MSU Pork Quarterly

Information for an Industry on the Move

September 2019 Vol. 24 No.3

In This Issue...

1 Disinfectant Strategies for Swine Facilities

4 Feeding Pigs in Extensive Production: Part 2

6 Precision Livestock Farming Technology

9 BlockChain and the Pork Chain

ANIMAL AGRICULTURE INITIATIVE

This newsletter is edited by:

Casey Zangaro, MSU Extension Swine Pork Team, zangaroc@msu.edu
& Emily Schmitt MPPA, Program Director

Disinfectant Strategies for Swine Facilities

Is It Useful to Rotate Disinfectants Used in Swine Production?

Dave Thompson, Beth Ferry (MSU Extension, Pork Working Group) and Kevin Turner (Manager, MSU Swine Research Facility)

With fall just around the corner, it's useful to be mindful of the fact that cold, wet weather brings added pressure on swine health due to viral infections (especially PRRS and influenza), and it becomes even more important to maintain sound cleaning and disinfection practices in your swine facilities. The important role cleaning and disinfection play in maintaining pig health and performance (Hurnik, 2003) may, in fact, be heightened by new rules that have markedly reduced the use of feed grade antibiotics in livestock production (FDA Summary Report, Dec 2018).

There are numerous cleaners and disinfectants available for use in livestock facilities (Table 1). Selecting the right product(s) for use on your farm requires careful consideration of recent disease history and several other farm-specific factors, including hardness and pH of water servicing the barn, types of flooring and other surfaces, potential environmental concerns, staff experience and cost (Bruins and Dyer, 1995; Dvorak, 2008). Your veterinarian can provide useful information on diseases seen in your area and their susceptibility to specific products.

A long-running debate exists around the question of whether it's useful to rotate disinfectants used in swine barns, in the same manner that you might rotate antibiotics or parasiticides, in order to prevent selection for resistant strains of pathogenic organisms. Rotating disinfectants is frequently practiced in hospitals and drug manufacturing facilities (Booth, 2018); however, it is less frequently practiced in swine production systems. There are reasonable arguments on both sides of this

Table 1. Disinfectants Used in Swine Facilities*

Class/Products	Strengths	Weaknesses
Acids Acetic acid Citric acid	-Mycoplasmas, G+, G-, enveloped viruses, FMD -Low cost	-Can cause burns, toxic fumes when concentrated -Weakened by organic matter
Alcohols Ethanol Isopropanol	-Mycoplasmas, G+, G-, enveloped viruses, FMD -Very fast-acting vs bacteria -Leaves no residues	-Weak vs viruses -Weakened by organic matter -Damages rubber & plastic -May irritate skin -Flammable
Aldehydes Formaldahyde Glutaraldehyde	Broadest spectrum (includes spores) -Glutaraldehyde > formaldehyde if organic matter present	Highly irritating -Potential carcinogen -Must Seal building, PPE required, 2 workers required for use in fumigant form
Biguanides Nolvasan™ Chlorhexidine™	-Highly effective against mycoplasmas, G+ and G- bacteria -Low cost	-Limited spectrum -Only function at pH 5-7 -Toxic to fish
Halogens Chlorox™	-Broad spectrum -Fast-acting -Low cost -Low toxicity	-Variable activity vs spores -Weakened by organic matter and some metals -Irritates eyes -Forms toxic chlorine gas if mixed with acid
Oxidizing Agents Virkon-S™ Intervention™	-Broad spectrum -Some activity even with organic material, -Very fast-acting -May be formulated with surfactants	-Concentrated forms can irritate
Phenols Tek-Trol™ Pine-Sol™	-G+, G-, mycoplasmas, coccidia -Long-acting -Works in hard water -Works if organic matter present	-Non-enveloped viruses, spores

**Products listed are provided as examples representing each class; the list is not exhaustive, and product inclusion in this table is not meant to imply that MSU-Extensionrecommends its use.*

issue.

On the side of not rotating, there is considerable evidence showing that, for most disinfectants typically used in hog production, true resistance has not been observed. Resistance occurs when an important pathogen is shown to become less sensitive to the disinfectant when tested in a culture plate or test tube (McDonnell and Russell, 1999). In some cases, where higher than normal disinfectant levels are required, what has been called "resistance", can actually be better described as "tolerance" which is defined as protective effects that permit microorganisms to survive in the presence of an active agent. For example, increased levels of "tolerance" can sometimes be attributed to the presence of biofilms, where cells become embedded in an extracellular environment, providing protection from the active ingredients in disinfectants. Biofilm build-up, which presents itself as a slimy coating on equipment, fencing and facilities will need to be addressed for any disinfectant to work properly. Second, many successful farms never rotate their disinfectants, adhering to the old-age belief that if it isn't broken, why fix it. They wait until there is a health challenge to their system or in a neighboring farm, then change disinfectant or even cleaning products or procedures used. Third, rotation might add unwanted complexity to the process, in terms of product purchases, storage and staff training, perhaps without bringing added value.

The argument in favor of rotating disinfectants, though less supported by observed evidence, follows better with what we know about the biology of disease-causing micro-organisms in general. First and foremost, there is clear evidence for functional or physiological adaptation to several antibiotic-like disinfectants used on farms, including chlorhexidine (a biguanide) and triclosan (a phenol) (Martinez, 2009). In these cases, the underlying molecular mechanisms accounting for reduced efficacy of these products have been established. Second, rotation is a common practice in many well-managed swine production facilities… and swine farmers are known for managing input costs carefully. Rotation is also frequently practiced in other types of facilities where sound biosecurity practices are critical, including some hospitals, drug manufacturing facilities and food processors (Murtaugh et al., 2000). In these facilities, preventing spread of disease and minimizing the selection of resistant strains of pathogenic micro-organisms are essential. It is also possible that rotating two disinfectants from different chemical classes, especially if they work by different mechanisms, might help address problems presented by the biofilm, and help prevent some new forms of adaptation that might develop because of it. Some modern products used in swine facilities combine two or more disinfectants in the same bottle, ensuring compatibility of the active ingredients and that the proper ratio of each disinfectant is applied. Finally, the cost associated with rotating disinfectants may be small relative to potential long-term benefits.

On some farms, a stronger case might be made for periodically rotating in a different detergent that addresses the biofilm build-up issue by better removing mineral and scale deposits that can provide a protected micro-environment for bacteria, mold and viruses, or trying a more effective sporicidal disinfectant (e.g., fumigation using a glutaraldehyde-based product), either of which may bring more value.

The swine research facility at Michigan State University currently uses a hydrogen peroxide-based disinfectant that is broad-spectrum and highly effective, but also user-safe, simple to use, and environmentally-friendly. However, the best option for disinfecting your facility should reflect careful consideration of the factors described above, especially recent disease history, coupled with the advice of your veterinarian. Also, remember that it's essential to follow manufacturer's instructions for use of the product(s) and to clean all barn surfaces and equipment thoroughly before applying disinfectant, as residual organic material (manure, contaminated feed, dirt, straw) can inactivate most disinfectants (Benjamin, 2018).

References and useful links

Benjamin, N. (2018) Tips for proper selection of cleaning, disinfection products, The Pig Site, https://pighealthtoday.com/tips-for-proper-selection-of-cleaning-disinfection-products/

Booth, C.M. (2018) Should you rotate disinfectants? Industry experts weigh in. Pharmaceutical ONLINE, https://www.pharmaceuticalonline.com/doc/should-you-rotate-disinfectants-industry-experts-weigh-in-0001

Bruins, G. and Dyer, J.A. (1995) Environmental considerations of disinfectants used in agriculture, Rev. Sci.Tech.Off.Int.Epiz.14:81-94.

Dvorak, G. (2008) Disinfection 101, https://www.coursehero.com/file/10125880/Disinfection101/

FDA Summary Report (Dec 2018), Antimicrobials Sold or Distributed for Use in Food Producing Animals, https://www.fda.gov/animal-veterinary/cvm-updates/fda-releases-annual-summary-report-antimicrobials-sold-or-distributed-2017-use-food-producing

Hurnik, D. (2003) Barn Wash/Disinfection Trials, The Pig Site, http://www.thepigsite.com/articles/883/barn-wash-disinfection-trials/

Martínez, J.E. (2009) The Rotation of Disinfectants Principle: True or False? Pharmaceutical Technology (33) http://www.pharmtech.com/rotation-disinfectants-principle-true-or-false?id=&sk=&date=&pageID=10

McDonnell and Russell (1999) Antiseptics and Disinfectants: Activity, Action and Resistance, Clinical Microbiology Reviews, Jan. 1999, p. 147–179

Murtaugh, S.M et al. (2000), A Survey of disinfectant use in hospital pharmacy aseptic preparation areas, Pharmaceutical Journal 264:446-448.

Shannon, M.C. and Fangman, T.J. (2000) Swine Antibiotics and Feed Additives: Food Safety Considerations, M.U. Guide, G2353.

Feeding Pigs in Extensive Production: Part 2

Dale W. Rozeboom, Professor/Extension Specialist,
Department of Animal Science, Michigan State University

In this article, the second in a two-part series (for Part 1, see MSU Pork Quarterly, May 2019), several management and procurement approaches are discussed relative to feeding pigs in extensive settings. Feed may be formulated and manufactured on-farm, purchased in ready-to-feed bags or ready-to-feed bulk. Once again, the cost of feed decreases with increasing responsibility for grinding, formulating, mixing, storage and quality control. Taking on responsibility for devising the nutritional program and making the feed must result in equivalent or improved production and a cost improvement that accounts for the added time and knowledge (more time formulating, buying individual ingredients, more automation for bulk procurement of ingredients, equipment and power to manufacture feed, automation for delivery to bins, and delivery to feeders).

Mixing Complete Feeds

If purchasing one ton of feed at a time is too much, you may consider planning ahead for the mixing of two different complete feeds. This can be advantageous as it still allows you to purchase feeds in one-ton quantities which is less expensive than buying smaller quantities. Mixing two complete diets together eliminates the over-feeding of nutrients as pigs get older and the under feeding of pigs if price of feed is encouraging the avoidance of purchasing too much of the expensive starter diet. Mix proportions of a "dense" ration with a "less dense" ration to get a "moderately dense" ration. For example, a grower 1 diet containing 1.1% total lysine could be mixed 1-to-1 with a finisher diet containing 0.8% lysine, and the resulting feed would be 0.95% lysine and appropriate as a grower 2 diet. This simple example assumes that other amino acid concentrations will be portioned similarly and that the minerals and vitamins in both the grower 1 and finisher diets are equal. If not similar, then the 'mixed diet should be evaluated for any estimated concentrations that do not meet the minimum of NRC (2012)[2]. You can blend by the scoop, bucket or bushel basket full. You use the feed quickly and avoid loss of available nutrients with extended storage. You do not have to store feed until the next reproductive cycle, when you have pigs of a given maturity once again. And you do not have to own a grinder-mixer.

Topdressing

Purchasing one ton of bulk complete feed may still be an option, even if you do not have enough pigs to eat all of it in an appropriate amount of time. With topdressing, one ton of a "less dense" ration is purchased, and then daily portions are top-dressed with soybean meal or another protein source with each feeding. You may buy one bag of soybean meal at a time. The amount of soybean meal will vary and decrease as pigs grow; anywhere from a quarter to one full cup (about 150 grams) per pig per day. One cup of 47.5% soybean meal provides about 4.7 g of lysine. The farmer who grows soybeans or other protein sources can use these to top-dress, keeping in mind that soybeans must be cooked or steamed prior to feeding.

Grind and Mixing Feed at Home

A farmer may grind and mix their own rations if they have accurately determined that the cost savings in doing so are real. The cost of procuring all ingredients, equipment, delivery, processing, interest, depreciation and labor must be considered. The decision to process feed on the farm must not only be cost effective, but also requires the owner be responsible for being knowledgeable about formulations and feed quality.

Feed processing on the farm can be done with varying amounts of complexity. Most simply, a PTO drive grinder mixer may be used to grind grains and mix with a purchased complete supplement, often called a 'vitamin and mineral mix', or 'vitamin-mineral pre-mix', which includes all other ingredients. As the size of the swine enterprise increases, justification for complexity increases, and a farmer may consider purchasing individual lots of a protein source, a calcium source, a phosphorus source, salt, a trace mineral premix, and a vitamin premix. In an older Pork Industry Handbook bulletin, Bloome and others suggests at 200 to 400 tons per year (30 to 60 sows farrow-to-finish) as the break-even volume of feed for a PTO grinder-mixer. The North Carolina State University Swine Nutrition Guide 7 suggests that 500 to 750 tons of feed per year justify use of a stationary mill and mixer for on-farm feed processing. It takes about 70 to 100 sows in farrow-to-finish production to justify raising corn, oats, or other grains and the costs of labor, transportation, feed manufacturing, and feed storage. Other questions to consider when deciding whether to process feed on-farm are presented in a Pork Information Gateway resource by Holden and Starkey .

Alternative Feedstuffs

Periodically, extensive producers have access to a surplus low-cost byproduct which they would like to feed to swine. These vary considerably in nutrient profile and availability based on location and season, making general guidelines for their use challenging. The challenges with feeding these alternative feedstuffs are: knowing nutrient availabilities and amino acid relationships in that alternative feedstuff. Thaler and Holden have provided upper inclusion limits (amount or percentage) for various alternative feedstuffs. Farmers should seek the advice of a nutritionist, extension specialist, or consultant to evaluate ingredient and finished feed quality. When managed appropriately, there are many local sources of vegetables, dairy whey, root crops, and other alternative feeds that add variety to pigs' diets and may reduce feed costs. Older swine husbandry books, some now available electronically, have nutritional values for some of these alternatives, but recognize there can be considerable variation around these averages.

Pasture and forage

Many extensive producers raise their herds on pasture or in woodlots, and the right kind of forages can add significant nutrients to swine feeding programs. For example, sows on good quality pasture can be fed less often and with a smaller amount of concentrate . Forage adds protein, fiber, and essential vitamins and minerals to the diet, but should not be considered as a substitute for a grain-based complete diet. The nutritional value of forages depends upon the type and quality of plants in the pasture. As a rule of thumb, high quality forage can substitute for up to 20-30% of the diet. At the 20% mark, the farmer should consult with a nutritionist to make adjustments in formulation of the complete diet to ensure all nutritional requirements are being met. Opportunities for foraging grain or crop fields after harvest may be available seasonally. Silage may also be fed to sows , if protein and energy levels are maintained at appropriate levels in the overall diet.

Feed Co-op

In the history of swine production in North America, we can read about the formation of producer cooperatives. This is another historical approach which extensive swine farmers can consider. Like-minded extensive farmers can more easily experience the economies of scale by cooperatively buying complete feed or feed ingredients in larger quantities. Historically, this was referred to as a 'feed co-op.' If large enough, they could save substantial amounts of money by buying other supplies and equipment together as well. Of course the co-op needs to be managed and records maintained, so this benefit is not without some expense or effort.

Summary

Often mentioned in nutrition discussions is the fact that feed typically represent 60 to 75% of variable production costs in pig production. Extensive farmers looking to decrease feed costs must decide if the reduction in all costs with a potential alternative approaches does exist, and that they have the ability to control the quality of processing and presentation. The feed procurement approach should achieve desirable nutrition, health and productivity.

Notes:

[1] Bloome, P., A. Jensen, L. Rottman, and E. Rothenberger. 1990. On Farm Feed Processing. Pork Industry Handbook, E-1064.

[2] Holden, P. and C. Starkey. 2012. Should I purchase or make my own feed? Pork Production How-To: Pork Information Gateway http://porkgateway.org/wp-content/uploads/2015/07/should-i-purchase-or-make-my-own-feed1.pdf

[3] Thaler, B. and P. Holden. 2010. By-product feed ingredients for use in swine diets. Pork Information Gateway Factsheet PIG 07-06-01. Accessed at: https://www.extension.purdue.edu/extmedia/AS/07-06-01.pdf

[4] Kephart, K.B., G. R. Hollis, and D. M. Danielson, 2006. Forages for swine. Pork Information Gateway Factsheet 07-06-04. Accessed at: http://www.porkgateway.org/FileLibrary/PIGLibrary/Factsheets/07-06-04g_c052006.pdf

[5] Wheaton, H.N. and J. C. Rea, 1993. Forages for Swine. University of Missouri Factsheet G2360. Accessed at: http://extension.missouri.edu/p/G2360

Precision Livestock Farming Technology for Remote Monitoring of Pig Welfare and Health.

Madonna Benjamin, DVM, MS. Assistant Professor, Department of Large Animal Clinical Sciences, College of Veterinary Medicine, Michigan State University
Marlo Macai Schneider, University of Western States. Portland, OR

Livestock producers and stakeholder industries will be challenged to meet the rising demand for animal protein derived from a growing global population. By 2050, the global population is projected to be over 9 billion, consuming 50-60% more food (based on today's consumption patterns), according to Food and Agriculture Organization (FAO) of the United Nations 2009 report[1]. One solution to this global food security issue is to produce more food while equaling the current level of input or intensifying sustainably[2]. This demand will require further intensification, which raises ethical questions, including animal welfare concerns over animal living space. As such, animal welfare may be one potential trade-off in favor of sustainable intensification[2].

One would be hard-pressed to find many similarities between the entertainment room of the typical North American home and improvements in swine welfare. However, through the use of sensors, artificial intelligence and animal behavior research, the very technology that is helping to bring video games to life for the average American is used by engineers and researchers to develop various automate monitoring technologies, forming the concept of Precision Livestock Farming[3,4]. The microphones, infrared cameras, pressure sensors, and other technology used in gaming systems such as Sony PlayStation®, Microsoft XBox®, and Nintendo Wii™ are being explored as possible assistants to veterinarians and producers in the care of their livestock. Cameras capable of capturing images of 3-dimensional objects for enhanced gameplay may make it possible to automatically detect illness in swine and other livestock. Movement trackers and sensors designed to immerse players in the fantasy world of gaming could play a role in collecting information about the quality of movement and welfare of pigs. For example, facial recognition software that identifies one human from another is sophisticated enough to identify individual animals[5]. As the possibilities continue to increase, the experts responsible for the health and welfare of their swine can draw inspiration for the use of technology from their counterparts in human medicine. In this area, similar technology is being coupled with artificial intelligence to recognize patterns and predict outcomes, assisting doctors in the recognition of at-risk patients and the making of diagnoses. Veterinarians may be able to use very similar techniques for the improvement of animal welfare in swine production, but before all of these advancements can be implemented there must be greater understanding of the technology itself. In a series of articles published in the Pork Quarterly, 1) a general introduction to algorithms and computers, 2) potential applications of remote monitoring and 3) the implications for farmers and their veterinarians and finally 4) areas of future research.

A general introduction to Precision Livestock Farming

Precision Livestock Farming (PLF) also known as Integrated Management Systems/Precision Animal Management, is defined by Wathes as "the management of livestock production using the principles and technology of process engineering to monitor, model and manage animal production"[6]. PLF applies technological advances to the monitoring of and data collection from individual animals within large herds with the hope of optimizing the welfare and contribution of each animal. While PLF for swine farming relies on new technology, it cannot be considered a new science. For example, in 1988, DeShazer et al.[7] reported over 90 applications for image analysis in pig production. Applications,and availability of precision livestock farming tools have greatly increased making it a field that should catch the attention of veterinarians and stockpeople alike. This increase is not limited to the livestock sector and across a wide variety of fields the rate of technological advancement of the last two decades leaves even the most committed enthusiast in the dust. When we consider Moore's Law[8] - the principle that the number of transistors on an integrated circuit chip doubles approximately every two years - it is no wonder staying up-to-date seems to be a Sisyphean task. In 1971 a microprocessor housed approximately 2,308 transistors, while at the time of writing a microprocessor comfortably fits 19.2 billion. Perhaps a more relevant example based on the earlier discussion of machine learning, would be that of supercomputers' computational ability; Currently the most powerful supercomputers can complete 93 trillion computations per second[8]. Suddenly, with figures such as these in our minds it becomes increasingly easy to see how powerful machine learning is and how it could be a highly beneficial component of PLF.

While principally a review of scientific literature of PLF between 2012 to present, this series will review information gleaned from proprietary data, institutional input, market conditions and scholarly ethical assessments. It is provided as information targeting an emphasis of food animal welfare including (but not limited to) health, productivity, behavior, and physiological responses and as defined by American Veterinary Medical Association (AVMA) Welfare Principles[9]. Mention of trade names, products, commercial practices or organizations does not imply endorsement by the authors.

A) Analysis and decision making for agriculture - It's all in the algorithm.

An algorithm is a formula, or step-by-step set of operations, utilized to solve a specific problem or class of problems. A programming algorithm is a computer procedure that tells the computer precisely what steps to take to solve a problem utilizing inputs to determine the outputs. Programmers provide the human initiation of the process by writing the algorithm that instructs the computer how to perform the specific operations necessary to solve a problem. Machine learning, also referred to as deep learning, is a family of computational methods that allows an algorithm to program itself using large sets of examples that demonstrate the desired behavior. Because the computer "learns" from these example sets of existing data, a human is not constantly required to specify steps or rules for the computer to follow[10]. For example, algorithms are often used in research for determining gait kinematic patterns for conditions such as hip osteoarthritis[11], Parkinson's disease[12], and multiple sclerosis[13] and show potential for future clinical use.

B) Machines Mimicking the Mind: Machine Learning

Data mining is the process by which useful information and trends are extracted from large databases and datasets, and swine veterinarians are accustomed to using the process to glean information on topics such as sow performance and history. The use of data mining can be observed in "information-provided" database software systems (ie PigCHAMP, Swine Management Systems, Cloudfarms, PigKnows, MetaFarms, Farms.com) that are driven by the input of observed data (e.g. days to first estrus, number of piglets born alive). In contrast to this, machine learning differs because it learns from a pool of probability models that best predict unobserved data. Beginning with group or individual patient-level observations, algorithms sift through variables searching for combinations that reliably predict outcomes. One of the greatest benefits of machine learning is its ability to use highly complex data, such as a collection of predictors, to produce vastly richer estimates than would be possible through standard statistical models[10]. This capacity allows for the use of new kinds of data, those whose sheer volume or complexity would previously have made analyzing them unimaginable.

Artificial neural networks (ANNs) are systems that can be a component of machine learning. They are modeled off of the design and function of the brain. In these systems, input data in the form of a number enters and is connected by synapses to neurons that perform specific calculations and output a result. ANNs can have many layers of synapses, allowing for complex calculations and even deeper machine learning. When presented with images and video, ANNs are particularly useful because they are capable of extracting many different data points simultaneously and recognizing patterns and trends within the image itself[14].

Machine learning particularly benefits from the use of open source access, a practice that allows programmers to collaborate together to alter and improve algorithms. Open source is similar to a colleague discussion because it functions on the premise that more heads are better than one when it comes to resolving an issue. Open source allows people to freely access online local versions of algorithms, edit them to complete new tasks, and grow the code beyond its original release. For example, to train the computer a programmer will classify an item multiple times until the computer can classify it on its own. This particular form of machine learning can be expanded from classifying stationary objects in an image to classifying a moving object through the addition of an image tracking program that follows an item as it continues to classify. One open source program called YOLO (You Only Look Once) utilizes Darknet, an image tracking program. Open sourcing in the development of Darknet has allowed for classification in motion from one image every 20 seconds to an image every 1/20 of a second and improved tracking time by 1000 percent[15]. For more information on object detection and tracking watch https://pjreddie.com/darknet/yolo/.

With this basic introduction to algorithms, machine learning, and PLF, the focus can now be turned to exploring the different types of technology that makes the essential collection of data possible. In recent years, stockpeople implementing PLF typically utilize the sensors initially developed for use with gaming systems such as Xbox, Halo™, and Wii Connect. This off-label utilization of technology for agriculture carries along with it the benefit of widespread availability and consumer-driven lower costs giving livestock farmers easy and inexpensive access to 3-dimensional sensors, cameras, and microphones. Through the following series of articles, we will look at technologies currently in use and some that show potential for implementation in PLF practices.

References

1. FAO. The State of Food and Agriculture: Livestock in Balance.; 2009. doi:10.1016/S0140-6736(75)92740-3

2. Godfray HCJ, Garnett T. Food security and sustainable intensification. Philos Trans R Soc B Biol Sci. 2014;369(1639):20120273-20120273. doi:10.1098/rstb.2012.0273

3. Neethirajan S. Recent advances in wearable sensors for animal health management. Sens Bio-Sensing Res. 2017;12:15-29. doi:10.1016/j.sbsr.2016.11.004

4. Berckmans D. Precision livestock farming technologies for welfare management in intensive livestock systems. Rev sci tech Off int Epiz. 2014. doi:10.20506/rst.33.1.2273

5. Hansen, MF, Smith ML, Smith LN, Salter MG, Baxter EM, Farish M., Grieve B. (2018). Towards on-farm pig face recognition using convolutional neural networks. Computers in Industry, 2018;98:145–152. doi:10.1016/J.COMPIND.2018.02.016.

6. Wathes CM. Precision livestock farming for animal health, welfare and production. In: Aland A, Madec F, eds. Sustainable Animal Production. Wageningen Academic Publishers; 2009:411-419.

7. DeShazer JA, Moran P, Onyango CM, Randall JM, Schofield CP. Imaging Systems to Improve Stockmanship in Pig Production. AFRC Institute of Engineering Research: 1988.

8. Fueling innovation we love and depend on: Over 50 Years of Moore's Law. https://www.intel.com/content/www/us/en/silicon-innovations/moores-law-technology.html. Accessed August 31, 2019.

9. AVMA. Animal Welfare: What Is It? https://www.avma.org/KB/Resources/Reference/AnimalWelfare/Pages/what-is-animal-welfare.aspx. Accessed August 31, 2019.

10. Obermeyer Z, Emanuel EJ. HHS Public Access. N Engl J Med. 2016;375(13):1216-1219. doi:10.1056/NEJMp1606181. Predicting the Future — Big Data, Machine Learning, and Clinical Medicine. The New Eng J Med. 2016;375(13):1216-1219. doi:10.1056/NEJMp1606181.

11. Allison K, Hall M, Wrigley TV, Pua Y-H, Metcalf B, Bennell KL. Sex-specific walking kinematics and kinetics in individuals with unilateral, symptomatic hip osteoarthritis: A cross sectional study. Gait Posture. 2018;65:234-239. doi:10.1016/j.gaitpost.2018.07.179.

12. Creaby MW, Cole MH. Gait characteristics and falls in Parkinson's disease: A systematic review and meta-analysis. Parkinsonism Relat D. 2018. doi:10.1016/j.parkreldis.2018.07.008.

13. Sosnoff JJ, Sandroff BM, Motl RW. Quantifying gait abnormalities in persons with multiple sclerosis with minimal disability. Gait Posture. 2012;36(1):154-156. doi:10.1016/j.gaitpost.2011.11.027.

14. Puri M, Solanki A, Padawer T, Tipparaju SM, Moreno WA, Pathak Y. Introduction to Artificial Neural Network (ANN) as a Predictive Tool for Drug Design, Discovery, Delivery, and Disposition: Basic Concepts and Modeling. Basic Concepts and Modeling. Elsevier Inc.; 2015. doi:10.1016/B978-0-12-801559-9.00001-6

15. Ren P, Fang W, Djahel S. A novel YOLO-Based real-Time people counting approach. 2017 Int Smart Cities Conf ISC2 2017. 2017;243:3-4. doi:10.1109/ISC2.2017.8090864.

BlockChain and the PorkChain – A Strategy for both Producers and Consumer

Madonna Benjamin, DVM, MS. Assistant Professor, Department of Large Animal Clinical Sciences, College of Veterinary Medicine, Michigan State University

Dave Thompson, MSU Extension, Pork Working Group

If you are not aware of Blockchain you may have heard or invested in Bitcoin. The premise is similar in that both Bitcoin and BlockChain are technologies that are traceable and immutable. Once the information is entered into an electronic ledger, it cannot be erased.

Dr. Candace Croney and others have emphasized that consumers are looking for greater transparency in food production. Consumers want to know that their food is safe, high in nutrients, humanely raised with minimal use of antibiotics/hormones/GMOs/carbon footprint and grown locally. Bill Gutrich, senior director of global food industry engagement at Elanco stated "…we should be in a positive posture, not constantly defending". He notes the importance of understanding both that people buy the "why" we raise pork and recommends to producers to "determine the most important attributes of our product and then market that brand…".

BlockChain definition and brief historical

Most press has focused on potential applications in banking and e-commerce (e.g., BitCoin)… but there are many others at various stages of development/implementation, including several food chains. BlockChain is an immutable (irreversible and permanent) electronic ledger which allows information to be stored and shared among permitted stakeholders. Please see our interpretation in Figure 1 shown on page 11.

BlockChain applications in the food industry

IBM Food Trust is a partnership with Walmart for food transparency, food safety and reduced food waste. Its importance included a reduced time to investigate the origin of food borne illness. Walmart reduced the time required to track food-born illness (for mangoes) from 6 days to 2.5 seconds! In addition, when they identified a food safety issue in leafy vegetables, they were able, through blockchain, to track contamination to a specific field, rather than wasting an entire load or day of processing, and reducing food waste. Key elements of this BlockChain strategy: provenance (where came from), traceability (whose hands did it cross), trust (disease free) and efficiency (fast, no paper). If the consumers' "why" is food safety and reduced food waste, Walmart has an immutable story.

BeefChain, initiative by Wyoming Beef Task Force, is the first blockchain company to receive certification from USDA as a Process Verified Program (PVP) –programs in line with current USDA regulatory compliance. Started by a group of Wyoming beef producers who wanted to add value, in the form of information, to their product, BeefChain includes two certified programs. First is "BeefChain Natural" which fits with the definition of "Natural" program, no antibiotics or hormones, plus grass-fed. The second program is "BeefChain Wyoming Plus" which relates to age and source verification. Using GPS technology and individual cattle identification, they are able to verify the cattle are pasture-raised. As per traceability, the BeefChain allows producers to take advantage of production benefits to improve margins. In his blog, Benjamin Pirus notes, a calf born in Wyoming, can be finished in a California feed yard as long as the yard is certified by BeefChain. The ultimate goal of BeefChain is to combine traceability with a digital record of health and digital marketplace


USDA

CERTIFICATE OF CONFORMANCE

United States Department of Agriculture

Agricultural Marketing Service

Livestock and Poultry Program

Certifies that:

BeefChain, LLC

Cheyenne, Wyoming, U.S.A.

has met the requirements of the

USDA Process Verified Program

and is entitled to market products as "USDA Process Verified" for the scope of

Provide an objective foundation for monitoring and verification for the certification of cattle for client beef producers/feeders to meet:

- **Specific USDA Beef Program(s) requirements: Source and Age Verification (SAV), Non-Hormone Treated Cattle (NHTC).**
- **BeefChain Natural requirements: Cattle are raised without the use of any hormones, antibiotics, animal byproducts, or ionophores, and cattle must be pastured raised and/or on natural forage for 90% of the time for the first 6 months of life as verified by records and/or GPS devices.**
- **BeefChain Wyoming+ - calves are born and raised in the state of Wyoming, as verified by records and/or GPS devices.**

as described in the

BeefChain LLC Process Verified Program Manual

Certificate No: PV9086AJA
Issue Date: April 09, 2019
Renewal Date: October 09, 2019

USDA PROCESS VERIFIED

Steve Ross, Program Manager
Quality Assessment Division
Livestock and Poultry Program
Agricultural Marketing Service

This certificate is receivable by all officers of all courts of the United States as prima facie evidence of the truth of the statements therein contained. This certificate does not excuse failure to comply with any of the regulatory laws enforced by the United States Department of Agriculture (USDA).

The USDA is an equal opportunity provider, employer, and lender.

QAD 1001 Certificate May 25, 2018

for ranchers to tell their story while allowing a premium price for product.

Andy Brudtkuhl, National Pork Board, shares strategic thinking around BlockChain as an enabling component of its WE CARE℠ framework, underpinning the stated 6 principles guiding U.S. pork production with a business to business focus on transparency and food safety. https://m.youtube.com/watch?v=N6Bc-qlIHwI

Conclusions

Adoption of blockchain technologies by U.S. pork producers, distributors and even consumers is already well underway. Exposés such as the animal abuse scandals, tend to paint food animal production in one stroke. BlockChain can provide immutable proof of our "why" based on the We Care℠ Principles.

We wonder, following examples of BeefChain, if there are good opportunities for producers to share their "why" directly with consumers. A producer's value statement might include a multigenerational family farm raising pigs with high welfare and environmental standards. Or perhaps the intersection between the producer and consumer are more closely aligned with cultural and religious values.

We are enthralled with the possibilities and expectations of Blockchain for pork producers and for emphasizing trust in our product. BlockChain can provide proof and trust in food based on the We Care℠ Principles.

For more information please see:

Candace Croney - https://www.purdue.edu/vet/CAWS/

Bill Gutrich – A seat at the Table - https://www.youtube.com/watch?v=TBv3lhlsfpg

Walmart - https://www.ibm.com/blockchain/solutions/food-trust

BeefChain - https://beefchain.com/

MICHIGAN STATE UNIVERSITY | Extension

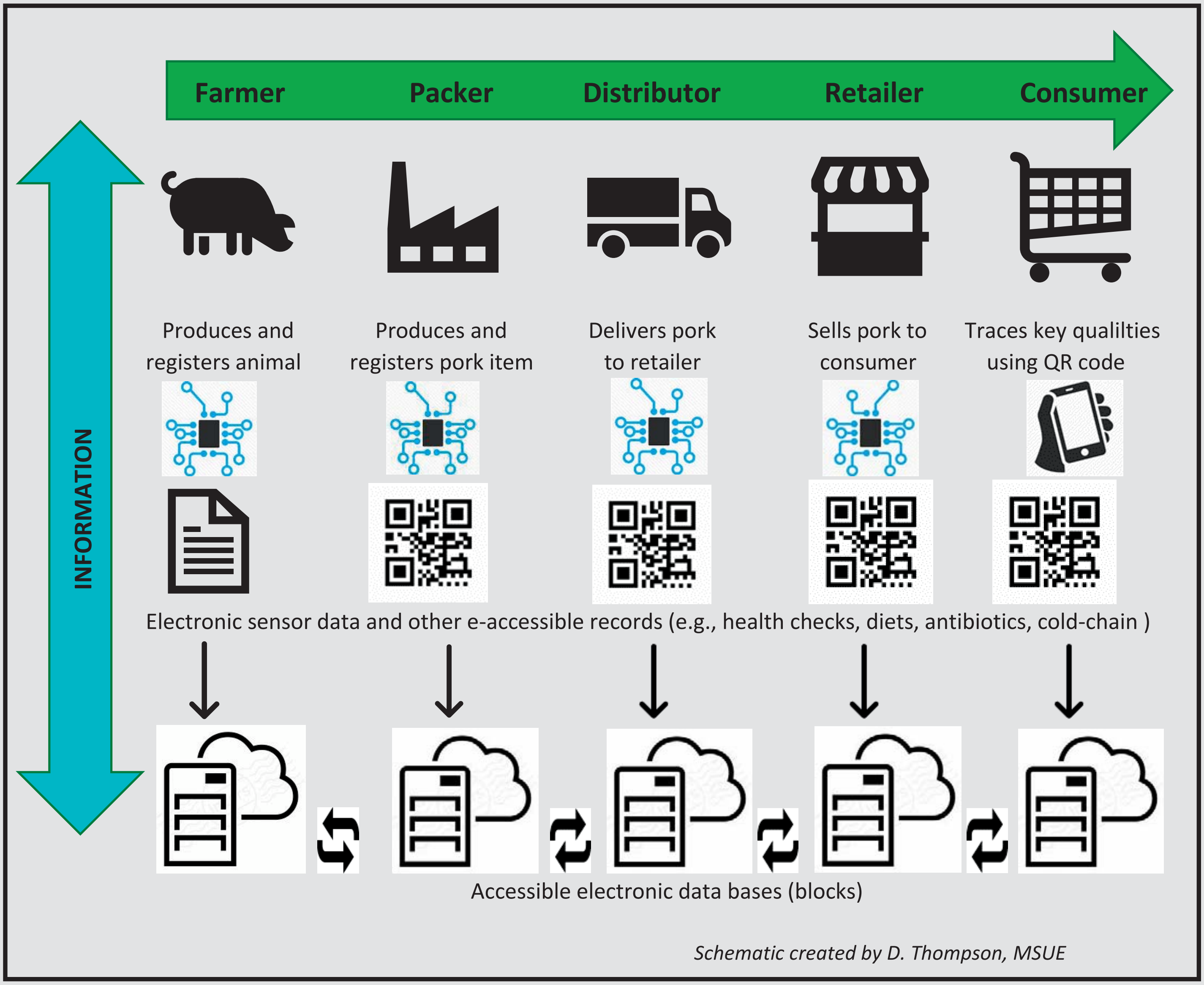


Figure 1. Global Pork Supply Chain depicting origin, storage and flow of information as pork products move from the farm and through processing and distribution channels to consumers. Consumers would generally enter the blockchain (information stored in cloud-based platforms) using their hand-held devices (ie SmartPhones) that recognize quick response codes affixed to the package of pork. Information accessible to consumers in the pork blockchain might include antibiotics administered to pig, farm environmental policy/record, packer and retailer food safety record. It might also include specific meat quality information, such as fat, protein or salt content. It might include a record of the farm's value statement.

All comments and suggestions should be directed to the:

MSU Pork Team

Dale Rozeboom: Extension Specialist
(517) 355-8398, *rozeboom@msu.edu*

Madonna Benjamin: Extension Swine Vet
(517) 614-8875, *gemus@cvm.msu.edu*

Melissa Millerick-May: MSU, Division of Occupational and Environmental Medicine
(517) 432-0707, *melissa.may@hc.msu.edu*

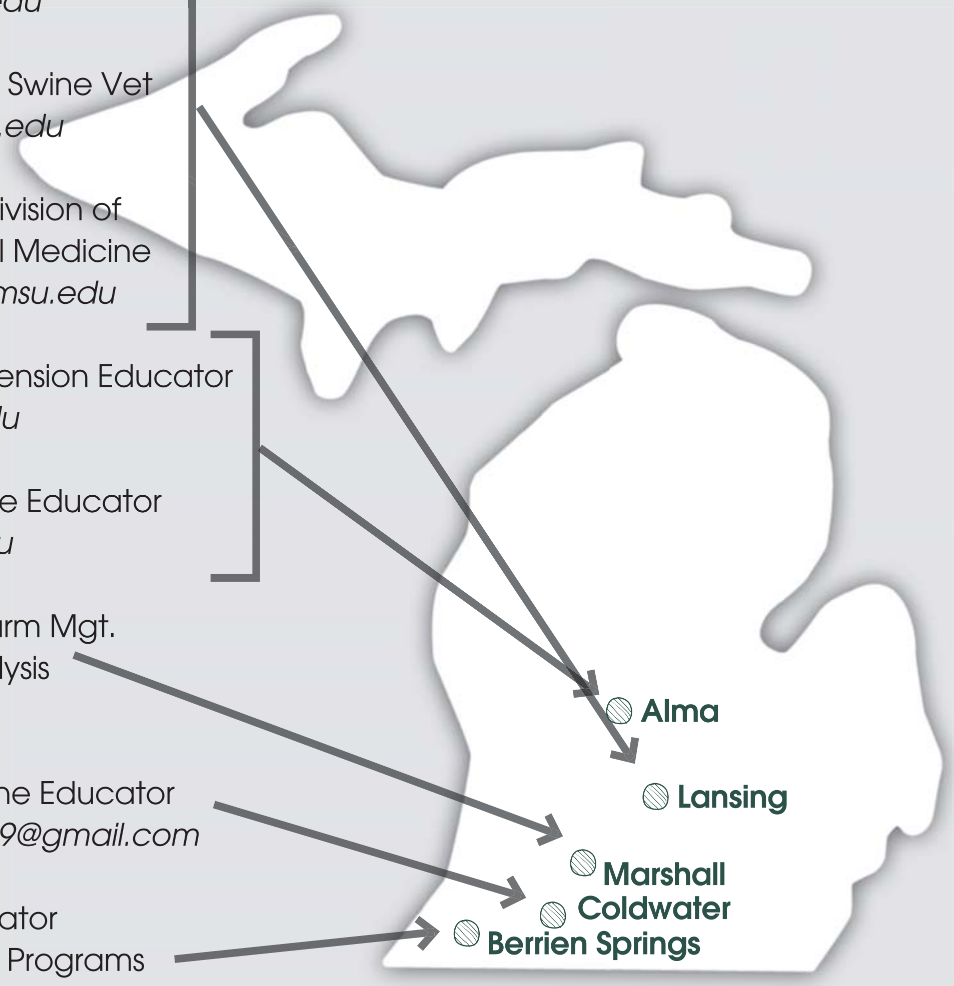
Erica Rogers: Environmental Extension Educator
(989) 875-5296, roger392@msu.edu

Casey Zangaro: Extension Swine Educator
(989) 875-5292, zangaro@msu.edu

Roger Betz: Southwest District Farm Mgt.
Finance, Cash Flow, Business Analysis
(269) 781-0784, *betz@msu.edu*

Dave Thompson: Extension Swine Educator
(269) 832-8403, davethompson729@gmail.com

Beth Ferry: Southwest Pork Educator
Management, Quality Assurance Programs
(269) 876-2745, *franzeli@msu.edu*



Sign Up for the Latest News for Agriculture

Want to stay updated on various MSU Extension topics? Sign up for news digests online! Visit bit.ly/MSUENews, and follow the prompts to get customized email digests. Digests are electronic newsletters of recent articles published on the MSU Extension website. You can unsubscribe or change your areas of interest anytime. The digests contain information on categories including agriculture, business, community, family, food and health, lawn and garden, 4-H and youth, and natural resources. Each category has multiple subcategories, so subscribers can narrow down their choices to fit their specific interests.