologies. In Australia at least, there is significant start-up investment being poured into companies attempting to develop these tools. While this may provide the solutions required, there is also a good chance that producers may be caught up in this hype cycle and become disillusioned as technologies fail to meet their expectations (Lamb et al., 2008). This presentation will focus on how some of these technologies actually work and what their current limitations might be. The hope is that by improving an understanding of how these technologies work, industry expectations might be better aligned with what can be delivered by the technology providers.

THE COMPONENTS OF PA IN GRAZING SYSTEMS

In many of the intensive animal industries PA is focussed on measuring and influencing individual animal productivity. The environment is important, but the focus is on identifying highly performing animals to breed from, or identifying why certain individuals are not performing and finding solutions to this.

In extensive grazing systems, the individual animal component is critical but so is monitoring and managing of the feed-base and landscape. This means that PA tools have been developed for both these applications, measuring and monitoring the animal as well as measuring and monitoring the landscape. Similarly, tools and systems have also been developed to manage both the landscape and the individual animal. This is the frame work in which PA in livestock will be discussed.

PA SENSORS AND TOOLS FOR MONITORING THE GRAZING LANDSCAPE AND FEEDBASE

One of the key issues for animal managers in grazing systems is setting appropriate stocking rates. To do this well, a manager needs to understand exactly how much pasture will be available over the short, medium and long term. There have been a variety of sensor systems developed for measuring pasture (Trotter et al., 2010a). Some of the more recent advances include: the development of LiDAR based proximal systems (for vehicle based measurements - (Trotter et al., 2016)); and unmanned aerial vehicle based image analysis for vegetation volumetrics (Grüner et al., 2019). However, one of the most promising sources of information for grazing landscape assessment remains satellite data. While there are limitations with traditional multispectral imagery (particularly cloud cover), the development of new constellations that can collect imagery more frequently and at higher resolution is ameliorating this (Figure 1).



Figure 1. NDVI Image showing variability in pasture caused by electric fence strip grazing (A. Recovering Pasture; B. Just grazed; C. Being grazed; and D. Yet to be grazed pasture). The key innovation is that information is now freely available through web services from the Sentinel satellite (~5m pixel resolution) every 5 days).

Radar based satellite systems also provide some hope for regions in which cloud cover is frequent (e.g. New Zealand). These new active radar systems can effectively “see” through the cloud and have in, some situations at least, proven accurate (Schmidt et al., 2016). One critical feature of satellite derived data is that it is constantly being collected as opposed to on-ground sensor systems which require support from the producer.

There are also now a number of data platforms integrating remote sensed imagery with other data sources to provide the pasture biomass information sought by producers, for example: Pasture.io; Cibo Labs; GeoGraze and FarmMap4D.

MANAGING GRAZING LANDSCAPE AND FEEDBASE VARIABILITY

Collecting the data from all these sensors remains of little value if a producer cannot implement a management decision that drives production efficiency. There are numerous ways in which the data collected from sensors can be applied, as discussed earlier this information is most commonly used to adjust stocking rates to optimise pasture utilisation.

In addition to this some graziers are starting to consider how their fertiliser management might be impacted by spatial variability in the feed-base. Research has shown a large variation in soil nutrient variability in grazing landscapes (Trotter et al., 2014) and this is now beginning to be exploited by producers in the development of variable rate fertiliser prescriptions, a tool previously only used in the cropping industry (Figure 2).

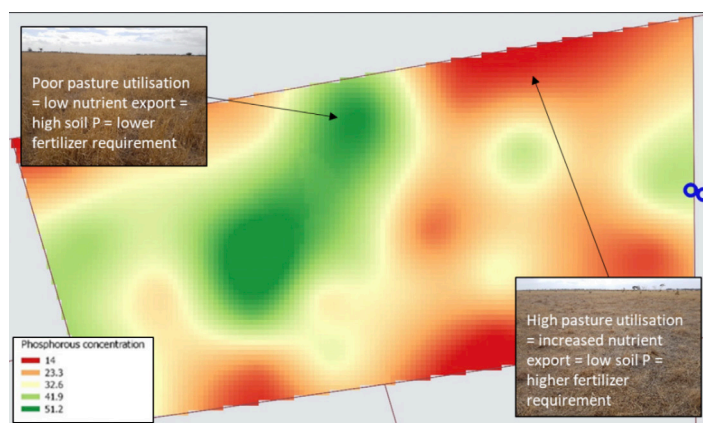


Figure 2. A soil Phosphorus (P) map developed from gridded soil sampling after reviewing GPS tracking data from livestock and variation in pasture biomass. These insights led this producer to develop and implement a variable rate fertiliser management strategy across this and other fields. This meant fertiliser was only spread in the areas that needed it and not in those parts of the field, it reduced fertiliser costs and will likely improve overall production.

PA SENSORS AND TOOLS FOR MONITORING THE GRAZING LIVESTOCK

There are numerous tools and sensor systems which have been adapted from the intensive livestock industries for use in the beef sector over the years. Individual animal

performance recording is becoming increasingly common amongst commercial producers whereas it was once the domain of only seed stock breeders. Collecting the data on grazing animals is a key problem in extensive environments and has seen the development of a number of innovations.

In-field walk-over-weigh technology is now being used on a number of commercial beef properties in Australia (González et al., 2014). This innovation involves setting up weigh scales on a platform that cattle walk over on a daily basis to access an attractant (usually water). These systems provide producers with estimates of live-weight change without the need to bring animals into a central holding facility to weight them (Figure 3). The data can be used to monitor breeding animals to meet body condition score targets or for finishing animals to identify likely turn-off dates. There have also been a range of other applications found from these systems including: detection of parturition (Menzies et al., 2018); dam and calf matching (Menzies et al., 2017); and oestrus detection (Corbet et al., 2018).



Figure 3. A Walk-over-weigh systems developed by DataMuster™. This systems enables collection of liveweight data on a regular basis while animals are located out in the pasture. This particular system has an “auto-drafter” attached which is being used to sort cows from calves automatically.

On animal sensor systems is another focus of research and commercial investment. This involves the deployment of some kind of sensor system on the animal, most commonly as a collar or ear tag (Figure 4 & Figure 6). The dairy industry has been using these sensors for decades



Figure 4. A Cattle fitted with an early version of the Ceres Tag™ GPS ear tag. Inset shows the approximate size and the prominence of the solar panels required to provide energy to power these devices (source Ceres Tag)



Figure 6. This heifer is wearing a Herddog™ ear tag (blue circular tag next to visual id tag). This device uses an accelerometer to detect activity patterns that can be associated with oestrus and other key behaviours of interest.

with the feedlot industry now also exploring their value. The extensive grazing industries pose a more significant challenge in that connectivity to the sensor remains an issue when animals are located on a distant range.

In extensive landscapes, producers are keen to know both the behaviour of the animal as well as its location (whereas in dairy and feedlot, location is less important). As such, many technology companies are focussed on developing monitoring systems that use GPS to collect location data (Trotter et al., 2010b) and accelerometers to monitor behaviour (Barwick et al., 2018). These sensors, along with the radio connection all use energy that must be supplied by battery or some sort of energy harvesting device (usually a solar panel). This energy use and generation issue remains one of the key challenges for technology developers in this field. These sensors will provide data to enable producers to better understand their livestock behaviour and physiological state. There is good evidence to suggest that these systems can provide early warning to disease (Bailey et al., 2018), predation events (Manning et al., 2014), reproductive behaviours (Abell et al., 2017), and feedbase related behaviours (Roberts et al., 2015). They can also be used to develop landscape utilisation maps (Figure 5) similar to the yield maps currently used in the cropping industries.

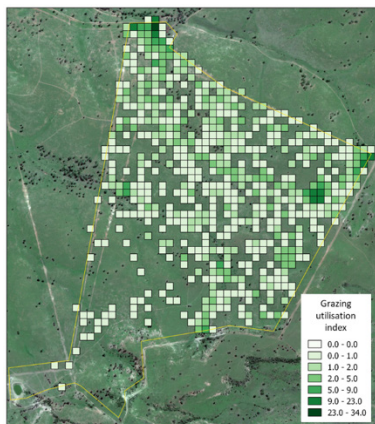


Figure 5. A grazing distribution map derived from GPS data. This information shows how animals prefer to graze in the northern parts of this field and avoid the south east corner. Producers can use this information to help guide paddock and water point design.

There are now several commercial companies seeking to provide these tools to the industry, for example: Ceres Tag, Moovement and Smart Paddock.

MANAGING GRAZING ANIMAL VARIABILITY

While the development of on animal sensor systems many benefits, the industry is also exploring opportunities to use technology to actively manage how animals interact with the landscape.

Perhaps one of the most anticipated technologies in the grazing industries is virtual fencing (Anderson, 2007). Using a collar born system (Figure 7) this technology enables a grazier to set boundaries within which an animal can move. This enables a range of grazing management practices to be achieved where traditional permanent or electric fencing would never be feasible.

While this technology looks promising the specific value proposition around costs and likely benefits is yet to be fully understood. There is also some concern from the community in terms of social license. The RSPCA (peak body for animal welfare) does not currently support VF in Australia.

There are several companies currently in varying stages of commercial development, for example: Agersens; Vence and Halter.

A QUICK COMMENT ON TECHNOLOGY USE IN GENETIC SELECTION

The potential for improved genetic selection through automated phenotyping has been widely suggested. However, the potential for these technologies to provide key insights in some specific areas is worth noting. Using GPS tracking technologies to understand grazing distributions and then select for animals that display ideal habits (Bailey et al., 2015) holds significant promise for landscapes in which sustainability is a key issue. The ability to use sensors to quantify feed use efficiency from pasture (Greenwood et al., 2018) is also of interest to many grass based production systems.

One key future issue may be the need for selection around new traits that enable improved compliance with the technologies. Virtual fencing is a good example of this, with a requirement for animals that respond favourably to this technology likely to be necessary and selected for in the future.

CONCLUSION

The development of digital technologies for monitoring and managing extensive grazing livestock systems has enormous potential. The ability to synoptically view the landscape in terms of feed-base characteristics along

with monitoring the fine scale behaviours of livestock 24-7 is something that has never been possible before. The challenge remains operationalising these systems in the difficult and challenging environment of pasture and rangeland systems. If the industry can work closely with technology companies to guide the development so that valuable information that influences production efficiency decisions can be made, we will reduce the risk of producers becoming disillusioned. Even with this ideal situation, there will need to be a significant effort made in extension to facilitate successful and widespread adoption of these emerging technologies.

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THE USE OF 'BIG DATA' IN A MODERN SWINE BREEDING PROGRAM NOW AND IN THE FUTURE

Jeremy Howard, Ph.D. | Smithfield Premium Genetics

INTRODUCTION

Considerable progress has been made in the use of tools to routinely monitor and collect data on animals without the need for humans to manually capture that data. Furthermore, the computing power continues to increase, along with a decrease in the amount of space required for its components, such that smartphones now have more processing power than a supercomputer 20 years ago. As a result, innovative high-throughput data recording and phenotyping platforms via the use of pictures, sensor (e.g., temperature, GPS position, accelerometer data, RFID, etc.) and sound data have begun to be prototyped and/or used within commercial swine companies (Brünger et al. 2019; Fernandes et al. 2019). 3D Camera technology has improved rapidly and with it, innovative uses have been investigated and include monitoring behavior in sows and pigs, predicting pig weights, reading ear identification tags, estimating the lean meat percentage (Lohumi et al. 2018) and more recently facial recognition to identify individual pigs (Hansen et al. 2018). Furthermore, a system that continuously monitors a group of animals has been developed to detect abnormal behavior in the form of how much an animal is eating and drinking, along with animal movement (Psota et al. 2019).

The development of innovating high-throughput data recording platforms will continue, but another challenge that is actively being researched, is reliable and in real-time extraction of important conclusions from the data generated. The large amount of data generated can be defined as 'big data', although the definition varies considerably across disciplines (Morota et al. 2018). The large amount of data that is generated from high-throughput platforms often contains a greater amount of errors (e.g., missing data, outliers, etc.) compared to traditional data collected via humans (e.g., body weights, litters size). Furthermore, visually inspecting the data is much more time consuming and, in some cases, no longer possible to effectively visualize all the data. As a result, effective ways to manage the data being collected along with diagnosing data issues in real-time is important to ensure the data generated is useful and accurately portrays what is actually occurring for any downstream analysis.

HISTORICAL USE OF BIG DATA

Historically, the swine industry has been using big data in the form of high throughput feed intake data beginning around the early 1990s. Electronic feeders utilize radio

frequency identification (RFID) tags to determine which pig is at the feeder, the amount of feed consumed and the weight of the animal. Electronic feeder systems have been traditionally utilized to improve the genetics of feed efficiency. Several other metrics are generated from electronic feeding systems and include feeding duration, amount of feed consumed for a visit and time at which an animal eats. Recently, the use of electronic feeders has been used to extract resilience phenotypes based on the variability of feed intake or feed intake duration within an animal across time during the growth period (Putz et al. 2019). Animals with higher resilience are less affected by environmental changes such as disease or weather and, as a result, show fewer fluctuations in their daily feed intake. Although electronic feeders provide a wealth of data, the cost for each station is high, which usually limits the number of pigs that can be evaluated at one time. Furthermore, in a swine breeding program, the breeding goal is to maximize crossbred performance (e.g., commercial market animals and commercial dam), which can be accomplished via selection at the purebred level when the genetic correlation between purebred and crossbred performance is close to unity (Bijma et al. 1998). Literature estimates of the genetic correlation between purebred and crossbred performance for feed intake traits have ranged from 0.62 to 0.67 (Godinho et al. 2018). Traditionally electronic feeders have been placed on disease-free nucleus farms and measured on purebred animals. As a result, the feed efficiency response achieved at the purebred level is not being fully realized at the commercial level as a result of environmental differences between the two environments.

FUTURE OF BIG DATA IN AN INTEGRATED SWINE COMPANY

Use of big data allows for one to more effectively focus on how the biological system can be managed at the individual animal level, in order to reduce the phenotypic variability and minimize the impact of environmental, disease and/or technological issues (e.g. ventilation malfunctioning) when they occur. Integrated companies that have genetic data from the commercial level flowing back to selection candidates at the nucleus can also leverage the data to not only select animals that excel in economically important traits, but can be used to more effectively manage a group of pigs at the commercial sector to achieve the maximum productivity and uniformity. As a result, integrated companies can leverage big data across multiple sectors (genetics, animal production,

packing plant) in order to improve the profitability of the whole system. Furthermore, the highest value of any given high-throughput recording platform is not realized one technology, at a time in isolation, rather, through the broad adoption of multiple platforms. As an example, electronic feeders provide a wealth of data regarding how much an animal is consuming, but it doesn't provide any information on what an animal is doing when it is not eating or environmental stressors that may have caused an animal to reduce its feed intake. For example, a finisher animal on average spends a little over an hour (e.g. 76.7 minutes; Brown-Brandl et al. 2013) a day eating, which provides only 5 % of the activity information for an animal in a given day. As a result, behavior data in the form of animal activity and barn temperature along with a feed intake recording system could potentially provide more information than any one recording platform. Lastly, machine vision technology offers the potential to realize a low cost and non-intrusive method to identify individual animals, which when scaling data capture and animal traceability at the commercial level, could greatly reduce the complexity of tracking a large number of commercial animals from birth to slaughter. The use of high-throughput data recording, animal identification, and phenotyping platforms has the potential to revolutionize the way pigs are managed to achieve maximum production along with phenotype collection that is less labor intensive. The novel phenotypes collected via automated recording platforms could provide a more comprehensive overview of the genetic potential of an animal in regards to how its behavior and response to environmental stressors interact with routinely collected weight, reproductive and carcass information.

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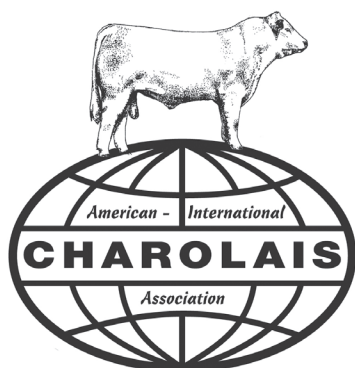


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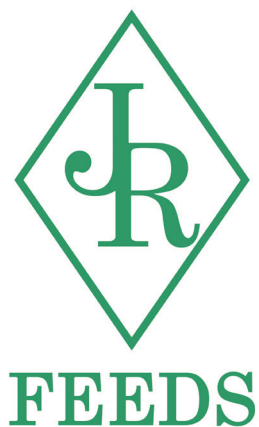
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