HIGHLIGHTING RESEARCH
AND OUTREACH EFFORTS AT
THE UNIVERSITY OF KENTUCKY

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ESR

Equine Science Review is a monthly College of Agriculture, Food and Environment newsletter that highlights important equine work happening at the University of Kentucky.

Photo courtesy Jimmy Henning, PhD, extension professor, Plant and Soil Sciences

HARNESSING THE POWER OF BIG DATA HOLDS PROMISE FOR EQUINE PRECISION MEDICINE

It might seem a paradox. By starting with an enormous amount of data, data sets so large they can only be explored via supercomputers, there is now the possibility of customized medicine precisely tailored to a single, individual horse.

This innovation in equine medicine follows the work that has been going on in human medicine. It is built on the foundation of the first whole-genomic DNA sequence of the horse, called the Equine Reference Genome, an accomplishment widely considered to be one of the most important in equine science to date.

Behind the computer screens, finding patterns in the hundreds of terabytes of data generated through genetic and genomic studies on the horse, is Ted Kalbfleisch, PhD, associate professor at the University of Kentucky's Gluck Equine Research Center.

Kalbfleisch specializes in bioinformatics, an interdisciplinary field that combines biology, computer science, information science, mathematics and statistics to analyze and interpret biological data. The growing need for and promise of that interpretation is why Kalbfleisch's name appears next to the researchers leading several of the studies currently being done at the Gluck Center that have a genetic or genomic component to them. (Genomics is the study of all the DNA, or the genome, including genes and interactions of those genes with each other and the horse's environment.)

"Those reference genomes are the foundation of nearly all genetic and genomic work that is being done in horses, and in fact, across nearly all human health related organisms and agricultural species. The reference genomes that have emerged in the last decade have been transformative in the way we do science," he said. "The word unprecedented is thrown around a lot these days, but to be clear, the revolution that assembled genomes have driven in health science is truly without precedent in any other field of science. All that said, these are still very early days in this new era."

PHOTO CREDIT: PHOTOS.COM.

According to Kalbfleisch, the ultimate objective of using "big data" and the promise it holds for equine health outcomes is what is being called "precision medicine" in clinical applications with both human and veterinary patients.

He said he looks at it this way, "Given everything that can be known about an animal, its genome, the genomes of the bacteria working away in the animal's gut, what can we do specifically for that animal to increase the odds that it lives a healthy, productive life? And if it does become ill, what can we do to make certain the treatment is tailored to that animal to ensure recovery without side effects, or other collateral damage?"

In a chapter he and James MacLeod, VMD, PhD, John S. and Elizabeth A. Knight chair at the Gluck Center and director of UK Ag Equine Programs, co-wrote for a recently published textbook (*Vet Clin North Am Equine Pract. 2020 Aug;36(2):173-181. doi: 10.1016/j.cveq.2020.04.002*), they explained that the applied aspects of genomics are now coming to fruition in many areas of equine science and veterinary medicine, including the emergence of what they call equine precision P4 medicine: predictive, preventative, personalized and participatory.

An excerpt from that book chapter:

This is the dawn of P4 medicine. Fortunately for horses and the people who care about them, equine science and equine veterinary medicine are well-positioned to participate. Precision medicine, earlier referred to as personalized medicine, is now an established concept that has become a major driver for transformative changes underway in health care and biomedical research. Each individual patient, as opposed to a large group or population of patients, is the focus. This is true for human and veterinary patients, including prophylactic, diagnostic, therapeutic and patient monitoring applications.

Shifting the emphasis of health care from treating disease (reaction) to maintaining health (prevention), or at least balancing these relationships, is a foundation of the changes underway.

THE EQUINE GENOME

The first version of the human reference genome was published at the beginning of 2000. This achievement took approximately 10 years, the efforts of hundreds of scientists and a global investment of several billions of dollars to complete.

A horse has 31 pairs of autosomal chromosomes, half coming from the sire and the other half from the dam. Each horse's genome has about 2.5 billion bases of DNA. The first whole genomic DNA sequence of the horse, a map of the DNA of a Thoroughbred mare named Twilight, was completed in 2007 and published in 2009. This achievement included contributions from MacLeod and Ernest Bailey, PhD, professor at the Gluck Center. In 2014, the equine genomics research community began a project to improve the reference sequence for the horse, a project led by Kalbfleisch that included contributions from MacLeod and Bailey.

By re-analyzing DNA from the original horse reference genome, scientists generated a more than tenfold increase in data and types of data to correct thousands of errors in the original sequence. In the years since the first equine genome was published, costs associated with generating genome sequences have also seen a change. Now, for around $1,000 and the appropriate computer software and expertise, a genome sequence can be generated for an animal. This means that equine scientists and veterinarians could soon be able to fully and routinely sequence and analyze the genomes of horses in research and clinical settings.

SOME OF THE LESS COMPLEX GENE-PHENOTYPE DISEASE RELATIONSHIPS ARE ALREADY WELL UNDERSTOOD. IN OTHER WORDS, PRECISION MEDICINE IS UPON US.

According to Kalbfleisch and MacLeod, the possibilities now exist that in the coming years, we will likely be able to predict simple and complex phenotypes, or physical characteristics that may take years to express themselves, while adjusting management and other environmental variables to minimize or even avoid the impact of disease predispositions. Some of the less complex gene-phenotype disease relationships are already well understood. In other words, precision medicine is upon us.

THE FIRST WHOLE EQUINE GENOMIC DNA SEQUENCE WAS COMPLETED ON A THOROUGHBRED MARE, TWILIGHT, FROM CORNELL UNIVERSITY. PHOTO COURTESY DR. DOUG ATCZAK.

WHAT IS BIG DATA?

The amount of information created through these studies and by the creation of a genome is enormous. This "big data" and finding patterns in that data is where Kalbfleisch comes in.

He explains the progression of in-formation and the ability to analyze that information.

"Since the late 1990s, the way research is done has been turned a bit on its head," he said. "We used to ask very specific questions when we would perform measurements to study the molecular biology of living systems. With the limited information we had with respect to the genome, it was difficult to design assays (analyses done to determine the genomic composition of something) that were both sensitive and specific enough to provide the answers needed, but scientists persevered."

Kalbfleisch said that the technology that allowed researchers to study tens of thousands of genes at once and the data necessary to design the research questions on those data was coming online during that time.

"Now instead of generating a handful of data points, we were generating hundreds of thousands of data points. And then we weren't simply asking questions about how one gene might behave, but how it and a network of other genes might cooperate in a pathway that drives biological function," he said. "All of a sudden our notebooks were insufficient, and we needed big disk drives for storage, and big computers to analyze all of this data. About 10 years later, things got more interesting still when we could sequence genomes and transcriptomes in a completely unbiased fashion. At this point, we began generating billions of datapoints to pose even the most routine of research questions.

"Any sensible person would ask, 'When specific questions worked so well for so long, why spend time and money to generate and deal with all of this data, most

of which you won't need?' It turns out that it is often less expensive, nearly always faster and always more accurate to generate all of the data than to try to query specific bits of it in the context of a research study," he said. "And although it is true that much of the data is irrelevant to what is ultimately found to be the answer to the research question at hand, going into the project, we usually have no idea what subset of the data the important bits will be. We know a lot, but what we don't know dwarfs what we do. And, as important, all of these data are still biologically information rich, and are an incredible resource when made available to the research community through public repositories."

When asked just how big a change "big data" has brought, Kalbfleisch explained, "I've heard it said that the entire recorded history of mankind, up through the year 2000, would have fit into about a terabyte of storage. Now, just about any research project in genetics or genomics will generate at least that much, if not a lot more. My research program alone has 300 terabytes of storage to manage the data my collaborators and I generate. Although it might sound daunting, what has emerged over the last decade in terms of computing power, storage capacity and sophisticated algorithms capable of analyzing all of this data has exceeded our demands. As a result, given a well-defined research question with high quality samples, it is a relatively straightforward process to winnow from these vast quantities of data the information we need to understand the molecular biology of these magnificent animals."

WHAT ARE SOME SPECIFIC AREAS OF PROMISE USING THIS DATA FOR EQUINE MEDICINE?

There are many applications for matching the genetic information found in all this data with the specific medical treatment needed for a single horse. Kalbfleisch outlined a few examples, "Some relatively low hanging fruit one could imagine are more precise targeting of antibiotics. If, for example, you could know for certain what strain of bacteria was making your horse sick and you could avoid using an antibiotic to which that strain of bacteria was known to be resistant, that would be a very good thing. If you could identify a gene or genes that were transcribed at high levels when a horse was experiencing an unhealthy level of stress on bones or joints, you could opt to rest it until it was healthy. If you know of a particular bad trait that runs in a pedigree, you could look at the genomes of affected and unaffected individuals in the pedigree and identify the genetic component responsible for the trait, and in turn make herd management decisions based on whether or not a horse had the genotype for the trait."

It's a statistical tool that Kalbfleisch said is a bit like playing a game of "one of these things is not like the other" to determine what traits a population has in common and the traits that might be missing or rare in another population.

ENSURING GENETIC DIVERSITY IN THE DATA

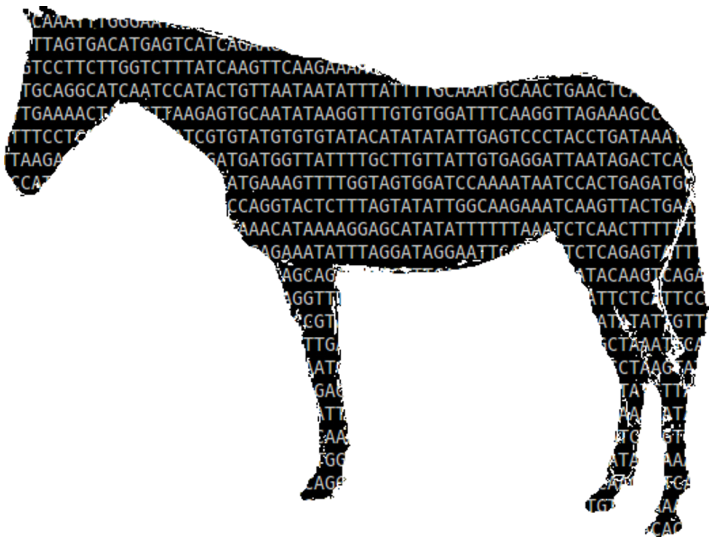
One thing Kalbfleisch has been working to improve in the area of genome resources is to add in more genetic diversity. Consider that the Equine Reference Genome is based on a Thoroughbred mare from Cornell named Twilight.

According to Kalbfleisch, the reference works very well for Thoroughbreds and other breeds close to the Thoroughbred but has deficiencies when it comes to other breeds of horses that are more distant.

"The fact that these other breeds aren't well served by the Twilight reference is a serious problem since many of these differences are likely the very genetic components that distinguish these breeds from the Thoroughbred and, as such, are essential to understand if you hope to do genetic research on them," he said. "The single reference for the horse is analogous the Model T in cars. And much as with the automobile industry, in the near future, we will begin to see a proliferation of new and varied genomes such that ultimately each major breed has its own. It will be difficult for the research community to manage all of this, but as technologies and our computing infrastructures become more powerful, it is certain that these new resources will make it possible for us to better understand the genetic basis of health in horses."

He and colleagues are now working to collect samples to catalog genetic diversity across North American Thoroughbreds.

"Genetic diversity is important in any species or breed, and very little is known with respect to the population structure of this wonderful breed. We are working



GRAPHIC COURTESY DRS. JAMES MACLEOD AND MATT HESTAND.

to collect samples from as many animals as possible and will begin by fully sequencing the genomes of as many as 100 of them. As resources become available, we will work to analyze as many of the samples as possible so we have an understanding of what the population structure is now so that we can monitor how genetic diversity changes over time," he said.

PANDORA'S BOX?

When it comes to genetic studies, there's also sometimes a concern by horse owners and breeders that DNA tests will reveal that a bloodline or particular valued horse has a bad genetic variant (one of two or more versions of a gene). If so, does that mean they shouldn't breed that animal?

Actually, genetic testing may provide more opportunities than problems for breeders. First, when a stallion is suspected of harboring a deleterious genetic trait, breeders will shun that stallion (unless his offspring are great runners!). However, genetic testing can exonerate the reputation of a suspect stallion. Second, if a stallion is found to carry a genetic variant that is undesirable, breeders can use genetic tests to design matings and produce offspring in a manner to avoid the deleterious trait.

This is the way that Arabian horse breeders approached the discovery of the recessive deleterious variant causing the disease severe combined immunodeficiency (SCID) in Arabian horses. Once a test was invented, they could have culled all carriers. However, the carriers presumably had a lot of good genetic variants. With the use of the test, it was possible to avoid matings that produced SCID and even purchase offspring from SCID carriers that could be certified as free of SCID.

The role of genetics research and genetic testing is to provide breeders with useful information that allows them to make informed decisions about breeding. Genomic research can turn genetics from a black box into a useful tool.

Kalbfleisch also reiterated that researchers work hard to maintain confidentiality of the specific horse genetic information they work with because they do recognize the concerns horse owners and breeders have.

Partnerships with the industry are important

On Kalbfleisch's wish list for more data? He said it would be to engage more productively with producers and with veterinarians in order to build a conduit for research to help with the problems people have. Having access to samples and really good phenotype information is key.

EXCITEMENT ABOUT WHAT THE FUTURE HOLDS

When asked what excites him about his research, Kalbfleisch was quick to respond. "We know the genome of the horse and where the genes are and much about what they do. The cell doesn't know anything about any of that. It just functions. It reacts according to the physical and chemical laws that govern everything else. What I'd like to do is to move all of this to where we're no longer applying these biological or biochemical rules, but to where we're just using more simple physics and chemistry. And just see how a cell is going to behave when it has a genome that looks like your horse's," he said.

"It's just the opportunity to fill in all of those blanks, all this stuff that we don't know. Maybe not in 10 years, but in my lifetime. That's exciting," he said.

| Holly Wiemers, MA, APR, is the communications and managing director for UK Ag Equine Programs.

EQUINE INNOVATORS: RACETRACK SURFACES WITH DR. MICK PETERSON

Learn about the science behind creating safe racing surfaces from Mick Peterson, PhD, director of the University of Kentucky's Racetrack Safety Program and faculty member within the Department of Biosystems and Agricultural Engineering.

Properly preparing racetrack surfaces is imperative for horse and jockey safety. It requires selecting the right materials, monitoring moisture content, watching the weather and finely tuned maintenance from a highly trained crew. In this Equine Innovators podcast, we talk to Peterson. As a bioengineer, he and his team studies how horses interact with track surfaces to help improve safety and performance. They also monitor tracks throughout the United States.

This podcast is the fourth episode in our "Equine Innovators" podcast series, brought to you by Zoetis. You can find the Equine Innovators podcast on TheHorse.com, Apple Podcasts, Spotify, Stitcher and Google Podcast. *Source: TheHorse.com*

ROOTS: BUILDING HEALTHIER PASTURES FROM THE GROUND UP

Horse owners and horse farm managers often think of pastures starting at the soil and representing all the biomass seen above the soil. But truly healthy pastures also have a rich network of roots below the surface. Astute mangers consider these when making management decisions. The roots of pasture grasses and legumes serve many functions: retrieving nutrients, holding soil in place during wet weather, housing a host of beneficial microbes and storing carbohydrates and minerals to support regrowth and overwintering.

If you buy into the phrase, "no hoof, no horse," consider that a similar phrase, "no roots, no pasture," is also accurate.

GRAPHIC: PLANTS THAT ARE MAINTAINED SHORT WILL HAVE LESS ROOT VOLUME AND THEREFORE WILL BE MORE SUSCEPTIBLE TO DROUGHT AND OTHER STRESSES (LEFT), WHILE PASTURES MAINTAINED IN A TALLER, LEAFY STATE WILL HAVE A MORE ROBUST ROOT SYSTEM ABLE TO CARRY THE PLANT THROUGH PERIODS OF STRESS (RIGHT).

PLANT PHYSIOLOGY 101

We all should know the basic concept of photosynthesis. Plants capture sunlight and use that energy to make sugars from carbon dioxide in the air. These sugars are the source of energy for growth or to store for later use. This energy, in the form of sugars or starch (carbohydrates), is stored at the base of the plant and in the roots and used to regrow leaves when the plant is defoliated by grazing animals, mowing or hay harvesting. Repeated, frequent defoliation will deplete the carbohydrate stores and physically shrink the root system until it lacks the volume to absorb enough nutrients or water to survive. Better management that results in thick and robust roots allows plants to quickly recover after defoliation and to better survive droughts because they are able to reach deeper into the soil in search of water and other nutrients.

Think of the soil surface as a mirror, whatever is growing above it is also what is growing beneath it.

BUILDING GOOD ROOTS FROM THE BEGINNING

When new pastures are being established, it is often recommended to take a hay harvest before the pasture is introduced into the grazing rotation. There is no magic to this recommendation at all, simply that most managers will not cut hay when the grass is only a few inches tall. By waiting for a hay harvest, it gives the plants time to grow tall, and therefore establish deep roots. Keep in mind that once cool season grasses begin to put up a seedhead (elongate), they are no longer using energy to build leaves or roots, because all energy has been diverted to seed production. For this reason, a hay harvest on newly-established pastures should be at the boot to early head stage (just as the seedhead is emerging from the leaf sheath). This will result in lower yield, but higher quality hay, as well as encourage the plants to grow down (roots) and out (new tillers) and form a dense sod.

If you don't want to harvest hay, simply keeping the pasture mowed high will accomplish the same thing. Cool season grass pastures should be allowed to grow to 8-10 inches of leafy growth before grazing. Strategic mowing of new pasture is needed to keep weeds from overshadowing new grasses and to prevent seedheads from forming. Adjust the mower to clip pastures above the new grasses, therefore only removing weeds and seedheads. If pastures are allowed to get too tall and rank (excessive weeds or seedheads) then mowing will cause a thatch layer that can lay on top of new grasses and shade them out. If this is the case, then you may need to use a tedder to spread out the clumps or heavy thatch or remove the excess material as hay.

MANAGING GRAZING FOR GOOD ROOTS

For those of us with established

pastures, we can still have a great effect on root growth by controlling defoliation. This means 1) not mow pastures too frequently or closely and 2) graze rotationally, allowing pastures time to rest and rejuvenate.

Pastures are not lawns or golf courses and shouldn't be managed as such. Mowing should not be dictated by the calendar but instead by the pastures and the needs of the animals grazing on them.

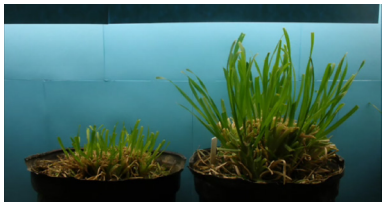
Here are the best times/reasons to mow a pasture:

- When animals have just been rotated off – this is to even out the pasture, so typically mowing around 3-4 inches
- When seedheads are growing - mow high enough to clip the seedheads of grasses or weeds but leave green vegetative material, which will drive regrowth and keep the ground shaded, typically around 8 inches.
- Before seeding – this is to open up the canopy, allowing sunlight to reach the soil surface for new seedlings. In this case, mow as close as possible.

Horses are notorious spot grazers, coming back to the same location to graze again and again while ignoring other areas. This could be because it is near the barn, a buddy in a neighboring pasture, shade or water or just out of habit. Because of this, even low stocked pastures will have some areas that are overgrazed and needing rest. Horse farms are also frequently overstocked, so often pastures are significantly overgrazed. In both cases, giving pastures a rest is vital to maintaining healthy grass and roots. Rest periods are best dictated by forage needs and availability, but a simple two weeks on, two weeks off rotation is a great place to start and will likely still yield many benefits. Pastures will be more resilient if you can maintain a 3 to 4 inch residual height as much of the year as possible, especially during the hotter months.

To demonstrate the effects of rotational vs. continuous grazing, the UK Forage Extension team put together a time lapse video of two orchardgrass plants. One plant was clipped monthly at 3.5 inches to simulate rotational grazing (right) while the other was clipped weekly to 1 inch for four weeks (left) to simulate continuous horse grazing. Five days of regrowth were then captured by video. The plant that was rested for a month with a 3.5-inch residual produced significant regrowth in just five days because it had sufficient root reserves that allowed it to rebound quickly. The continuously grazed plant produced little growth because root reserves were exhausted, and the low cutting height left few leaves to generate new energy. You can view the full video here.

One last thing to consider in root management is soil fertility. If soils are deficient in any required nutrient, the growth of the entire plant will be negatively impacted. Phosphorus is especially important to root growth and development



but is rarely low in soils in Central Kentucky. A soil test can easily determine if phosphorus or other soil amendment is needed. For most pastures, fall nitrogen applications will also boost root growth as nitrogen stimulates grass growth and similarly speeds root growth.

Next time you walk through your pasture, take a moment to consider what you see above ground, and what that suggests exists below.

| Krista Lea, MS, coordinator of the University of Kentucky's Horse Pasture Evaluation Program, and Jimmy Henning, PhD, extension professor in the Department of Plant and Soil Sciences, provided this information.

FORAGE TIMELY TIPS:

- If not already done, soil sample and apply fertilizer as needed.
- Plant perennial grasses and legumes. Consider using a novel endophyte tall fescue.
- Harvest hay as needed. Do NOT harvest alfalfa after mid-September.
- Scout pastures. Identify perennial weeds and woody brush. Consult an agricultural professional to determine the control strategy.
- Closely monitor livestock and do NOT overgraze. Pasture plants accumulate energy reserves in the fall that help them overwinter and regrow in the spring.
- Feed hay to allow pastures to stockpile for winter grazing.
- Rest native warm-season grass fields until after frost for better winter survival.

Source: University of Kentucky Forage News, August 31, 2020

GRADUATE STUDENT SPOTLIGHT: MORGAN PYLES

This month, I had the opportunity to speak with doctoral candidate Morgan Pyles, MS, before she left for her new job. As a graduate research assistant under Laurie Lawrence, PhD, professor in the University of Kentucky's Department of Animal and Food Sciences, Pyles has researched issues related to mare milk composition and foal digestive health. She received two degrees from UK: a Bachelor of Science in equine science and management and Master of Science in animal sciences, specializing in equine nutrition. She will defend her doctoral work shortly and expects to receive her PhD in animal sciences, specializing in equine nutrition.

FIRST, CAN YOU FILL US IN ON YOUR NEW POSITION SO WE CAN CONGRATULATE YOU ON THIS EXCITING NEW PHASE OF YOUR CAREER? I KNOW YOU ARE TEACHING THIS SEMESTER. IS THAT PART OF THE NEW POSITION?

I have accepted an equine science lecturer position at the University of Minnesota, Crookston. The four-year equine program offers a range of equine science and equitation courses. I am teaching a variety of equine classes, including equine exercise physiology, reproduction, horse production and western equitation.

YOU ARE ON TRACK TO RECEIVE THREE DEGREES FROM UK. DID YOU THINK ABOUT GOING ELSEWHERE FOR ONE OF THEM? WERE YOU WORRIED THAT THREE DEGREES FROM THE SAME INSTITUTION WOULD BE A LIMITING FACTOR?

Yes, I will have three degrees from UK. However, before coming to UK, I attended Central Wyoming College, where I obtained an AAS in horse management and two credentials. The equine program in Wyoming was quite different than here at UK and provided diverse experiences for me. Toward the end of my MS, I did consider going elsewhere for my PhD. I was in contact with several other schools and had a wonderful opportunity for a doctoral fellowship at the University of Florida. However, Dr. Lawrence also offered for me to stay with her for my PhD. Deciding where I wanted to spend the next four to five years working toward a PhD is an important decision, and it wasn't mine alone. I have a husband and a son, and they were very important in making that decision as well. Many factors went into my decision to stay at UK. First, I don't think I could find a better mentor to study under than Dr. Lawrence. She has an unending wealth of knowledge and I wanted to learn as much as I could from her. When deciding to start a PhD program, it is very important to be passionate about the research that you are going to be entrenched in for the next several years. I felt I had just barely scratched the surface of my research area with my MS project and was excited about the possibility of continuing my mare and foal research through my PhD program. At about the time I was finishing my MS, our department hired a new assistant professor, Dr. Rachel Schendel, who is an expert in carbohydrates. One of my interests for my PhD research was to investigate carbohydrates in mare milk, and she was just the person. Not only did we have great options and support for doctoral work option at UK, but we also have great support in our personal lives. I went into my PhD with a 3-year-old, so having support was invaluable. My husband's parents live in Kentucky and have been our go-to babysitters over the years when I had research studies, classes and all the business that comes with graduate school.

PHOTO COURTESY MORGAN PYLES.

So together, being able to do the research that I wanted to do, with the mentor that I had and support system available to me, staying at UK was the best option for me and my family.

There are a lot of different opinions on having several degrees from the same institution. I have been fortunate to be able to work in many different labs across the university, including the USDA ARS Microbiology lab, a food science lab, ruminant nutrition lab and Regulatory Services. Being able to collaborate and make connections is important regardless of where you earn your degrees and I think I have been successful in doing just that. I think that if you are productive, involved, actively seek out opportunities to diversify your experiences, then the location of your degree programs is somewhat irrelevant.

PHOTO COURTESY MORGAN PYLES.

IF GRADUATE SCHOOL HADN'T WORKED OUT, DID YOU HAVE A FALLBACK CAREER IN MIND? WHAT WAS IT?

To be honest, not really. I have wanted to teach and be involved in academia since my first TA experience in Wyoming. That was my goal and I was going to work hard until I got there.

HOW DID YOU GET INTERESTED IN EQUINE NUTRITION? HOW DID YOU GET TO WORK IN DR. LAWRENCE'S LAB?

I knew I wanted to get some research experience during my undergrad years and both nutrition and reproduction piqued my interest during my undergraduate program. My undergraduate advisor, Dr. Coleman, connected me with Dr. Ed Squires and the equine reproduction group in the Veterinary Science Department. I was hired as an undergraduate research assistant to primarily help on a stallion study; Dr. Lawrence was a collaborator on the study as it involved a feed supplement. Through that study, I met Dr. Lawrence and when she found out I was looking for a graduate position, she offered me the position. I was very fortunate that I was in the right place at the right time to be able to start my graduate program in Dr. Lawrence's lab. Dr. Lawrence already had the funding for my MS project, which evaluated the effect of starch source on fecal bacteria in mares and their foals. I also conducted an additional study during my MS program that investigated changes in fecal bacteria with probiotic use during an antibiotic challenge. Through my master's program, I really fell in love with nutrition and came to realize that nutrition can have an impact on every other area of equine science.

YOU HAVE 18 PUBLICATIONS TO YOUR CREDIT. WHAT DID YOU LEARN ABOUT THE PROCESS OF WRITING RESEARCH ARTICLES FOR PEER-REVIEWED JOURNALS?

Writing in the sciences takes a lot more time than you think it will take. Reading articles and critically evaluating them is a great way to learn how to write. We have weekly lab meetings where we will present and discuss journal articles. I always learn something by doing this, what to do, not to do, areas that needed more description, etc.

WHAT SURPRISED YOU MOST ABOUT FOLLOWING THIS ACADEMIC PATH? WHAT DID YOU FIND MOST REWARDING?

I really enjoy being with the horses. Most of my research has been with mares and foals, and let me tell you, I have gained a lot of respect for these broodmares. They are tough, resilient and are fighters, putting in time and effort behind the scenes to produce future generations. I love being able to follow the foals that have been on my studies as they are sold at Fasig-Tipton and move on to have great careers!

I also really enjoy sharing my research at various conferences and events. It is so rewarding to see the end result of all of the hard work that went into conducting the study, feeding, collecting samples, lab work and analyzing samples. Putting it all together to tell a story and share that story with others is exciting to me.

WHAT HAVE YOU ENJOYED MOST ABOUT WORKING IN DR. LAWRENCE'S LAB?

The people that I have worked with through Dr. Lawrence's lab are some of the best! Words cannot express how much our lab techs, Susan Hayes and Andrea Crum, mean to me. They have been there through all of the highs and lows of grad school, spending hours and hours at the farm and in the lab. I have really enjoyed the support in Dr. Lawrence's lab. When I started my PhD program, I wanted to analyze milk oligosaccharides in mare milk. No one had done that before at UK and I had the support I needed to help develop and validate the assay.

CAN YOU DESCRIBE WHAT YOUR ACTUAL WORK AS A DOCTORAL CANDIDATE WAS LIKE SO READERS HAVE AN IDEA OF WHAT YOU DID ON A DAILY OR WEEKLY BASIS?

It was quite varied, as expected, depending on where I was in my program. I was taking classes each fall and spring semester during the first two years of my PhD program. The classes I took were decided upon by through discussions with Dr. Lawrence and my PhD advisory committee and included classes in animal science,

statistics, teaching and biochemistry, among others.

My research was with mares and foals; therefore, my studies were pretty much scheduled for me. Mares are having foals in the spring whether I was ready or not. During research studies, the graduate student is responsible for the care of those horses, meaning I was there morning and afternoon, every day, for the duration of the study to feed, sample and care for the horses. I would sample foals throughout their first month after birth, so my studies typically ran from about February to June. Some of the samples that I collected involved fecal samples from foals. We found out that foals do not defecate very frequently in their early days, thus I have spent countless hours watching and waiting for foal feces! All the while, I was still taking classes. I knew from the beginning of my graduate career that I wanted to eventually have a teaching component to my career. Because of that, I sought out opportunities to serve as a TA or guest lecture when I could. About two years into my PhD program, I took my qualifying exams, and was done with classes. For the past two years I have continued with research projects, lab work, presenting and writing. I also was hired as an adjunct faculty at Georgetown College to teach an animal nutrition course in 2018.

In summary, my responsibilities as a grad student included taking classes, conducting research (feeding and caring for the horses and sampling), analyzing samples in the lab, teaching/helping with classes and presenting research findings at conferences.

YOU HAVE DONE A LOT OF RESEARCH ON MARES AND FOALS. WHICH DO YOU PREFER TO WORK WITH, AND WHY?

Watching foals grow and develop is very satisfying to me. Through my research, we are trying to figure out what is going on in their little gut and how to keep these foals as healthy as can be. I love that my research focuses on trying to improve the health of the foal by understanding the factors that may predispose them to developing gastrointestinal upsets.

PHOTOS COURTESY MORGAN PYLES.

WHAT ARE SOME OF YOUR PLANS FOR THE COMING YEAR(S), EITHER IN THE LAB/SCHOOL, WITH YOUR HORSE OR PERSONALLY?

Getting settled into Minnesota. I am really excited to get involved in the equine industry in Minnesota. I am hoping to get back to competing on my horses, hopefully get back to rodeoing and some reined cow horse shows.

NOW THAT YOU ARE FINISHED WITH YOUR DOCTORAL WORK, DO YOU THINK YOUR LIFE WILL SLOW DOWN A LITTLE? WHAT ARE YOU LOOKING FORWARD TO DOING MOST NOW THAT YOU ARE ALMOST DONE?

Well, I am still finishing up writing my dissertation and will be doing that remotely while teaching in Minnesota. I am planning to defend within the next six months. So no, I don't think things will slow down quite yet with starting a job while finishing up my dissertation. But when I was contacted about this position, I couldn't pass up the opportunity for a great job, especially during these difficult times.

I do have two horses. One is somewhat retired, the other I have been able to ride through graduate school, but not quite as much as I would like. Before coming to Kentucky, I roped, barrel raced and started in reined cow horse shows.

I UNDERSTAND YOU ARE INVOLVED IN THE EQUINE ALUMNI AFFILIATE NETWORK. CAN YOU TELL ME ABOUT THAT EXPERIENCE?

I have been involved with this alumni group for the past four years. We started out just as a small group of a few alums that Kristen Wilson had organized to help plan a tailgate at Rolex. We had so much fun doing that, and we saw the need to continue organizing events and activities to bring together alumni from UK's equine undergraduate program. I have been part of the executive committee as the secretary since its inauguration, and we became an official alumni affiliate network in 2019. We have such wonderful alums serving on our board of directors, and we have been able to accomplish such great things in the few years we have been together. I have really enjoyed the experience and will continue to serve as the secretary. I see it as a way to give back to the program that has done so much for me.

| *Karin Pekarchik, MS, senior extension associate for distance learning and founder of the UK Female Equestrian Health and Wellness Community of Practice, provided this information.*

WANTED DEAD OR ALIVE – DOES PCR SUPERSEDE TRADITIONAL TECHNIQUES?

As we discussed in a previous issue (PCR – what's behind this commonly used acronym?) PCR, or the polymerase chain reaction, is an incredibly sensitive technique to detect DNA. The technique is used for parentage testing, in forensic science and is heavily relied upon in medical testing to diagnose diseases, such as those caused by bacteria and viruses.

Our desire for rapid and sensitive tests to diagnose infections has pushed us to expand the number of PCR tests available and validated for use. As we discussed before, PCR can be performed in a matter of hours, whereas other techniques can take days to weeks. So why do we even need to retain the more traditional techniques at all when we have this amazing modern age method in our toolkit?

Well, as anyone who has watched a crime show on TV can tell you, DNA is a very stable molecule and can be detected easily with modern PCR techniques. This can lead to minute traces of DNA being enough to find the culprit of the crime, but is it as accurate when we are looking for the culprit responsible for disease in an animal?

There are a few factors to consider here. The first factor is the incredible stability of the DNA molecule. DNA fragments can exist in the environment for some time and can still be detected via PCR testing *if* the fragment corresponds the right primer sequence added to the reagent mix as we discussed in the previous article. That brings us to our next considerations. Since we use short (~20 nucleotide) sequences unique enough to identify a specific bacteria or virus, how do we know if these sequences come from a fragment of the genome of interest or the presence of the whole genome? Additionally, do we know if that bacterium is still viable and capable of replicating and causing disease? The answers are not clear cut.

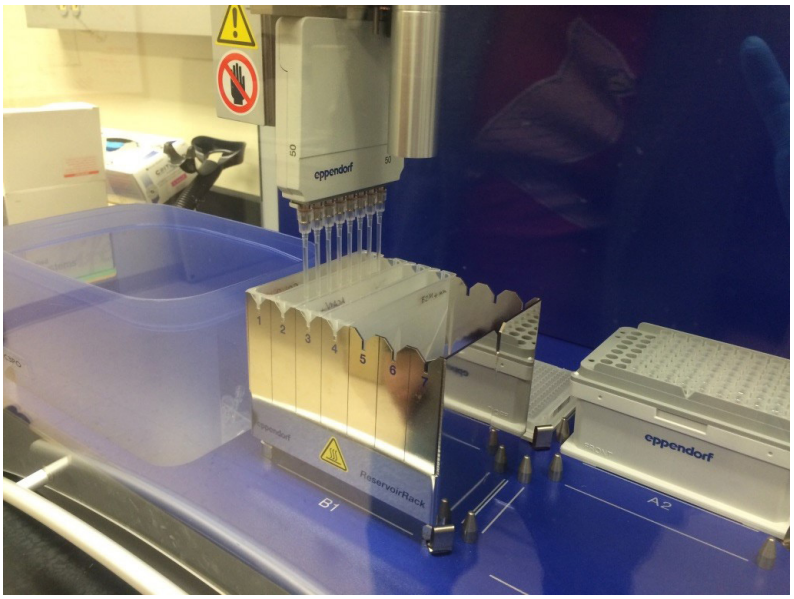


PHOTO COURTESY DR. EMMA ADAM.

Bacteria and viruses can survive in the environment and remain viable for variable periods of time depending on conditions and the veracity of the agent itself. Viruses are obligate intracellular pathogens and, as a result of that, virus isolation techniques are quite involved but do remain the 'gold standard.' Techniques to isolate viruses require special lab equipment, skilled staff and can take days to weeks, even when there is considerable knowledge on how to culture that particular virus.

Bacteria have traditionally been considered easier to culture in the lab and we have a long history of research that has generated knowledge on how to grow certain types of bacteria, prevent overgrowth of fastidious bacteria by those that grow easily *in vitro* and so on. Bacteria can be difficult to grow if the animal has received antibiotics, present in small numbers and easily overgrown by other bacteria in the sample or prefers conditions that we don't yet understand or replicate *in vitro*. As such, whilst culturing bacteria is a more accessible and quicker process than it might be with viruses, it's not without issues. That said, the ability to demonstrate bacterial growth from a sample is the ultimate demonstration that the bacteria are present, viable and can replicate, making culture still the 'gold standard.'

Let us consider two real world scenarios. *Streptococcus equi* subspecies *equi*, the causative agent of 'strangles' is not a commensal

organism (a relationship in which one organism derives food or other benefits from another organism without hurting or helping it) and it is always considered a pathogen when identified by culture or PCR. A PCR test was performed on a mare entering a herd to make sure she was not a carrier of this dangerous organism. The test involved flushing sterile saline into her guttural pouches and catching it in a sterile cup as it ran out of her nostrils. This is a pretty standard technique that allows the saline to interact with the guttural pouch, pharynx and nasal passages. The PCR test came back positive, so the mare was examined and cultures were performed. These cultures turned out to be repeatedly negative, but the washes from her nose were positive on PCR. At a loss, finally the equipment was tested and it became apparent that the farm's rope twitch was the source of the *Streptococcus equi* subspecies *equi* DNA. Biosecurity and disinfection measures were adjusted, and all was well. Not only does this demonstrate the sensitivity of PCR, but also the importance of using more than one testing modality (as well as a reminder about biosecurity being of paramount importance!)

A second scenario relates to the presentation of a placenta to the University of Kentucky Veterinary Diagnostic Laboratory that was thought to have an infection caused by a group of organisms collectively termed 'nocardioform bacteria.' The placenta had the characteristic physical changes seen in this disease process, the mare had had all the clinical signs consistent with the disease as diagnosed by her veterinarian and the microscopic exam of the tissues were also consistent with the diagnosis. However, nocardioform organisms could not be grown from the placental tissue. The placental sample was positive on PCR testing, however. So how did this occur when everything pointed to the bacterial infection? The deduction was that because the mare had received antibiotics, the bacteria were either dead or inhibited from growing in culture. We don't know for sure, but this example is one seen in many situations where antibiotic therapy has been instituted and bacteria cannot be cultured.

These examples and considerations make it hugely important that we maintain and support labs capable of using advanced techniques to get to the bottom of such issues. Fortunately, we have the resources offered by UK's Veterinary Diagnostic Laboratory and Gluck Equine Research Center, as well as the clinical expertise of our veterinary community, to ensure we get the best answers possible for our equine population. Each test and each examination are a piece of the jigsaw puzzle that we try to put together to understand disease. It is rare that one single test will deliver the answers 100% of the time.

| Emma Adam, DVM, PhD, DACVIM, DACVS, based at UK's Gluck Center and Veterinary Diagnostic Lab, is responsible for research and serves as veterinary industry liaison. Jackie Smith, MSc, PhD, MACE, Dipl AVES, is an epidemiologist based at the UK Veterinary Diagnostic Lab.

UK AG EQUINE PROGRAMS LAUNCHES NEW WEBSITE

UK Ag Equine Programs unveiled a new website this month, coinciding with the start of a new semester.

The updated site includes increased functionality and resources for students, horse owners and industry professionals. Visit https://equine.ca.uky.edu/ to see what's new!

University of Kentucky
Ag Equine Programs
College of Agriculture, Food and Environment

UNDERGRAD RESEARCH PROJECT STUDIES HORSES' INCLINATION TO SEEK SHADE AT CERTAIN TEMPS AND TIMES OF DAY IN CENTRAL KENTUCKY

In the last Equine Science Review, an undergraduate independent research project that examined shade seeking behavior in Texas was discussed. A similar study was done in Central Kentucky by Kassie Rutherford, an undergraduate equine junior at the University of Kentucky. Rutherford completed an independent research project observing horses in Midway, Kentucky. She also worked with Camie Heleski, PhD, senior lecturer within the equine undergraduate degree program, on a quest to learn more about horses' desire to seek shade during different times of the day.

Rutherford conducted this research primarily at Heronwood Farm and surrounding facilities because of their wide array of breeds, ages and disciplines.

"Right now I'm still on my horse, and I'm looking at two horses that belong to a racehorse trainer, two other horses that belong to the owner and I'm looking at a different property with mares and foals. That's what was so great about where I was at, because I could collect information while I rode," Rutherford said.

"I loved how Kassie incorporated her data collection into moving around the farm, sometimes exercising her horses simultaneously," Heleski said. "She was really diligent about entering the data into her cell phone so she could do both."

During her project, Rutherford observed at what point of the day was it hot enough for horses to seek out shade. This was to establish if there were temperature or time of day patterns. Like Underwood in the Texas study, Rutherford was interested in seeing if the horses would seek shade in temperatures greater than 85 degrees Fahrenheit.

PHOTO COURTESY KASSIE RUTHERFORD.

"Some of it was a pattern, but I think it had a lot to do with where the sun was, what the actual UV-Index was and if there were clouds covering the sun. Because even in the morning when it was full sun, they were almost never in the shelter," Rutherford said.

PHOTO COURTESY KASSIE RUTHERFORD.

When asked about her findings, she said that she believed it wasn't necessarily due to the positioning of the sun in the sky, but more so the hottest point of the day.

"What I found was that it wasn't where the sun was the highest in the sky, it was actually the hottest part of the day, which is typically, from what I found, between 3 to 6 p.m. It was between those times that the horses started to seek out shelter," Rutherford said.

"This echoes my casual observations over the summer," Heleski said. "Kassie seemed to see that sometimes it also had a lot to do with the group dynamics of the herd on a per pasture basis; sometimes it seemed that the heat was eliciting shade seeking behavior in one pasture, but just one pasture over, it might be that none of the horses were seeking shade."

Rutherford was also interested in learning if there was a preference in types of shade. For example, if horses would seek out manmade shelter versus trees, and

PHOTO COURTESY KASSIE RUTHERFORD.

what the difference between those might be.

"I would walk out to my horses' field and I would stand in the shelter with a thermometer, and there were several days that it was 8-10 degrees hotter within the shelter, even though it was shady. So then, they would rather stand under tree shade because of the breeze and the fresh air that they got that was inhibited by the shelter," Rutherford said.

"I do feel this is a very important point; some people who build sheds for their horses get frustrated that the horses don't seem to use the shade much in the summer. But, unless we know the actual temperature inside the shelter, it's hard to say the horses aren't using common sense by avoiding the shelter during peak heat times," Heleski said.

When asked about Underwood's findings about the horses seeking shade due to the UV index, Rutherford agreed that it could be a possible explanation, but that it wasn't something she directly measured.

"You know how there's days where it's bright outside, but it might not actually be full sun? It could be that those are the days that the UV index is a little bit lower. I would agree with her that the UV index plays a role if they want to be in the shelter or not," Rutherford said.

PHOTO COURTESY KASSIE RUTHERFORD.

Rutherford said her experience with undergraduate research has strongly impacted her life and future decisions.

"I definitely found myself outside of my research looking at farms and how their horses were responding to the heat, if they were seeking out shade," she said. "One of the things that I've found with this degree, is that even if I don't get a career in the equine industry, everything I learned, I can apply to my own life as a horse owner. This research has already helped me to decide what kind of shelter I want to have for my horses on my own property."

She said that the level of responsibility that is given to students in undergraduate research is extremely important.

"First of all, you're accountable for something that's more than just homework. It's under your prerogative to find that research, find the horses that you are looking for and do it. It just gives a certain level of responsibility to undergrads doing this research, so I think it's really good. It's good to have a project that you don't have a lot of guidance on, it's up to you how you conduct it," Rutherford said.

| Sabrina Jacobs, a senior majoring in equine science and management and minoring in wildlife biology and management, is a communications and student relations intern with UK Ag Equine Programs.

PASTURE RENOVATIONS WILL HELP HORSE FARM IMPLEMENT ROTATIONAL GRAZING

Spendthrift Farm is one of Lexington's iconic Thoroughbred breeding and racing operations. Due to recent expansion, the farm wanted to renovate some unused fields and develop them into pastures to use in a rotational grazing system. They turned to forage experts with the Horse Pasture Evaluation Program in the University of Kentucky College of Agriculture, Food and Environment for their recommendations.

"The Horse Pasture Evaluation Program is a good tool for all horse farms to use," said Robbie Moreland, Spendthrift maintenance manager. "It gives us options and guidelines that we can use to develop the land to suit our needs."

Spendthrift Farm has worked with Krista Lea, MS, UK research analyst, and Ray Smith, PhD, UK forage extension specialist, for a number of years to evaluate and renovate fields on their main farm through the program.

"They have done a good job of implementing grazing rotations, as well as removing fescue from some key broodmare fields and having good success with over seeding," Lea said. "This was our first endeavor with them trying to completely re-establish a pasture."

Thick, lush grasses grow on the renovated pasture at Spendthrift Farm. Photo by Katie Pratt, UK agricultural communications.

The pasture renovation that began in summer 2019 includes 130 acres of an adjoining property the farm purchased a few years back but had not fully incorporated into their operation.

"The land was physically rough, and the grass was consumed by weeds. We decided the best thing to do was just to start completely over again and develop a grass pasture," Moreland said. Farm management wanted to establish pastures that were healthy and beneficial for their horses and good for the natural environment. In 2019, they opted to kill off the existing vegetation using tillage, rather than a traditional field burndown with glyphosate. They reseeded the fields with a mixture of bluegrass, orchardgrass and perennial ryegrass. Even though Central Kentucky experienced a drought last fall, the seed germinated and created a lush stand of grass.

HORSES GRAZE AT SPENDTHRIFT FARM. THE FARM HAS WORKED WITH THE UK HORSE PASTURE EVALUATION PROGRAM FOR SEVERAL YEARS TO MAKE SURE ITS HORSES HAVE ACCESS TO HIGH QUALITY FORAGES. PHOTO BY KATIE PRATT, UK AGRICULTURAL COMMUNICATIONS.

Moreland said Spendthrift plans to start fencing the renovated pasture and building a barn this fall, with the goal of allowing horses to graze in the pasture in the spring. Moreland said it was important to the farm to slowly and methodically prepare the ground for grazing.

"We would like to keep these pastures lush," Moreland said. "To do this, we are going to use it as a pasture rotation with our main farm. The new pastures and barn will be used for our mares and weanlings."

Spendthrift Farm is just one of the farms the Horse Pasture Evaluation Program advises each year. From its beginnings in 2005 to 2019, the program conducted more than 250 evaluations on horse farms of all sizes and breeds. In 2020, Lea and her student interns have evaluated nearly 30 farms. This is the highest number of operations they have serviced in any one year.

"A high-quality pasture is beneficial to both horses and the environment," Lea said. "It allows horses to select the best possible forage and stay away from undesirable weeds. We know that good quality pasture maintains a lot of cover, and that reduces soil erosion, prevents nutrients from leaching off that pasture and maintains the soil that is there."

More information about the program can be found here. Video for this story can be found here.

| Katie Pratt is an agricultural communications specialist within UK's College of Agriculture, Food and Environment. Source: Sept. 3 news relese.

TO SPRAY OR NOT TO SPRAY?

PHOTO COURTESY DR. JIMMY HENNING.

Here are some guidelines that help me formulate a weed control plan. I will be the first to admit this is a highly subjective set of guidelines or suggestions.

Would you spray the field pictured above? Tough question to weigh the value of a good stand of vigorous red clover (18 inches tall) compared to freedom from ironweed (24 inches tall). The decision to spray is a subjective process depending on many factors, including weed pressure, invasiveness and/or toxicity of the weed, cost of the control measure, forage value of the weed and its life cycle and the ability to restore the pasture stand.

NON-CHEMICAL CONTROL

Farmers have other options besides spraying herbicide. Sometimes the best approach is to use cultural practices or grazing management to strengthen the forage crop and deal with the weed. Ragweed and some thistles are common examples. The UK publication AGR 207 'Controlling Broadleaf Weeds in Kentucky Pastures' evaluates the effectiveness of mowing as a weed management tool for many of our problem pasture weeds.

THE CLOVER DILEMMA

A vigorous stand of red clover would be worth protecting in all but the worst weed infestations. A stand of small, white dutch clover, probably not. And remember that some new herbicide formulations will take out broadleaves without killing clover. Proclova ® is one example.

ANNUALS

With annual weeds, it is usually best to first try to thicken up the forage stand. Annuals are opportunistic; they germinate and grow when forage stands get sparse. Addressing lime, P and K needs and strategic use of nitrogen fertilizer are some of the most powerful tools to shift the advantage to the desirable forage. Implementing rotational grazing and maintaining good residual heights on the base grass will help suppress the onset of these weeds.

TOXIC AND INVASIVE PLANTS

Toxic and invasive weeds will often necessitate the use of herbicides. The cost/benefit ratio of using chemical control is influenced greatly by the threat of loss of livestock and the loss of value due to their presence in hay.

CASH HAY VS PASTURE

Some weeds can be tolerated or even be beneficial in pasture that would warrant herbicide application in a cash hay crop. For example, johnsongrass and crabgrass are highly palatable forages that benefit summer pastures but are not welcome in hay intended for high end horse markets.

WEED GROWTH STAGE MATTERS

Weeds are most easily controlled when they are green and actively growing. For perennials like ironweed, time herbicide applications so that plants are young and vegetative. Often that means timely mowing in mid-summer to knock them back and following up with herbicide in two or three weeks.

REPLANT STRATEGY

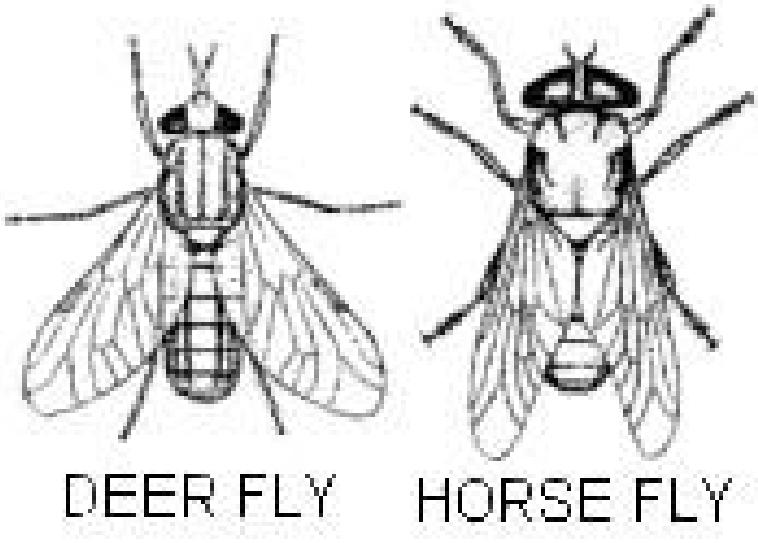
A plan to spray almost always requires a plan to replant because when the weed is gone, mother nature will insert another one. Refer to the label for the proper re-seeding interval.

The decision to spray herbicide on pastures and hayfields is complicated. The decision to spray is a subjective process depending on many factors, including the visual assessment of the weed pressure, the invasiveness and/or toxicity of the weed, the cost of the control measure, the forage value of the weed and its life cycle and the ability to restore the pasture stand. Don't forget that the best first step is to thicken up the existing stand of forage. Happy foraging.

| Jimmy Henning, PhD, extension forage specialist in UK's Department of Plant and Soil Sciences provided this information. Source: Aug. 31, Kentucky Forage News excerpt of Farmer's Pride story. Subscribe to The Farmer's Pride to read the full article.

HORSE FLIES AND DEER FLIES FACT SHEET FROM UK'S ENTOMOLOGY DEPARTMENT

HORSE FLIES SEEM TO BE ESPECIALLY BAD THIS YEAR, AT LEAST ACCORDING TO RIDERS WHO ARE SHARING STORIES ABOUT RIDES BEING DISRUPTED BY THEIR HORSES FENDING OFF THE BLOODTHIRSTY PESTS. THE UNIVERSITY OF KENTUCKY DEPARTMENT OF ENTOMOLOGY IN THE COLLEGE OF AGRICULTURE, FOOD AND ENVIRONMENT PROVIDES SEVERAL FACT SHEETS ABOUT PESTS THAT AFFECT HORSES, INCLUDING HORSE FLIES AND DEER FLIES. PUBLICATION ENTFACT – 511 CAN BE FOUND ONLINE HERE.



GRAPHIC COURTESY UK'S DEPARTMENT OF ENTOMOLOGY.

Horse flies and deer flies are bloodsucking insects that can be serious pests of cattle, horses and humans. Horse flies range in size from 3/4 to 1-1/4 inches long and usually have clear or solidly colored wings and brightly colored eyes. Deer flies, which commonly bite humans, are smaller with dark bands across the wings and colored eyes similar to those of horse flies. Attack by a few of these persistent flies can make outdoor work and recreation miserable. The numbers of flies and the intensity of their attack vary from year to year.

Numerous painful bites from large populations of these flies can reduce milk production from dairy and beef cattle and interfere with grazing of cattle and horses because animals under attack will bunch together. Animals may even injure themselves as they run to escape these flies. Blood loss can be significant. In a U.S. Department of Agriculture Bulletin 1218, Webb and Wells estimated that horse flies would consume 1 cc of blood for their meal, and they calculated that 20 to 30 flies feeding for six hours would take 20 teaspoons. This would amount to one quart of blood in 10 days. Female horse flies and deer flies are active during the day. These flies apparently are attracted to such things as movement, shiny surfaces, carbon dioxide and warmth. Once on a host, they use their knife-like mouthparts to slice the skin and feed on the blood pool that is created. Bites can be very painful and there may be an allergic reaction to the salivary secretions released by the insects as they feed. The irritation and swelling from bites usually disappears in a day or so. However, secondary infections may occur when bites are scratched. General first aid-type skin creams may help to relieve the pain from bites. In rare instances, there may be allergic reactions involving hives and wheezing. Male flies feed on nectar and are of no consequence as animal pests.

Horse flies and deer flies are intermittent feeders. Their painful bites generally elicit a response from the victim so the fly is forced to move to another host. Consequently, they may be mechanical vectors of some animal and human diseases.

LIFE CYCLE

The larvae of horse fly and deer fly species develop in the mud along pond edges or stream banks, wetlands or seepage areas. Some are aquatic and a few develop in relatively dry soil. Females lay batches of 25 to 1,000 eggs on vegetation that stand over water or wet sites. The larvae that hatch from these eggs fall to the ground and feed upon decaying organic matter or small organisms in the soil or water. The larvae stage usually lasts from one to three years, depending on the species. Mature larvae crawl to drier areas to pupate and ultimately emerge as adults.

PROTECTING YOURSELF

Deer flies are usually active for specific periods of time during the summer. When outside, repellents such as Deet and Off (N-diethyl-meta-toluamide) can provide several hours of protection. Follow label instructions because some people can develop allergies with repeated use; look for age restrictions.

Permethrin-based repellents are for application to clothing only but typically provide a longer period of protection. Repellents can prevent flies from landing or cause them to leave before feeding but the factors that attract them (movement, carbon dioxide, etc.) are still present. These flies will continue to swarm around even after a treatment is applied. Light colored clothing and protective mesh outdoor wear may be of some value in reducing annoyance from biting flies. In extreme cases,

hats with mesh face and neck veils and neckerchiefs may add some protection.

PROTECTING ANIMALS

Horse flies and deer flies can be serious nuisances around swimming pools. They may be attracted by the shiny surface of the water or by movement of the swimmers. There are no effective recommendations to reduce this problem.

Permethrin-based sprays are labeled for application to livestock and horses. These insecticides are very irritating to the flies and cause them to leave almost immediately after landing. Often, the flies are not in contact with the insecticide long enough to be killed so they continue to be an annoyance. These flies will swarm persistently around animals and feed where the spray coverage was not complete (underbelly or legs) or where it has worn off. Repeated applications may be needed. Check the label about minimum retreatment intervals. Pyrethrin sprays also are effective but do not last as long as permethrin.

Horse flies and deer flies like sunny areas and usually will not enter barns or deep shade. If animals have access to protection during the day, they can escape the constant attack of these annoying pests. They can graze at night when the flies are not active.

CONTROL

It is difficult to impossible to locate and/or eliminate breeding sites of horse flies and deer flies. They breed in environmentally sensitive wetlands, so the effects of drainage or insecticide application on non-target organisms or water supplies is a concern. Also, these insects are strong fliers that can move in from some distance away. Breeding sites may be very extensive or some distance away from where problems are occurring.

Fortunately, horse flies and deer flies are sporadic problems for specific times of the year. Some adaptation in behavior or use of repellents can allow enjoyment of the outdoors.

| Lee Townsend, PhD, emeritus extension professor from the Department of Entomology in the College of Agriculture, Food and Environment, provided this information.

HORSE BOTS

Horse bots are honey bee-sized flies that dart around and glue their tiny eggs or nits to body hairs of horses, donkeys and mules. The fast movements of these flies frighten animals. Horses also can injure themselves as they attempt to relieve the irritation from burrowing activities of newly hatched bots. In addition, most of the larval or bot stage of the fly is spent as an internal parasite where it can cause serious problems.

LIFE CYCLE

There are three species of horse bots. Their life cycles are very similar, except in where they attach their yellow to gray eggs to the host. Common horse bot eggs most often are attached to hairs on the fore legs but can be found on the outside of the legs, the mane and on the flanks. Throat bot eggs are attached to the long hairs beneath the jaws. Nose bot eggs are stuck to hairs on the upper and lower lips. It is easy to see how horses can be spooked by flies buzzing at these areas and may injure themselves or people working or riding them at the time. Depending on the species, females deposit from a few hundred to 1,000 eggs during their lifetime.

Eggs of the common horse bot hatch after a two- to five-day incubation period, often stimulated by warmth and moisture from the animal's tongue. Eggs of the other species may hatch without stimulation. Newly hatched bot larvae enter or are taken into the mouth. They spend about three weeks in soft tissue of the lips, gums or tongue. The bots then migrate to the stomach or small intestine where they use sharp mouth hooks to attach to the lining of the organ. Bots can damage the lining of the stomach or small intestine, interfere with the passage of food, or cause other gastrointestinal disorders. They spend about seven months there before passing out in the feces. The mature larvae enter the soil below the dung pile and pupate. In two weeks to two months, depending upon the season, they emerge as adults.

The adults do not have functional mouthparts so they cannot feed. Females go to horses only to lay their eggs. Most of the egg-laying is done during August and September but may continue until the first hard frost.

CONTROL

While bot flies may or may not be noticed around horses, it is easy to look for nits, or eggs, on the animal's coat. Virtually all horses in Kentucky are likely to be infested. Most of the pest life cycle occurs in the horse. Consequently, an insecticide, applied internally, is necessary to provide effective control. Check product labels carefully, all equine deworming drugs do not necessarily control horse bots. Before purchasing any product, read the pest list on the label and note any precautions regarding product use.

Trichlorfon, an organophosphate insecticide, is available by itself (Combot) or included in some combination dewormers to provide bot control. No other organophosphate or cholinesterase inhibiting products, such as those containing dichlorvos (Vapona), coumaphos (Co-Ral) or tetrachlorvinphos (Rabon) should be applied to horses at the same time, or within several days of treatment. The product label will give specific restrictions. Ivermectrin, the active ingredient in products such as Eqvalan, Zimectrin, and Protectin 1, controls bots and other internal parasites and is not a cholinesterase inhibitor. No supplementary bot control material is needed when using products that have ivomectrin as the active ingredient.

Consult your veterinarian about an appropriate parasite control program.

ALTERNATIVES

Clipping hairs that harbor eggs is not a practical solution for these pests. Sponging areas of the fore legs where nits are attached with warm water (110-112 degrees Fahrenheit) may stimulate some eggs to hatch and the small larvae can then be washed off. This is of limited value and would have to be repeated frequently because new eggs are attached daily while the flies are most active.

| Lee Townsend, PhD, emeritus extension professor from the Department of Entomology in the College of Agriculture, Food and Environment, provided this information.