2022-2024 NBAF Science Accomplishments Report

U.S. Department of Agriculture (USDA)

National Bio and Agro-Defense Facility (NBAF)

NBAF Science Transition

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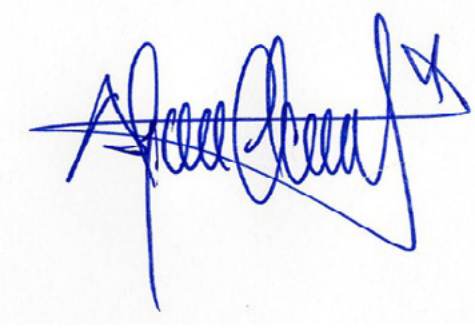
LETTER FROM THE DIRECTOR

As we transition from focusing on NBAF's operational readiness, we are phasing in science — initially working at BSL-2 and gradually moving into higher levels of biocontainment. This revitalizes the focus on NBAF's purpose: **The science**. Our facility will be a space where innovation, discovery and collaboration will flourish. As we continue preparing NBAF's spaces for science, we are reminded of the dedication and expertise of the talented individuals who work within these walls. Our scientists, diagnosticians, researchers, technicians and support staff bring with them a wealth of experience and a passion for inquiry that will drive our collective endeavors forward. Scientific operation is a critical element of NBAF's ability to achieve its mission and will define our success.

Today, we are confronted with a global challenge that underscores the critical importance of research and diagnostics in transboundary, emerging and zoonotic diseases. Research and diagnostics are our most potent weapons in the fight against these diseases. By deepening our understanding of the epidemiology, transmission dynamics and pathogenesis, we can develop more effective surveillance, prevention and control strategies. From diagnostic tools and vaccines to biosecurity measures and risk assessment frameworks, science empowers us to stay one step ahead of emerging threats and mitigate their impact on animal and human health. The recent outbreaks of novel pathogens have highlighted the urgency of understanding, combating and ultimately preventing the spread of infectious animal diseases. In an interconnected world where pathogens know no borders, transboundary, emerging and zoonotic diseases pose a significant threat to animal and public health, economic stability and societal well-being.

We are presenting our science achievements for the past two fiscal years in this report. Although we are not fully operational yet and the scientific capacity at NBAF has not been fully established, we have started science in and outside NBAF's walls. As we embark on this OneNBAF journey, let us remember that the true measure of our success lies not only in our scientific achievements but also in the positive impact that we can have together on the community around us.



Dr. Alfonso Clavijo, DVM, PhD.
NBAF Director
National Bio and Agro-Defense Facility (NBAF)
U.S. Department of Agriculture (USDA)

National Bio & Agro-Defense Facility

MISSION

To protect the United States against transboundary, emerging and zoonotic diseases that threaten our food supply, agricultural economy and public health.

VISION

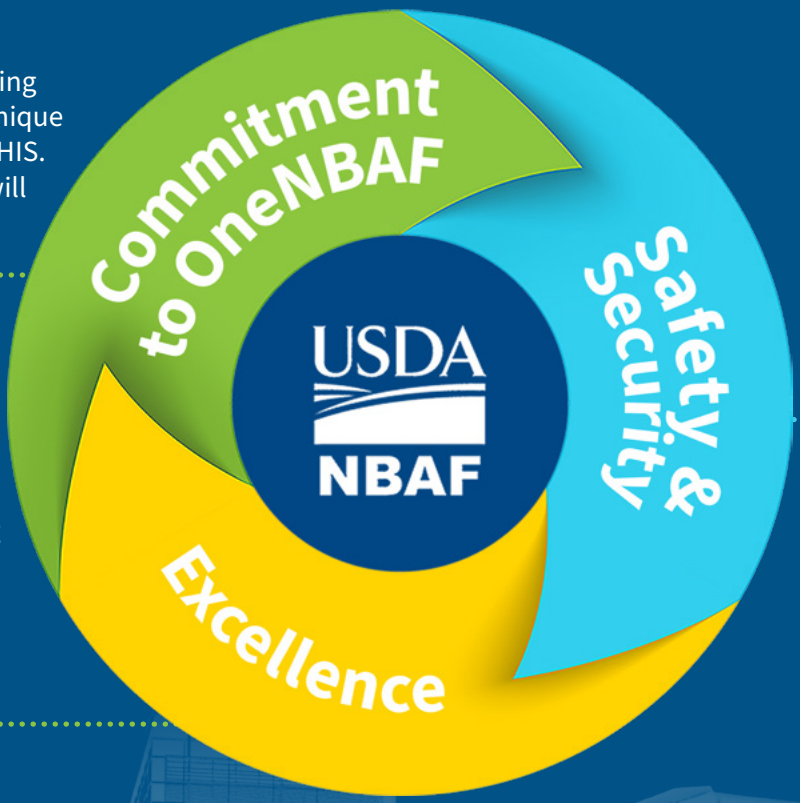
A safer and more resilient America through a world-class science facility for large animal agricultural research, training and diagnostics.

CORE VALUES

NBAF is dedicated to working together to leverage the unique capabilities of ARS and APHIS. Only united as OneNBAF will NBAF achieve its mission.

NBAF holds itself accountable for the safety and security of its employees, the environment and the community.

NBAF meets challenges by empowering and inspiring one another to achieve quality and excellence through continuous improvement.



EXECUTIVE SUMMARY

The National Bio and Agro-Defense Facility (NBAF) is designed to provide the United States (U.S.) with the capacity to conduct comprehensive research, develop vaccines and provide enhanced diagnostic and training capabilities to protect the U.S. food supply, agricultural economy and public health against the threat of transboundary, emerging and zoonotic animal diseases. NBAF is owned and operated by the U.S. Department of Agriculture (USDA) and will replace and expand on the mission of the Plum Island Animal Disease Center (PIADC), a biosafety level-3 facility established in the 1950s.

Currently, USDA's Agricultural Research Service (ARS) and Animal and Plant Health Inspection Service (APHIS) conduct foreign animal disease research, training and diagnostics at PIADC. These two agencies are promoting the "OneNBAF" mindset to operate NBAF jointly.

APHIS's Foreign Animal Disease Diagnostic Laboratory (FADDL) and ARS's Foreign Animal Disease Research Unit (FADRU) at Plum Island are transferring their science to NBAF. FADDL employees are involved in the prevention, surveillance, diagnosis and response to these transboundary diseases, including the expertise to manage two vaccine banks. FADRU and two new USDA units — the Foreign Arthropod-Borne Animal Disease Research Unit (FABADRU) and the Zoonotic and Emerging Disease Research Unit (ZEDRU) — are focused on research and countermeasures for animal diseases that could have devastating economic or public health consequences.

NBAF also has established the Biologics Development Module (BDM) to promote private-public partnerships, collaborations and opportunities. The BDM will generate data on product efficacy for licensure to expedite the transition of research products to commercially-viable veterinary countermeasures to meet emerging threats to U.S. agriculture.

NBAF has the only Animal Biosafety Level-4 Agriculture (ABSL-4Ag) spaces in the country designed to conduct large animal science under maximum containment. The NBAF BSL-4 suite containing the ABSL-4Ag spaces also is unique as it is the only laboratory suite that ARS and APHIS jointly operate. The research-based mission of ARS scientists, combined with the diagnostic and testing missions of APHIS scientists, embody the "OneNBAF" mindset of the NBAF BSL-4 team. The diverse knowledge, experience and skillsets of the NBAF BSL-4 team can be leveraged to engage in complex projects to safeguard the nation's food supply, agricultural economy and public health against emerging and zoonotic diseases.

Science at NBAF: By the Numbers (as of May 1, 2024)

ARS

Inter-American Institute for Cooperation on Agriculture (IICA), a cooperative organization of more than 30 countries in North, Central and South America as well as the Caribbean, based out of Costa Rica

Active Extramural Agreements Funding for FY22-23:

$55,049,111.81

141 Total Publications:

84 Peer-Reviewed Journal Publications

57 Abstract Only Submissions

162

Active Research Agreements

79 Unique Partners:

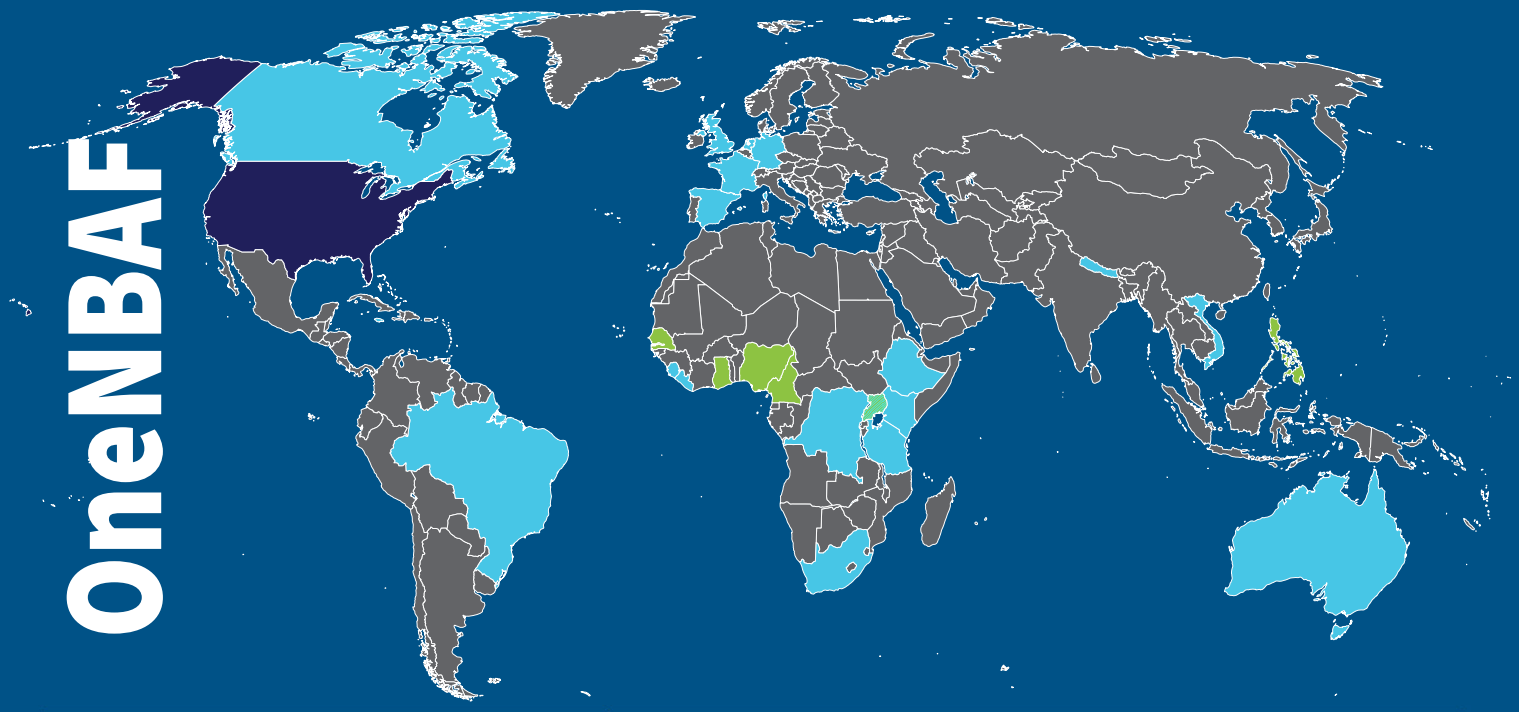
36 Academic Research Institutions

20 Industry Partners

23 National/International governmental or non-governmental agencies

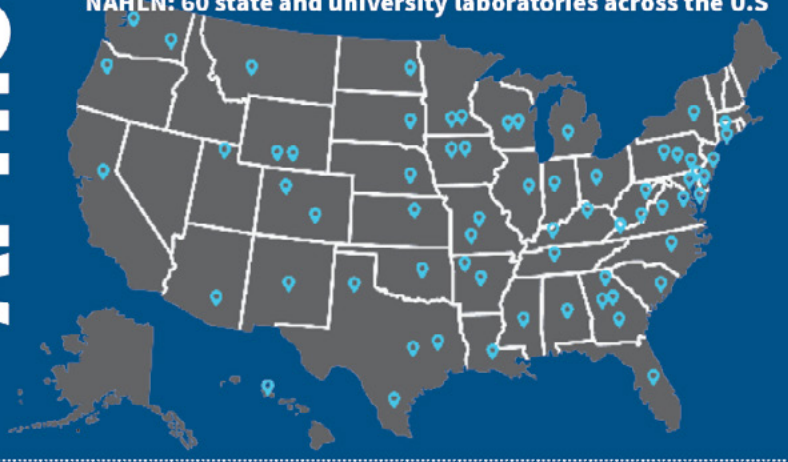
Partnered Countries (21): Australia, Brazil, Canada, Costa Rica, Democratic Republic of Congo, Ethiopia, France, Germany, Jamaica, Kenya, Liberia, Mexico, Nepal, Netherlands, Sierra Leone, South Africa, Spain, Tanzania, Uganda, United Kingdom, Vietnam

OneNBAF



APHIS

NAHLN: 60 state and university laboratories across the U.S



22

Peer-Reviewed Journal Publications

Global Partnerships for Animal and Zoonotic Disease Surveillance (GPAZDS):

- Uganda
- Nigeria
- Philippines
- Gambia
- Cameroon
- Senegal
- Ghana
- Jordan

National Animal Health Laboratory Network (NAHLN), a network of animal disease diagnostic laboratories that provide disease surveillance across the nation and can provide diagnostic needs during animal disease outbreaks.

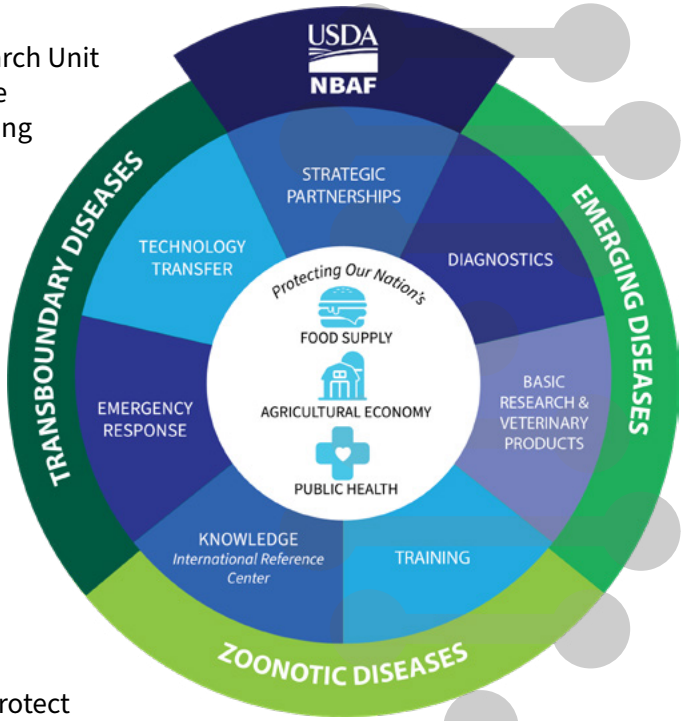
NBAF MISSION & CAPABILITIES

While **transboundary, emerging and zoonotic animal diseases** are constant threats to our nation's food supply, agricultural economy and public health, USDA's ARS and APHIS are working together to protect our nation by tackling some of the toughest problems facing agriculture. None of these problems can be solved without the unique capabilities of each of NBAF's science units.

For example, African swine fever (ASF) presents a very real threat to the American pork industry. In 2018-2019, about 25% of the global pig population succumbed to the disease or were culled to prevent spread. The virus has never been found in the U.S., yet it has moved closer. In July 2021, ASF was found in the Dominican Republic (DR), the first time it had been diagnosed in the Western Hemisphere since the 1980s. In September 2021, neighboring Haiti also reported ASF.

Through a **strategic partnership** with the DR, APHIS's Foreign Animal Disease Diagnostic Laboratory scientists were prepared for **emergency response** and confirmed the presence of ASF in the DR using **diagnostics** (see page 34). This confirmed diagnosis encouraged scientists to test swine in Puerto Rico, the closest U.S. neighbor to the affected swine populations, and **train** diagnosticians and veterinarians on the island to run tests and recognize the clinical signs of ASF in pigs. As more scientists and veterinarians gained hands-on experience in looking for and potentially mitigating ASF, **knowledge** and understanding of the virus and its epidemiology grew.

Meanwhile, scientists with ARS's Foreign Animal Disease Research Unit (FADRU) have conducted the **basic research** to understand the mechanisms of the ASF virus that make it so effective at infecting pigs. This research led to **developing veterinary products** — such as a new vaccine called NAVET-ASFVAC (see page 12). Widespread experimental use of the vaccine in laboratories and in the field in Vietnam has indicated that the vaccine is highly safe when properly administered as directed.



USDA scientists entered into a **technology transfer** agreement and **strategic partnership** so this vaccine could be used in countries where ASF is endemic. The Dominican Republic Ministry of Agriculture is considering procurement and use of this vaccine for the purpose of protecting pigs during the nation's ongoing ASF epidemic. Continuing safety studies will provide comprehensive information about NAVET-ASFVAC's safety to aid the ministry's decision about deploying the vaccine.

So far, this new vaccine has shown great promise for helping protect pigs from this terrible disease and hopefully reduce economic losses for swine producers but it takes all of NBAF's science units working together to protect our agriculture from these livestock diseases.

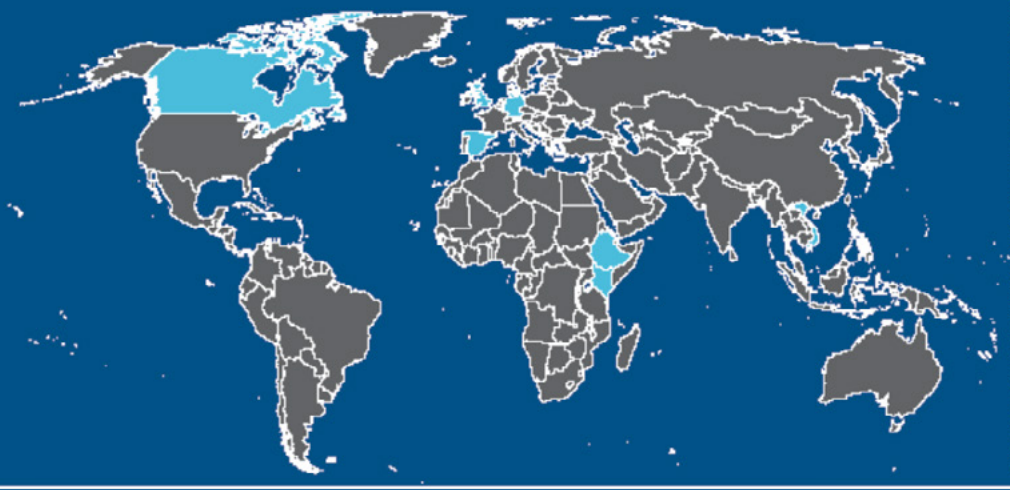
FADRU by the Numbers

FADRU

Active Extramural Agreements Funding for FY22-23: $15,385,000.00

Partner Countries (7):

Germany, Kenya, Ethiopia, Spain, Canada, the United Kingdom and Vietnam



78 Total Publications:

- 55 Peer-Reviewed Journal Publications
- 23 Abstract Only Submissions

32 Unique Partners:

- 10 Academic Research Institutions
- 9 Industry Partners
- 13 National/international governmental or non-governmental agencies

55
Active Research Agreements

FOREIGN ANIMAL DISEASE RESEARCH UNIT

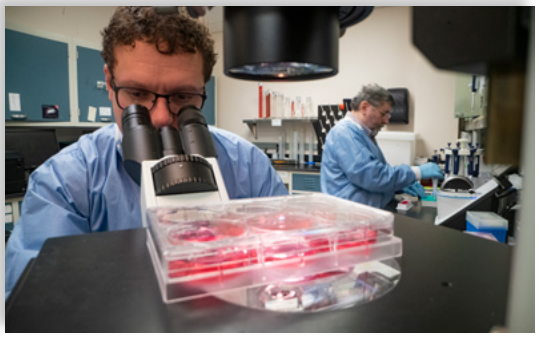
FADRU is one of three ARS research units at NBAF. This unit focuses efforts on **basic and applied research** of foreign animal disease and the **discovery of veterinary countermeasures.** Over the last 60 years, FADRU has conducted research at the Plum Island Animal Disease Center (PIADC) and provided solutions to critical agricultural problems, including novel rapid diagnostics, safe and effective vaccines, and advancing the scientific understanding of pathogens. FADRU's principal investigators are world-renowned experts in foreign animal diseases. Between 2019-2023, FADRU scientists received five prestigious national awards for influential research and technology transfer. Within FADRU, research associates, support scientists, research fellows and university collaborators work together to achieve the USDA, ARS and NBAF missions.

The FADRU mission is to protect the U.S. from foreign animal pathogens through the performance of basic and applied research. The unit's research focuses on the control and eradication of select high-consequence animal diseases: **foot-and-mouth disease (FMD), African swine fever (ASF) and classical swine fever (CSF).** Research includes understanding viral genomics, disease pathogenesis and disease ecology as well as applying this knowledge for rational and effective development of veterinary medical countermeasures such as biotherapeutics, vaccines and diagnostics. FADRU also conducts research on strategies for the prevention, control and recovery from foreign animal diseases and has developed new FMD and ASF vaccines. Recent FADRU research highlights how the disease spreads among a herd of animals and in the animal's body. Over the last 20 years, FADRU scientists have published more than 400 peer-reviewed research manuscripts and more than 30 patents relevant to foreign animal disease prevention and control.

FADRU's research is critical in protecting U.S. agriculture. While FMD has not been found in the U.S. since 1929, it is a highly contagious viral disease that affects animals with cloven hooves — like cattle and pigs — and would devastate the U.S. agriculture industry. ASF and CSF have similar potential consequences. Between 2019-2020, ASF outbreaks resulted in the destruction of more than 300 million pigs — almost half of the world's pig population. FADRU licensed the first molecular vaccine against foot-and-mouth disease virus (FMDV) for emergency use in the U.S., the first new generation inactivated vaccine against FMD in the U.S., and the first internationally licensed commercial vaccine against ASF. FADRU scientists also discovered and described the primary site of FMDV replication in animals along with the mechanisms associated with its persistent infection, providing a framework for examining FMD pathogenesis.

FADRU is currently standing up BSL-2 and BSL-3 laboratory spaces at NBAF. During the stand-up process at NBAF, FADRU will gradually begin decommissioning the laboratory spaces ARS occupies at Plum Island. FADRU is transferring its science operations to NBAF while training new scientists through Oak Ridge Institute for Science and Education (ORISE) and university collaborations. Throughout this process, FADRU continues the early development of vaccines relating to ASF, FMD and CSF.

Driving Development & Commercialization of the First ASF Vaccines



While not a threat to human health, African swine fever (ASF) poses a significant threat to agriculture. ASF Virus (ASFV) is the causative agent of ASF, a highly infectious and lethal disease that is a major threat to both wild and domestic swine populations. Endemic to Africa, an ongoing outbreak of ASF that started in the Republic of Georgia in 2007 has rapidly expanded into a global pandemic. It has spread to six continents, resulting in severe economic damage to the global pork industry in addition to the loss of tens of millions of animals. Although ASF has not reached the U.S., its presence in Haiti and the Dominican Republic poses a serious threat to the nation's agriculture. Protecting the U.S. livestock industry remains one of USDA's primary objectives.

ASFV is a large and complex virus. Historically, there has been no safe, reliable and effective commercially available vaccine, so strict quarantine protocols, halting of animal trade and the de-population of infected herds have been implemented to control the disease. These measures, while necessary to control spread of the virus, cause substantial economic hardships and threaten the livelihood of producers — particularly those in developing countries without resources to recover after the loss of their herds.

Culminating from years of research, FADRU scientists have developed an **effective ASFV vaccine candidate** that has entered the early stages of commercialization. The ASFV-G-ΔI177L vaccine is a live-attenuated vaccine derived from the ASFV strain first isolated from the outbreak in the Republic of Georgia. By deleting the I177L gene from the ASFV genome, researchers could attenuate, or weaken, the virus allowing it to be used as a vaccination platform. Before meeting the requirements for commercialization, FADRU scientists conducted numerous studies demonstrating the safety and efficacy of the vaccine. This included long-term studies demonstrating that the ASFV-G-ΔI177L vaccine did not maintain a residual ability to infect and cause disease in vaccinated animals and the vaccine strain of the virus did not regain virulence after opportunities for recombination with wild-type strains. *With initial safety and efficacy testing complete, the government of Vietnam, along with industry partners, licensed the FADRU-developed vaccine and became the first country in the world to begin manufacturing doses of an ASFV vaccine commercially.*

With commercial production and vaccination campaigns using this new vaccine in Vietnam, additional work has begun to expand vaccination options in the fight against ASF. In Europe, a consortium of more than 10 research laboratories and a major biotechnology manufacturer, began evaluating three vaccine candidates in 2023 that have been developed by FADRU scientists, including ASFV-G-ΔI177L. Led by the Friedrich-Loeffler-Institute in Griefswald, Germany, the consortium is seeking to determine if the ASFV vaccine candidates developed by USDA can be approved for use in the European Union (EU). Furthermore, FADRU researchers were able to engineer a genetic marker that enables the ability to Differentiate Infected from Vaccinated Animals (DIVA) into ASFV-G-ΔI177L. This DIVA capability, which involves removing a specific codon from the vaccine strain viral genome that can be identified during testing, is critical to an effective outbreak response as it enables responders to identify if ASFV antibodies detected in an animal are due to vaccination or natural infection with a wild-type strain. With FADRU scientific advances and partnerships continually driving and adding to ASF vaccine research, continual progress is being made to expand the arsenal of globally available tools to combat the virus.

FADRU Research Reclassifies the Number of Unique ASF Genotypes from 25 to 6

As with many viruses, small mutations or changes in ASFV's genetic code can lead to the rise of variants with slightly different genetic makeups or genotypes. These changes can have a dramatic impact on viral characteristics, such as its ability to infect target cells or avoid a host's immune response, and play a major role in vaccine effectiveness. Having immunity against one genotype of a virus does not automatically confer immunity against another, which is a major challenge when developing vaccines to protect against the disease. Due to the large size of the ASF genome, historical classification efforts have largely focused on differences in the DNA region encoding for a single gene called p72, which contains the genetic instructions for the virus to manufacture a protein of the same name. From this information, past researchers identified 25 separate ASFV genotypes in circulation around the globe.

With improvements in sequencing technology, FADRU ASF researchers sequenced ASF's whole genome and partnered with SciNET, the USDA's super-computer network, to re-evaluate the available ASF genetic data. To complete this analysis, researchers gathered all publicly available genomic data for ASF — nearly 12,000 sequences — from partial DNA fragments and complete genomic sequences. This data was fed through a software program that allowed them to examine each sequence and identify the section of DNA encoding for the p72 gene. Using the capabilities of SciNET, FADRU scientists were able to look at the p72 gene from a fresh perspective and found that many of the historically separate genotypes were functionally the same.

By re-analyzing the historical data, they were able to consolidate the previously identified 25 genotypes to 6 ASFV genotypes. This proposed re-classification scheme was detailed in the peer-reviewed journal Viruses* and published in November 2023. These findings have enormous potential ramifications, especially in the development of effective ASF vaccines. If the various strains of the virus that are circulating the globe are genetically more similar than initially believed, it could reduce the number of vaccines that would need to be developed to provide wide-ranging protection for susceptible animals. Researchers also may be able to focus vaccine development efforts to increase efficiency in vaccine developmental stages thus shortening the path to commercialization.

*Spinard, E., Dinhobl, M., Tesler, N., Birtley, H., Signore, A. V., Ambagala, A., Masembe, C., Borca, M. V., & Gladue, D. P. (2023). A Re-Evaluation of African swine fever Genotypes Based on p72 Sequences Reveals the Existence of Only Six Distinct p72 Groups. Viruses, 15(11), 2246.https://doi.org/10.3390/v15112246

Developing a Safe Vaccine Manufacturing Platform for FMD

Foot-and-mouth disease (FMD) is a highly infectious and economically devastating foreign animal disease. Although it rarely leads to death, the FMD virus (FMDV) causes distinctive, painful vesicles to develop on the hooves and in the mouths of infected animals. This results in lameness and loss of appetite, which in turn causes a severe reduction in productivity. The highly infectious nature of the virus means it can spread rapidly throughout populations of cloven-hooved animals such as cows, pigs, sheep, goats and deer, making the control and containment of outbreaks challenging. To contain outbreaks of FMDV, a heavy-handed response, including halting all animal trade, culling of infected herds and deploying an aggressive vaccination campaign is required. These mitigating measures, while necessary, would result in severe economic losses. (Continued on next page.)

Currently, FMD vaccines are manufactured by chemically inactivating infectious FMDV. The manufacturing requires using a large amount of live virus and specialized biocontainment facilities with layers of safety in place to prevent an accidental release. For this reason, the U.S. does not allow the production of FMD vaccines domestically, making the nation dependent on foreign suppliers. Therefore, FADRU scientists have designed an inactivated vaccine platform (FMDV-LL3B3D) that allows for the safe and rapid manufacturing of FMD vaccines. FMDV-LL3B3D provides a safer alternative to current virulent strains, and is currently under advanced development through a collaboration between FADRU and industry partners. Additional efforts are focused on increasing the coverage of FMD vaccines for different variants of the virus.

Studying FMD Pathogenesis to Protect the U.S. Homeland

On the frontlines of FMD research, FADRU scientists are leading efforts that include multifaceted approaches to protecting U.S. agriculture from transboundary animal diseases. FADRU is investigating how the virus infects and progresses through a host, between animals and changes itself through these different events.

FADRU's Epidemiology Modeling Studies Improve Understanding of FMD Global Movements

One of FADRU's core missions is to protect the nation's agriculture industries by monitoring and researching how diseases, like FMD, circulate. To achieve this goal, FADRU scientists collaborate with counterparts in various regions of the world with high incidents of FMD, such as Africa, Asia and South America. Ongoing collaborations in Vietnam, Pakistan, Uganda, India and Kenya also provide access to the latest specimens of this rapidly changing virus.

Molecular epidemiology studies based on surveillance in these countries enable a form of forensic tracking to understand the global movements of FMDV strains and help the U.S. prepare for a possible outbreak. Specifically, it is only through researching and characterizing strains as they emerge that vaccines and response measures are available to protect U.S. livestock herds when needed. These efforts have led to FADRU's discoveries of unique strains of FMDV from Asia and Africa and novel understandings of how the virus evolves in individual animals and populations.

FADRU's dual expertise in epidemiology and pathogenesis has led to contributions to a new branch of foreign animal disease prevention: **infectious disease modeling.** As with the COVID pandemic, modeling animal diseases is crucial to not only understanding how they infect and spread, but also for the practical aspects of stopping an outbreak in its tracks before it becomes a pandemic.

While the core FMDV insights are primarily derived from laboratory work and experiments, modeling serves as a bridge between these controlled environments and larger scale animal populations. The models help researchers compensate for limited field observation data, logistical challenges of conducting large-scale studies and animal health ethical concerns by estimating and simulating virus spread in a virtual environment. Modeling methods also support decision-making, disease management and outbreak response strategies. Scientists compare different modeling scenarios, evaluate proposed interventions and refine control measures to counter FMD spread. This part of FADRU's activities has already improved the U.S. National Models for FMD and ASF preparedness and response.

New Partnerships Support Stand Up of ASFV & FMDV Research Capabilities at NBAF

The transfer of FADRU's research mission from PIADC to NBAF is a complex process. Many logistical and procedural tasks must be accomplished before conducting the first FMD and ASF experiments with the live virus. While some researchers continue to conduct critical work at Plum Island to ensure FADRU's mission is uninterrupted, others are actively engaged in transition tasks to stand up NBAF laboratories.

One critical task in establishing our new operations is ensuring a steady supply of primary cells and cultured cell lines, which are essential for conducting research on ASF and FMD. The ASF donor program completed the necessary administrative steps to begin collecting and storing these cells for future use at the facility. In partnership with the NBAF Animal Resource Unit (ARU) and Midwest Veterinary Services (MVS), white blood cells, or macrophages, are harvested from healthy donor swine, processed and stored at the Insectary and Cell Culture Laboratory (ICCL) at the Center for Grain and Animal Health Research (CGAHR), another USDA ARS laboratory a few miles from NBAF. These cells are vital to NBAF's mission-critical work in developing diagnostics and veterinary countermeasures to combat ASF and prevent the virus from threatening the U.S. swine population. Ten macrophage harvests have been conducted under the program prior to May 2024 and represent a key milestone in the stand up of FADRU's capabilities at NBAF. We have partnered with American Type Culture Collection (ATCC) to guarantee the quality and control needed for the transfer of these cell lines and hybridomas to NBAF, facilitating basic research and the development of vaccine candidates.

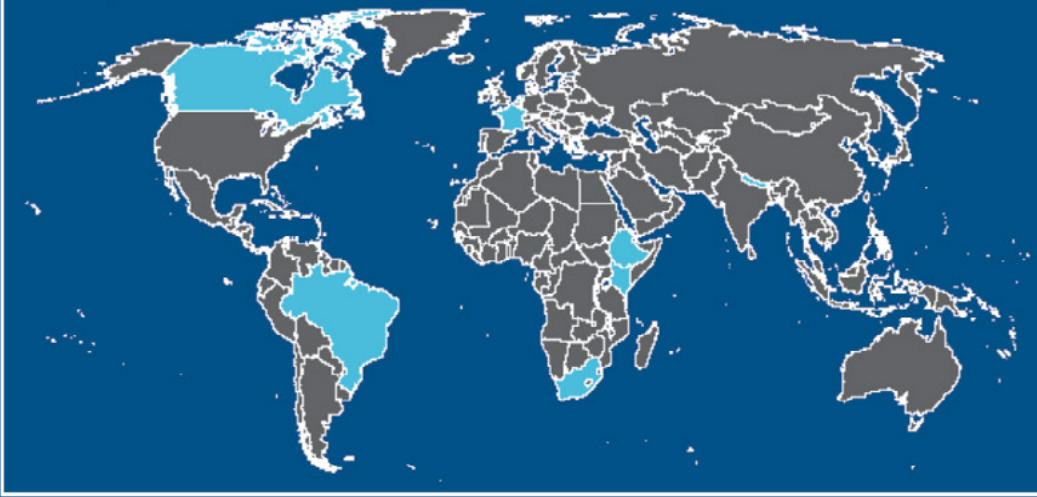
FABADRU by the Numbers

FABADRU

Active Extramural Agreements Funding for FY22-23: $15,332,000.00

Partner Countries (11):

France, The Netherlands, Kenya, Ethiopia, Canada, Mexico, Costa Rica, Jamaica, Brazil, South Africa and Nepal



58 Total Publications:

- 26 Peer-Reviewed Journal Publications
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32 Unique Partners:

- 19 Academic Research Institutions
- 8 Industry Partners
- 9 National/international governmental or non-governmental agencies

60

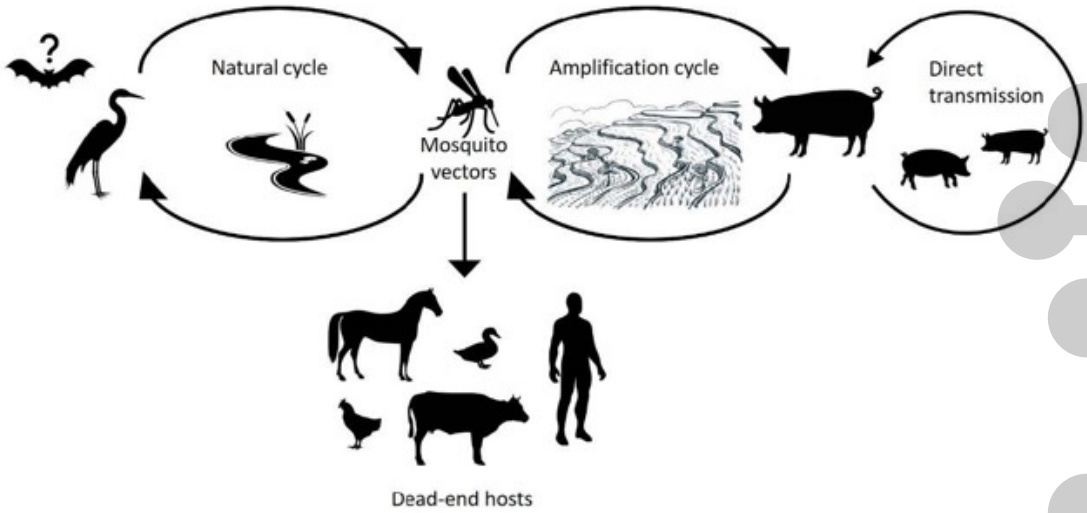
Active Research Agreements

FOREIGN ARTHROPOD-BORNE ANIMAL DISEASE RESEARCH UNIT

FABADRU is a new ARS research unit standing up to support NBAF's science mission. FABADRU focuses on viruses — specifically arboviruses — that are transmitted to animals and humans through arthropod vectors such as ticks, mosquitos, flies and biting midges. Arboviruses pose a threat to the U.S. livestock industry by causing significant disease and economic loss and have the potential to spread diseases to humans through contact with infected livestock. FABADRU aims to **understand risk, early detection and control of arboviruses as well as arthropod vectors** that threaten livestock and impact the health of farmers, veterinarians, meat producers and consumers.

Arbovirus transmission requires a complex balance: the virus must be able to simultaneously infect the arthropod and the mammalian host (FABADRU's focus). FABADRU scientists are working on understanding the intricacies of arbovirus transmission as well as discovering and implementing countermeasures during the transmission cycle that could be deployed in an outbreak or as a preventative measure.

FABADRU is primarily investigating **Rift Valley fever virus (RVFV), Japanese encephalitis virus (JEV)** and **vesicular stomatitis virus (VSV).** Of these, RVFV and JEV are transmitted by mosquitos, and VSV is transmitted by multiple arthropod vectors — including sand flies, black flies and biting midges. Each has a transmission cycle that includes an agricultural animal and can infect humans.



Mulvey, et al., Pathogens. 2021 Dec; 10(12): 1534, doi: 10.3390/pathogens10121534

FABADRU research molecular biologist working with non-infectious mosquitoes.

Building Partnerships to Support the FABADRU Stand-up

While starting operations in a new laboratory can present its own set of challenges, researchers from NBAF's FABADRU must also contend with the added challenge of being a brand-new research unit. Prior to the creation of FABADRU in 2021, the USDA's research on vector-borne pathogens that are transmitted by insects and other arthropods was conducted by the ARS Arthropod-Borne Animal Diseases Research Unit (ABADRU) at the Center for Grain and Animal Health Research (CGAHR), located just a few miles from the NBAF campus in Manhattan, KS.

The newly formed FABADRU received research programs focused on foreign or transboundary and potentially zoonotic animal diseases that can be transmitted by insect vectors from existing USDA units. FABADRU has made strides in standing up its capacity to conduct research on RVFV and JEV, which came from ABADRU and took over responsibility for the VSV research program from FADRU.

Through agreements with partners such as Kansas State University (K-State), researchers have established laboratories in university spaces while NBAF continues to make laboratory spaces operational. Furthermore, FABADRU scientists have partnered with the Biosecurity Research Institute (BRI) — K-State's high-containment teaching and research laboratory — to conduct studies requiring higher levels of biosafety. These studies have included research on JEV transmissibility by observing the ability of local mosquito species to transmit the virus to livestock. FABADRU also has maintained a connection to its origins at CGAHR through the USDA's Insectary and Cell Culture Laboratory (ICCL). This insect breeding and rearing facility, located on the CGAHR campus, receives half of its funding from NBAF and is used to supply the insects that FABADRU researchers need to conduct their mission-critical work.

While there are still milestones to meet before the arthropod laboratory spaces at NBAF are ready for research with live organisms, FABADRU is well on its way to achieving full mission capability. By building and fostering partnerships with K-State and CGAHR, FABADRU scientists can conduct mission-critical research locally in parallel with NBAF achieving full operational capability.

Creating JEV & RVFV Surveillance and Response Capabilities

Japanese encephalitis virus (JEV) and Rift Valley fever virus (RVFV) are viruses that cause vector-borne diseases and are a key focus of FABADRU's research mission. Both JEV and RVFV are zoonotic diseases that are mostly carried by mosquitos and infect both livestock and humans. In human cases, infection generally causes few, if any, clinical symptoms. However, in rare cases, JEV and RVFV can cause severe symptoms, including fever, vomiting and encephalitis — swelling of the brain that can result in debilitating and long-lasting neurological issues and even death.

JEV is largely endemic to the Asia-Pacific region, while RVFV is endemic to large swathes of Africa. While neither disease has yet been identified in the U.S., the warming climate and other factors have led to the expansion of many susceptible mosquito species into new geographical areas. For example, an outbreak of JEV in a previously JEV-free region of Australia — along with the virus's similarity to West Nile and other established vector-borne diseases in the U.S.— has raised concerns about the potential spread of the virus to the western hemisphere.

To prepare for the possible introduction of JEV and RVFV into the U.S., FABADRU has established a broad range of **domestic and international partnerships** to explore surveillance and response strategies nationally and in endemic regions. Through partnerships with the ICCL and K-State, FABADRU researchers have conducted transmissibility studies in pigs to determine if North American mosquito species can transmit JEV.

The scientists used a vaccine strain of JEV to examine if the virus could grow in swine and mosquito cell lines and observe wild-type viral transmission between live mosquitos and pigs in high-containment animal studies. Preliminary results from these studies — which wrapped up in 2022 — indicate that some common North American mosquito species are indeed capable of transmitting JEV. (Continued on next page.)

Trapping site in South Africa pictured above. (Photo Credit: FABADRU)

FABADRU

Additional collaborators at Colorado State University (CSU) are examining whether non-traditional species, including several wildlife species, can act as hosts for JEV — potentially contributing to the transmission cycle. The results of these studies could enhance researchers' understanding of JEV's potential pathways for introduction into the U.S. and expand the range of surveillance options to watch for the disease.

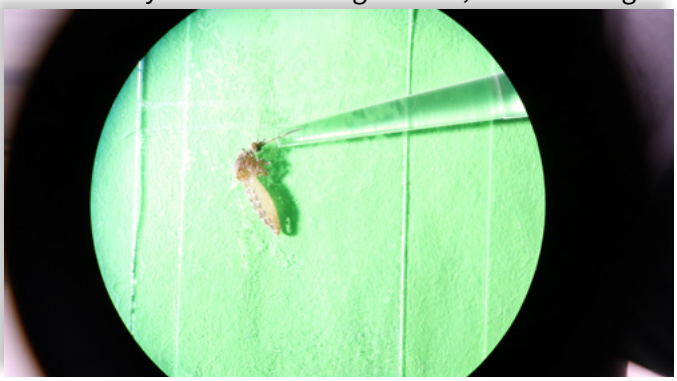
FABADRU molecular biologist setting trap in South Africa.

Much of FABADRU's work with RVFV includes developing diagnostic assays to accurately identify the presence of the virus in laboratory and field settings. This work involves collaborations with academic research institutions and commercial biotechnology companies and, in many cases, can be applied to both RVFV and JEV projects. FABADRU continues to maintain and build relationships with institutions in countries such as Kenya and South Africa, where RVFV is endemic. These international partnerships support surveillance efforts while also allowing FABADRU researchers to test out diagnostics in regions where they are needed most.

Work in these endemic areas also helps researchers better understand the ecological factors involved in viral transmission. For example, increased rainfall could be associated with an increased risk of RVFV transmission, as wetter conditions provide better habitat for mosquito reproduction in ponds, puddles and other bodies of stagnant water. As shifting climate could play a significant role in whether environmental conditions are ideal for RVFV spread, FABADRU has partnered with another team from CSU to examine the effects of temperature on the viral incubation period in mosquitoes. By better understanding the conditions that facilitate RVFV spread, researchers can be alerted to those conditions in the U.S. that could potentially lead to the introduction of the virus.

Developing AI & Machine Learning Tools to Watch for Arboviruses

To help predict outbreaks, FABADRU researchers have partnered with K-State to work on a web-based forecasting application as part of the Predicting Insect Contact and Transmission using historical Entomological and Environmental (PICTUREE) data. The PICTUREE system fuses mosquito population modeling, environmental data and mathematical models to predict disease prevalence and transmission, and forecast the geographical spread and intensity of disease outbreaks. Though it is currently focused on dengue fever, the team began work in 2023 to adapt the PICTUREE application to model JEV and other flaviviruses, such as the West Nile Virus. These cutting-edge advances will help FABADRU scientists improve monitoring capability and detection of potential arthropod-borne disease outbreaks and provide policymakers with the planning capabilities to respond, not just react if a new arboviral disease is introduced to the U.S.



A microscopic view of saliva collection from a non-infectious, female mosquito.

A herd of Jersey cows experiencing a VSV outbreak at a field site in Costa Rica.

Assuming Responsibility for VSV from FADRU

VSV is a virus endemic to Mexico that predominantly infects and causes disease in cattle and horses but also affects pigs, sheep and goats. It is a zoonotic disease, meaning it is capable of being transmitted from infected animals to humans, where it causes influenza-like symptoms. In animals, the virus mimics FMD by causing blister-like lesions in the mouths and on the hooves of infected animals. It is only distinguishable from FMD through laboratory testing. This similarity to FMD poses a threat in and of itself, as VSV outbreaks may mask the introduction of FMD into the U.S. As such, VSV research is one of ARS's critical focus areas.

The VSV lifecycle is complex and results in a cyclical pattern of outbreaks throughout the southwestern and western United States. Transmission of the virus involves multiple vector species, primarily black flies, sand flies and biting midges; however, the vector process is not entirely understood, and multiple other insect species such as mosquitoes could be involved as well. The complicated epidemiological nature of VSV outbreaks requires a comprehensive, holistic approach to study the disease.

In 2016, the USDA initiated a first-of-its-kind VSV Grand Challenge project. This multi-spectrum approach brings together virologists, entomologists, ecologists, climate scientists and epidemiologists with the USDA's SCINet super-computing capabilities to tackle the complex challenges posed by VSV. This project was originally spearheaded by FADRU out of Plum Island and includes agreements with units across USDA and academic research partners at New Mexico State University (NMSU).

Since this research program was established with FADRU and transferred to FABADRU, both units have been working together to continue coordinating and expanding the project. The data generated will be used to help model the distribution and expansion of VSV, especially in the context of continued climate change. The goal is to use VSV transmission as the basis of a model that can be used to prepare for outbreaks of other vector-borne diseases throughout the U.S.

ZEDRU by the Numbers

ZEDRU

Active Extramural Agreements Funding for FY22-23: $17,788,000.00

Partner Countries (7):

Australia, the Democratic Republic of Congo, Kenya, Liberia, Sierra Leone, Tanzania and Uganda

7 Total Publications:

- 3 Peer-Reviewed Journal Publications
- 2 Abstract Only Submissions
- 2 Book Chapters

18 Unique Partners:

- 11 Academic Research Institutions
- 2 Industry Partners
- 5 National/international governmental or non-governmental agencies

23 Active Research Agreements

ZOONOTIC & EMERGING DISEASE RESEARCH UNIT

ZEDRU is another new ARS research unit standing up to support NBAF's science mission. ZEDRU is focused on emerging and re-emerging pathogens that can potentially affect both animals and humans, primarily those classified as Risk Group 4 agents. These pathogens pose the greatest risk to animal and human health and require maximum biocontainment to work with and store. ZEDRU, in close coordination with other units at NBAF, will operate the facility's Animal Biosafety Level-4 Agriculture (ABSL-4Ag) laboratory. NBAF's ABSL-4Ag is the first laboratory in the U.S. specifically designed for work with livestock and other large animals requiring maximum biocontainment.

ZEDRU's mission is to protect the U.S. from zoonotic and emerging diseases of the highest consequence to animal and public health through the performance of **basic and applied research.** ZEDRU scientists work to understand disease pathogenesis and host-pathogen interactions. According to the World Health Organisation, more than 70% of new and emerging infectious diseases in humans are zoonotic, meaning they can be transmitted from animals to humans. By better understanding the distribution and risks associated with these diseases, ZEDRU scientists help prepare the U.S. to respond better to these biological threats.

The team is primarily focusing its efforts on **Crimean-Congo hemorrhagic fever (CCHF), Nipah** and **Hendra** viruses. While NBAF stands up science operations, ZEDRU staff have focused on establishing international partnerships to understand current and evolving needs to fight emerging and zoonotic animal diseases. ZEDRU is partnering with nearly 20 academic institutions, industry organizations and foreign governments to map disease distributions and risks. These partners are important in developing culturally appropriate protocols, including translations in areas where these diseases are endemic, national protocols to address USDA priorities, developing and implementing training and sharing timely information to assess risks.

Partnerships Drive Advancement of New Assays to Identify Henipaviruses

NBAF collaborator collects samples from a bat for evaluation of new assays.

A group of viruses known as henipavirus, mainly carried by fruit bats, includes several emerging pathogens, such as the **Hendra** and **Nipah** viruses, which can cause fatal disease outbreaks in humans and animals. In conjunction with their collaborators, the ZEDRU team seeks to better understand the complex ecological factors that drive the transmission of these viruses from their wildlife reservoirs to susceptible livestock and human hosts. Ultimately, researchers hope to use their findings to develop systems and strategies to detect, respond to and prevent henipavirus infection in domestic animals.

One of the key elements of a successful surveillance strategy is to develop **diagnostic assays,** or investigative procedures, that are sensitive, specific and easy to use. In partnership with the Broad Institute in Cambridge, Massachusetts, ZEDRU scientists are working to develop assays that can reliably detect henipaviruses in samples. Developed by the Broad Institute in 2020, the Combinatorial Arrayed Reactions for Multiplexed Evaluation of Nucleic acids (CARMEN) diagnostic platform is a technology that enables researchers to evaluate multiple samples for a wide range of potential pathogens. In 2023, ZEDRU researchers worked with the Broad Institute to adapt the CARMEN technology to detect henipaviruses. Scientists are continuing to develop and evaluate the CARMEN assay during 2024 to enhance diagnostic capability that can be shared with partner countries in high-threat regions.

By building both domestic and international collaborations, the ZEDRU team is laying the groundwork to establish a **formal laboratory network for international henipavirus surveillance.** This network will seek to standardize specimen collection, laboratory testing, quality control, specimen referral and laboratory accreditation. Through the provision of support and expertise, as well as continued work with collaborators such as the Broad Institute and the University of Texas Medical Branch (UTMB), the ZEDRU team at NBAF continues to address the emerging threat of henipaviruses.

International Efforts Develop Intervention Strategies to Prevent & Control CCHF

Crimean-Congo hemorrhagic fever (CCHF) is a viral zoonotic disease caused by the tick-borne virus, Nairovirus, which is primarily endemic to Africa, the Middle East and Central Asia, with portions of its range extending into southern Europe, China and the Indian subcontinent. The virus is spread through the bite of an infected tick or through contact with infected blood or animal tissues.

Though not currently found in the U.S., the potential importation or introduction of CCHF Virus (CCHFV) could profoundly impact the nation's agricultural sector. To help combat this threat and to support the wider global efforts to defend against CCHFV, ZEDRU researchers are partnering with multiple organizations to address gaps in the global research communities' understanding of these agents. These efforts include work to develop and strengthen new and existing surveillance programs in partner countries to better monitor the risks and prevalence of CCHFV in domestic livestock herds and to better understand the ecological factors that govern viral transmission.

A key component of these efforts has been ZEDRU's partnership with researchers at the University of California, Davis (UC Davis). In conjunction with their Tanzanian host-nation partner, the Ifakara Health Institute and Sokoine University of Agriculture, the team conducted in-country surveillance work to increase the understanding of the complex dynamics of CCHFV transmission between ticks, livestock and human populations in 2023.

There are still many steps to complete before NBAF's BSL-4 laboratory spaces are ready for ZEDRU scientists to begin studies on CCHFV and other high-consequence zoonotic agents. Partnering with a CCHF network of investigators allows ZEDRU scientists to leverage their expertise within the research and public health communities to accomplish their mission.

Attendees are pictured from the CCHF Research Gap Analysis in Montpellier, France.

Collaborating to Conduct a CCHF Research Gap Analysis

In recent years, CCHF has emerged as a disease of increasing priority in the international medical and scientific community. As climate change has expanded the geographical range of tick species that carry the virus, more countries are increasing research efforts to understand the ecology of CCHFV transmission better. Expanding surveillance and diagnostic capabilities also will help scientists monitor viral spread and reduce disease. ZEDRU and other USDA ARS partners have been driving efforts to connect CCHF researchers from the global scientific community, aiming to prioritize CCHF research in arthropods and animals as well as develop strategies and capabilities to respond to this emerging disease effectively.

In 2023, these efforts culminated in an international CCHF Gap Analysis Workshop hosted in Montpellier, France. Funded by USDA ARS and the French Agricultural Research Centre for International Development (CIRAD) and spearheaded by a ZEDRU collaborator at UTMB, the workshop expanded the discussion about CCHF research. More than 50 CCHF international researchers attended, including those from the USDA APHIS and ARS, other U.S. and Western European institutions, as well as many stakeholders from regions where CCHF is endemic, such as Kenya, Uganda, South Africa, India, Turkey and the United Arab Emirates (UAE).

Through the CCHF Gap Analysis workshop, ZEDRU and its partner organizations began fostering a network of investigators across the global research community. Key gaps identified during the workshop included a need to better understand why the virus causes disease in humans but not animals and to develop diagnostics and surveillance strategies to identify the spread of CCHFV in tick and animal populations to help prevent human infections. With a roadmap developed and a global community of researchers beginning to coalesce around the work, the team aims to establish a formal global alliance for CCHF research to tackle the complex challenges posed by CCHF and other emerging diseases.

BDM by the Numbers

BDM

Active Extramural Agreements Funding for FY22-23: $2,956,000.00

7 Unique Partners:

- 2 Academic Research Institutions
- 5 Industry Partners
- 1 National/international governmental or non-governmental agencies

60+

Stakeholder Tours

Stakeholder Conference:

- 75 Attendees
- 30+ Organizations

10

Active Research Agreements

BIOLOGICS DEVELOPMENT MODULE

The Biologics Development Module (BDM) is a unique, proof-of-concept production facility inside NBAF's secure campus. It is designed to enhance and expedite the transition of innovations from research to commercially-viable countermeasures like vaccines and diagnostics.

The BDM laboratory space exists outside NBAF's BSL-3 and BSL-4 laboratory spaces and operates as a BSL-2 laboratory space. Within NBAF's secure campus and with access to facility safety support systems, some areas of the BDM can scale up to function as a BSL-3 production space if needed.

Through a project development plan, the BDM will help industry partners see the potential in new discoveries developed through NBAF's research and de-risk those potential projects so industry stakeholders can understand their return on investment.

The BDM will focus its efforts on:

- Transitioning NBAF research projects into development projects.
- Performing proof-of-concept studies for safety and efficacy.
- Scaling up processes.
- Developing analytical tools to support projects.

By reducing the risk undertaken by industry partners, the BDM team hopes to enhance the number of veterinary medical countermeasures available on the market to meet emerging threats to U.S. agriculture.

The BDM will create opportunities for partnerships and collaborations between NBAF scientists and private pharmaceutical and animal health companies to develop new vaccines, biotherapeutics, diagnostics and pathogen detection products. They will perform the scientific work needed to confirm product efficacy and establish datasets needed for product licensure.

As a component of NBAF, the BDM has the capability to plan and facilitate animal studies in cattle, swine, goats and sheep to generate both proof-of concept data as well as the data required for regulatory submissions. The science done within the BDM will reduce the risk for industry partners in getting a veterinary product to licensure and allow for better realization of research discoveries applications.


BDIM

Building a Strong Foundation

With their focus on expediting research breakthroughs from the benchtop to the manufacturing space, the BDM team is diligently working to establish their unique capabilities within the NBAF team as the facility moves toward full-scale operations. As the first-of-its-kind in the USDA, the BDM is starting with a blank slate as they build out their laboratory spaces and develop the necessary workflow processes to accomplish their mission.

In 2023, the BDM completed the process of fitting out their spaces, moving more than 140 pieces of equipment into the laboratory and beginning the process of validating and calibrating the equipment for operation.

BDM Director Steve Witte setting up his space at NBAF.

BDM Hosts Stakeholders Conference

One of the key features of the BDM is its ability to work directly with external partners to support and accelerate the technology transfer of benchtop innovations to the industry. This synergy is designed to get the latest advances in diagnostics, biotherapeutics, vaccines and other veterinary medical countermeasures into the hands of farmers, producers and veterinarians as quickly as possible. It is a challenging mission requiring close collaboration between researchers and industry — especially since the BDM is a new organization within a brand-new facility.

A critical first step toward the successful start-up of the BDM is to establish and build relationships with industry partners and other external stakeholders. In June 2023, these partnership development initiatives culminated in the **NBAF BDM Stakeholder Conference.** This conference in Manhattan, KS, brought together more than 75 attendees from more than 30 government, academic and industry organizations. The conference allowed BDM leadership to discuss their mission and capabilities directly with potential collaborators. This interaction led to the development of **10 research agreements with industry partners.** These agreements will serve as the cornerstone of the BDM's initial involvement with industry and will pave the way for future engagements on innovations in veterinary biotechnology as the laboratory sets its sights on full operational capability.

NBAF hosted a BDM Stakeholder Conference in Manhattan, Kansas in June 2023.

FADDL by the Numbers

FADDL

22
Peer-Reviewed
Journal Publications

NAHLN: 60 state and university laboratories across the U.S

DIAGNOSTIC TESTING:

44K+
SAMPLES
(4,396 Accessions)

Global Partnerships for Animal and Zoonotic Disease Surveillance (GPAZDS):

- Uganda
- Nigeria
- Philippines
- Gambia
- Cameroon
- Senegal
- Ghana
- Jordan

National Animal Health Laboratory Network (NAHLN) is a network of animal disease diagnostic laboratories that provide disease surveillance across the nation and can provide diagnostic needs during animal disease outbreaks.

FOREIGN ANIMAL DISEASE DIAGNOSTIC LABORATORY

One of four National Veterinary Services Laboratories (NVSL), the Foreign Animal Disease Diagnostic Laboratory (FADDL) was established at the Plum Island Animal Disease Center (PIADC) in New York. FADDL's mission includes **24/7 diagnostic testing, emergency response and training support** for federal and state veterinarians and diagnosticians. This laboratory conducts diagnostic testing and develops response measures to high-consequence infectious diseases of livestock, including foot-and-mouth disease (FMD), African swine fever (ASF) and classical swine fever.

FADDL's diagnostic mission currently is accomplished in three locations: PIADC, NBAF and the Puerto Rico Department of Agriculture. FADDL is a **national reference laboratory** through the National Animal Health Laboratory Network (NAHLN), an **international reference laboratory** for the World Organisation for Animal Health (WOAH), and a reference center for the Food and Agriculture Organization (FAO) of the United Nations. FADDL also manages two vaccine banks that store vaccine antigen concentrate that can be formulated into vaccines if FMD introduction occurs in the United States. One of the banks also stores diagnostic kits and other countermeasures.

FADDL hosts the **Foreign Animal Disease Diagnostician (FADD) School,** a course that provides collaborative and interactive learning opportunities for federal, state and military veterinarians. The course includes instructor-led presentations, facilitated discussions, daily clinical rounds in the animal rooms, necropsies and a simulated foreign animal disease investigation. The FADD School trains participants in crucial field identification skills to establish a differential diagnosis of a foreign animal disease in poultry and livestock, as well as the steps to perform field investigations and correct sample submission procedures.

Left: Plum Island Animal Disease Center in Orient Point, NY; Right: Puerto Rico Department of Agriculture in Dorado, PR

FADDL is composed of five service sections:

THE DIAGNOSTIC SERVICES SECTION

Scientific staff in this section perform diagnostics for more than 30 foreign animal diseases, including FMD, CSF, ASF and other diseases listed by WOAH. They perform thousands of diagnostic tests each year, looking for the detection of foreign animal diseases. Tissue and blood samples that need testing are submitted by veterinarians who suspect a foreign disease in domestic livestock or by animal import centers testing quarantined animals for foreign diseases. Samples also are submitted by animal health professionals in other countries who need help with a diagnosis.

THE REAGENTS AND VACCINE SERVICES SECTION

Scientific staff in this section develop, produce and test standard diagnostic reagents, conduct material safety treatments, prepare animals for FAD demonstration in the Foreign Animal Disease Diagnostician School, operate the National Transboundary Animal Disease Biorepository and WOAH-FAO Rinderpest Holding Facility, and conduct diagnostic assay development and optimizations.

THE SCIENTIFIC LIAISON SERVICES SECTION

Scientific staff in this section provide scientific support for pathogen surveillance and discovery by developing and applying advanced metagenomics analysis, a genetic analysis of genomes contained with an environmental sample. They collaborate with national and international partners to develop and field-evaluate novel diagnostic methodologies as well as build and support NBAF's BSL-4 laboratory competency and operations.

On the left, a Plum Island scientist looks at flasks through a microscope in the 1950-60s. Recreating the image, NBAF's Alana Harrison, FADDL biological science laboratory technician, looks at a seed culture of hamster cells under a modern-day microscope in NBAF's BSL-2 laboratory.

THE PROFICIENCY AND VALIDATION SERVICE SECTION

Scientific staff in this section support the NAHLN by producing proficiency panels and controls for foreign animal disease diagnostics, verifying and validating diagnostic tests for internal and external stakeholders and serving as liaisons for risk analysis and coordination of foreign animal disease safety testing for import and export materials of animal origin.

THE VACCINE BANKS

Scientific staff in this section procure and test supplies for the North American Foot-and-Mouth Disease Vaccine Bank and the National Animal Vaccine and Veterinary Countermeasure Bank, maintain vaccine stockpiles, produce reagents, provide technical support and enhance preparedness and emergency response capability and capacity for foreign/transboundary animal diseases.

Ongoing Support of the ASF Outbreak Response in the Dominican Republic & Haiti

Preventing the potential introduction of African swine fever (ASF) into the U.S. has long been one of the key factors in USDA's strategic goal of providing America with a safe and secure food supply. Although the ASF virus does not threaten human health, this highly contagious disease is devastating to both wild and domestic pig populations.

In response to the expansion of ASF globally, a capacity building program was established in 2018 between USDA and the central veterinary laboratory in the Dominican Republic, Laboratorio Veterinario Central (LAVECEN). The program involved providing diagnostic resources to LAVECEN to build within-country capacity to conduct diagnostic testing for ASF. While the capacity building program was underway, samples were sent to FADDL quarterly to test high-risk swine populations for ASF. In July 2021, FADDL at PIADC confirmed ASF in a sample set from the Dominican Republic, which marked the first time the virus had been reported in the Western Hemisphere since the 1980s. Soon thereafter, due to relationship building with Haiti, ASF was also confirmed by FADDL to be present in Haiti. The detections initiated an island-wide outbreak response for Hispaniola. By August, the first team of FADDL scientists had deployed to the Dominican Republic to assist in containing the outbreak and providing in-country diagnostic support with colleagues in LAVECEN. Since 2021, the National Veterinary Services Laboratories (NVSL) has maintained a continual presence of diagnostic staff within LAVECEN through deployments to provide continued diagnostic support.

The broader response consists of two main lines of effort. FADDL scientists assist local scientists in the LAVECEN in Santo Domingo. There, they help run blood and tissue samples, sometimes a thousand or more samples a day, through polymerase chain reaction (PCR), identifying in animals and farms where the disease is present, shaping the outbreak response. Positive ASFV samples are collected and shipped to PIADC, where they can be sequenced so that researchers can better characterize the viral strains circulating on the island.

In tandem with direct support to the Dominican Republic, FADDL has increased ASF surveillance activities in Puerto Rico, which is just over 70 nautical miles from the Dominican Republic at its closest point and is the nearest U.S. territory to the outbreak. Because Puerto Rico is a U.S. territory and close to Dominican Republic, the USDA enacted a World Organisation of Animal Health Protection Zone around Puerto Rico, to provide additional support and protection from the introduction of ASF into Puerto Rico and the U.S. As the outbreak began on the island of Hispaniola, teams of scientists were deployed to support the development of USDA laboratory in Puerto Rico in collaboration with the Puerto Rico Department of Agriculture in Dorado, Puerto Rico, to test samples from pig populations throughout the island to ensure that they remained ASFV-free. These deployments continued until September 2022, when the USDA hired a full-time staff on-site to support these increased surveillance efforts. (Continued on next page.)

LAVECEN Microbiologist preparing a sample for African swine fever PCR testing.

Through the sustained and continuous deployment of scientists from PIADC, NBAF and across the NVSL to support the response efforts in the Dominican Republic, as well as the commitment to enhanced ASF surveillance in Puerto Rico, FADDL continues to demonstrate its commitment to defending the U.S. from the introduction of this highly destructive disease. Puerto Rico and the mainland U.S. continue to be free from ASF and continued efforts are directed to the Dominican Republic to control disease spread.

Ensuring Proficiency Where It's Needed Most

As the national and an international reference laboratory for foreign animal diseases, FADDL scientists are considered the foremost experts when it comes to confirming and responding to foreign or transboundary high-consequence pathogen outbreaks. However, they cannot accomplish this mission alone. The National Animal Health Laboratory Network (NAHLN) is a network and partnership of 60 state and university diagnostic laboratories across the U.S. During peacetime, this laboratory network conducts routine diagnostic testing for many animal diseases endemic to the U.S. The NAHLN also serves a unique role to receive samples of suspected foreign animal disease cases from veterinarians in the field and serves as the first line of defense in detecting biological threats to livestock. If the NAHLN were to have a non-negative test result, the result is confirmed at FADDL as the national reference laboratory.

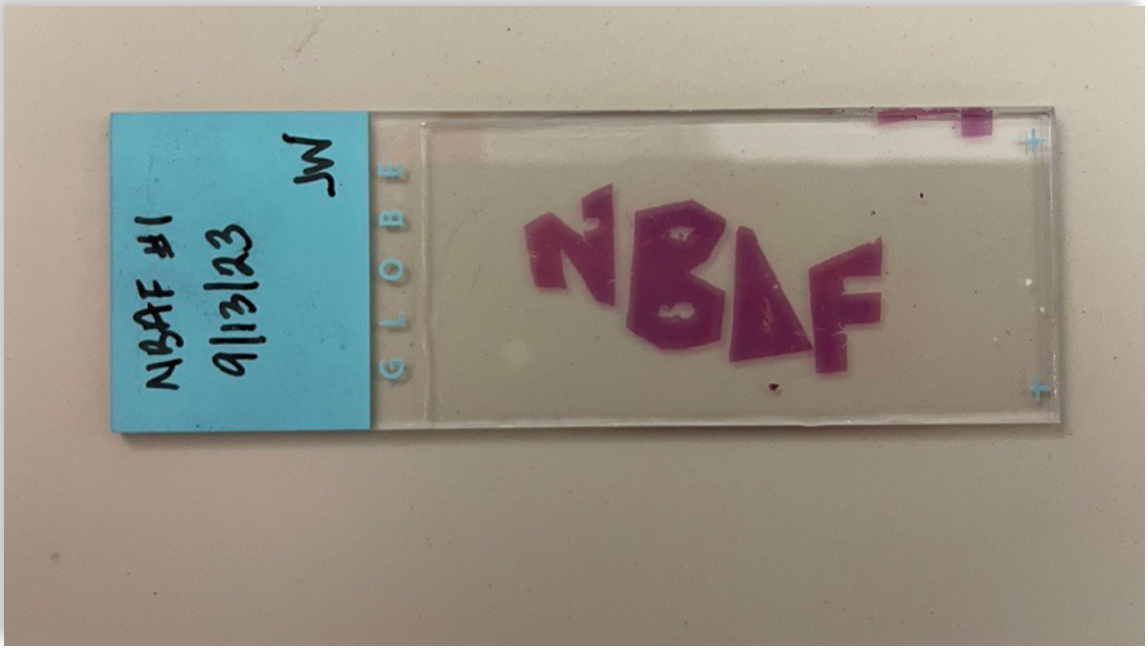
BSL-2 Laboratory at NBAF

Rapid and accurate identification of high-consequence pathogens is critical to ensuring a timely outbreak response. The FADDL Proficiency Testing (PT) Group is responsible for ensuring NAHLN laboratories can readily identify foreign high-consequence pathogens that could devastate animal agriculture in the U.S. and are meeting the quality standards required for diagnostic testing.

Every year, scientists from the FADDL PT group prepare, quality check, ship and administer proficiency testing to more than 300 individuals working in NAHLN laboratories to ensure that they are capable of accurately and consistently identifying samples that are positive for CSF, ASF and FMD through PCR. Each proficiency test is manufactured to the highest level of quality, with the PT Group having achieved ISO 17043 accreditation for both the FMD and CSF panels. Anywhere from 200 to 300 tests are manufactured annually for each of the targeted foreign animal diseases.

Through the development and administration of high-quality PT tests to NAHLN laboratories, the FADDL PT group ensures frontline laboratories across the country have the necessary skills and capabilities to diagnose foreign animal diseases rapidly and accurately. As the PT group can develop proficiency panels using synthetic components without needing to handle viruses, they will be one of the first groups to fully transfer operations from PIADC to NBAF. Laboratory stand-up activities in their laboratory spaces have been completed, and the next set of PT test panels are slated to be manufactured at the NBAF facility, with plans to pursue ISO 17043 accreditation for ASF panels in addition to those for FMD and CSF.

The FADDL PT team holds added value to support not only the NAHLN laboratories, but international stakeholders as well as internal stakeholders. The FADDL PT team supports the distribution of PT panels to other countries upon request to support international capacity building efforts, and supports staff within FADDL and the NVSL to build internal capacity for cross-training and expanded capability for diagnostic testing.



Tissue sections mounted on the slides were cut to form the word "NBAF" when viewed under a microscope.

Histopathology Lab Prepares for Diagnostics

An invaluable research asset for NBAF, the FADDL histopathology laboratory focuses on imaging and observing the effects of disease processes in animal tissues at the cellular level. To accomplish this mission, FADDL laboratorians take tissue samples from both diseased and healthy tissues for comparison, fix them in formalin, and then archive them in paraffin blocks for further study and developing a pathologic diagnosis.

To validate their processes and procedures, the FADDL histopathology team at NBAF recently teamed up with one of the other NVSL labs with expertise in pathology, the Diagnostic Bacteriology and Pathology Laboratory (DBPL) in Ames, Iowa. NVSL scientists shipped tissues from sheep that were verified to be disease-free to NBAF, where the tissues were processed and mounted on slides to be used as healthy reference tissues. These samples were some of the first scientific work to be conducted at the new facility. To mark this historic occasion, some of the tissue sections mounted on the slides were cut to form the word "NBAF" when viewed under a microscope. (See photo above.)

In addition to validating staining and tissue processing procedures and preparing for full-scale operations, scientists from the histopathology laboratory have been working to train on a new type of technology that changes the substrate color if a particular pathogen is present thus enhancing diagnostic capabilities. The histopathology laboratory at NBAF holds additional functionality in automated sample processing, digital scanning and inventory management of archived materials, further expanding upon the diagnostic capacity from PIADC.

With their initial capabilities validated and training underway to incorporate new technologies and skillsets into their repertoire, the scientists of the histopathology laboratory are ready to begin assuming the next stage of FADDL's operational diagnostic mission at NBAF.

FADDL

FADDL Genomics Core Established in NBAF First

FADDL Biological Scientist sequencing a house fly genome at NBAF.

The FADDL Genomics Core will provide diagnostic and methods development genome sequencing capabilities at NBAF. This team was the first laboratory cleared to conduct scientific work on-site at NBAF. To test their workflows and capabilities in the new space, FADDL scientists partnered with researchers from the ARS Arthropod-Borne Animal Disease Research Unit (ABADRU) at the USDA Center for Grain and Animal Health Research (CGHAR) to sequence house flies.

Scientists are exploring their potential role as vectors as part of a joint research project that started in September 2023. ABADRU researchers collected the flies from sample sites around Manhattan, KS and delivered them to NBAF personnel, who then prepared the samples and completed genetic sequencing. In addition to the fly's genetic information, sequencing can also detect the genomes of any bacterial or viral pathogens that may be present in the samples. Collaborations like this help illuminate the potential for certain species to act as reservoirs or vectors of disease and highlight what can be achieved by leveraging the unique capabilities provided by both FADDL and ARS.

As operations at PIADC begin to scale down through the PIADC to NBAF transition, the FADDL Genomics Core at NBAF will continually increase operations to support FADDL's diagnostic mission. In February 2024, the FADDL Genomics Core received the first samples for diagnostic characterization. The first samples originated in the Dominican Republic, tested positive for ASF virus by NVSL staff deployed at LAVECEN, then inactivated and sent to the NVSL in Ames, Iowa. NVSL colleagues in Ames then extracted the samples to yield purified DNA, which is considered BSL1 material. The purified DNA was then sent to NBAF to be sequenced in the FADDL Genomics Core. The team has sequenced over 200 samples and will continue to support and expand upon diagnostic sequencing capabilities through the transition from PIADC.

FADDL at NBAF receiving samples for diagnostic characterization in May 2024.

GPAZDS supporting capacity building workshop at the Center for Transboundary Animal Diseases, Central Luzon State University in The Philippines.

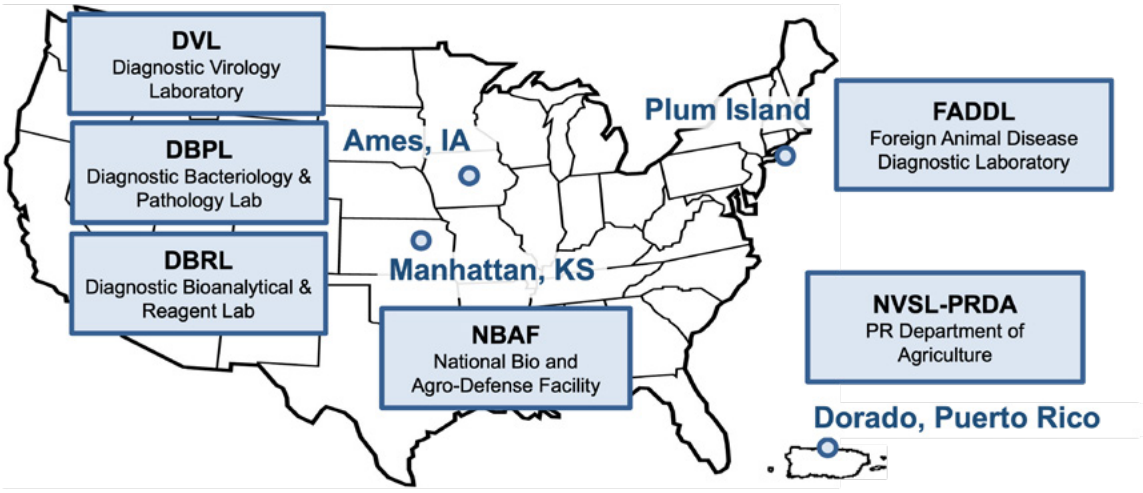
Forging Global Partnerships to Address Disease Threats

The mission of FADDL and NBAF focuses on high consequence transboundary diseases that are not within the U.S. In order to strengthen preparedness and response efforts to these diseases, it is critical that NBAF's scientists engage with international partners where the diseases are present, in order to understand disease dynamics and the effectiveness of disease response efforts currently in use.

To address this need, FADDL established a **Global Partnership for Animal and Zoonotic Disease Surveillance (GPAZDS),** which seeks to implement strategic surveillance support outbreak investigations of transboundary and emerging pathogens in partner endemic countries and acquire disease intelligence to protect U.S. agriculture and public health. The first round of the GPAZDS implementation involved nine laboratories from eight countries in South Asia and Africa, including the Philippines, The Gambia, Senegal, Cameroon, Ghana, Uganda, Nigeria and Jordan.

The partner laboratories and institutions successfully implemented their proposed projects on the different transboundary and emerging diseases, including African swine fever, Crimean Congo hemorrhagic fever (CCHF), Rift Valley fever (RVF), Peste des petites ruminants (PPR), Foot-and-mouth disease (FMD), classical swine fever (CSF), Japanese encephalitis (JE) and Marburg virus disease (MVD). Projects involved evaluation of seroprevalence studies of the disease of interest, as well as methods development to enhance diagnostic capacity.

THE NATIONAL VETERINARY SERVICES LABORATORIES (NVSL)



Partnering with Veterinary Diagnostic Laboratories

A critical stakeholder for FADDL is the National Animal Health Laboratory Network (NAHLN), which is a series of veterinary diagnostic laboratories across the U.S. conducting essential diagnostic and developmental activities to protect animal health. In order to connect the NAHLN with NBAF, a NAHLN-NBAF partnership was formed to improve the early detection of emerging diseases. In 2023, NAHLN laboratories from across the U.S. applied to be one of five NAHLN labs selected to partner with NBAF through this program. The five selected laboratories include Cornell University Animal Health Diagnostic Center and New York State Veterinary Diagnostic Laboratory (Region 1), Virginia Tech Animal Laboratory Services (Region 2), Michigan State University Veterinary Diagnostic Laboratory (Region 3), Arizona Veterinary Diagnostic Laboratory (Region 4) and the Washington Animal Disease Diagnostic Laboratory (Region 5).

The overall purpose of the NAHLN-NBAF Partnership is to expand the reach of NBAF, while simultaneously enhancing the capabilities and capacities of all laboratories within the network. Each of the five selected NAHLN laboratories will identify a dedicated scientist, who will provide risk assessments and response preparedness activities for animal and zoonotic disease threats in their region as well as across the U.S..

In 2023, the NAHLN-NBAF Partnership formed an ad hoc team to address the emerging concerns with Canine Infectious Respiratory Disease Complex, providing an opportunity to develop a framework and standard operating procedure for collaboration and response activities. The group evaluated laboratory capabilities and was able to support sharing protocols across laboratories. The laboratories developed a system to share sequence data so that a comparison of the sequence analysis and interpretation could occur. The Partnership host labs are reviewing a proposal to pilot an Electronic Laboratory Reporting tool in collaboration with the Center for Informatics and Center for Epidemiology and Animal Health.

The NAHLN-NBAF Partnership Laboratories further expanded their capacity by participating in the APHIS unusual morbidity and mortality event (UME) program, conducted PCRs for common differential diseases to unusual disease situations coupled with conventional and next-generation diagnostic methods and provided support through the avian metapneumovirus coordinating cell.

FADDL

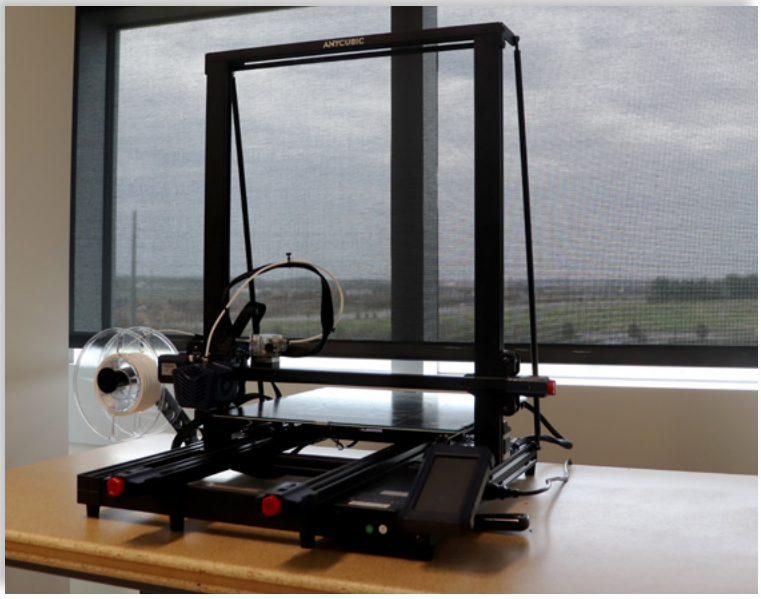
Evaluating Vector Risks Internationally

African swine fever (ASF) is a high-consequence disease of swine and has never been detected within the United States. Following the detection of ASF on the island of Hispaniola, response efforts amplified to assure preparedness and build diagnostic capacity within the U.S. Another area identified as a gap to address involved the risks associated with vector transmission of ASF. A National Pork Board-funded study was developed in collaboration between FADDL, the Diagnostic Bioanalytical and Reagent Laboratory (DBRL) of the NVSL and Texas A&M University.

Prior to the start of this study, researchers at PIADC had determined that soft ticks are present and widely distributed throughout the Dominican Republic and Haiti. This prior work did not detect ASF virus in any ticks collected in country; however, the methods for tick collection and virus detection used have since improved warranting further investigation during this second ASF virus outbreak in the Dominican Republic. The study objectives include to identify the species of *Ornithodoros* spp. of ticks found in the Dominican Republic, to assess threat risk and vulnerability of *Ornithodoros* spp. ticks to serve as potential ASF virus reservoirs and to test *Ornithodoros* spp. ticks for ASF virus.

A collaborative team including staff at the National Center for Animal Health, NBAF and Texas A&M meet regularly to plan the study. In May 2024, the team completed an initial scoping and capacity building trip to the Dominican Republic. The team met with stakeholders from the Ministry of Agriculture, the General Directorate for Livestock, LAVECEN and the Dominican Republic Pork Association to present the research proposal and gauge levels of stakeholder interest and support. The team secured laboratory spaces at LAVECEN for processing tick specimens and identified suitable sampling locations in the northern and eastern sections of the Dominican Republic. Additional trips will occur to collect ticks and begin sample processing and diagnostic testing.

Building Labs Through 3D Printing



NBAF 3D printer located in copy room in office spaces.

The stand-up of a new facility requires adaptability and flexibility. While lab spaces were outfitted with all the anticipated equipment and consumables to support scientific activities, situations have arisen where materials are needed that are customized to the uniqueness of the activities occurring within NBAF's laboratory spaces. In order to address the needs to be flexible and adaptable, in collaboration with colleagues at NCAH and PIADC, FADDL now has filament deposition modeling, also known as 3D printing, capabilities in laboratory support spaces at NBAF.

An example of the value of having the ability to print customized materials relates to FADDL's broader diagnostic mission and expanded capacity and technology at NBAF. FADDL laboratory spaces at NBAF have multiple liquid handler robotics platforms and these systems often require custom designed holders and racks to store materials on the robotics platform while liquid is being automatically moved from one tube to another inside the robotics platform and these custom-printed objects provide the ideal solution for that need.

Addressing Stakeholder Needs to Evaluate New Sample Types for ASF

Collecting aggregate oral fluid from pigs.

Due to the increased preparedness efforts for ASF, swine stakeholders across the U.S. have been sharing input on methods to improve disease detection and surveillance efforts. One sample type that has garnered significant interest is oral fluids.

In order to address stakeholder needs, FADDL has been collaborating with various entities to evaluate facets of oral fluids as a potential sample type for ASF, including limit of detection studies and lab-based infection studies of different ASF genotypes. A major gap from the studies conducted was the evaluation of oral fluids performance in the field in an endemic country.

Therefore, FADDL partnered with colleagues in Ghana to develop a field-based study on oral fluids for ASF. The study involved collecting oral fluids and paired approved sample types from swine infected with ASF in a natural outbreak setting but structured in sampling timelines to provide a robust dataset to be used to evaluate the ultimate fit-for-purpose of oral fluids for ASF.


oneNIBAIT

OneNBAF PARTNERSHIPS

Building the Four: ARS ZEDRU and APHIS FADDL Teams Work Together to Prepare NBAF BSL-4 Laboratory Spaces

NBAF is a state-of-the-art facility with a unique mission, requiring close collaboration between multiple agencies and operational units. This need for collaboration is readily apparent in the facility's BSL-4 laboratory spaces. While all units embrace the "OneNBAF" culture of collaboration, due to the unique nature of the working environment, the NBAF BSL-4 Team is jointly comprised of scientists and staff from APHIS, ARS and the Animal Resource Unit (ARU). This team works closely with other facility units, including Biorisk Management (BRM), Laboratory Support Services (LSS), the Facilities, Operations and Maintenance Unit (FOMU), as well as Security to prepare for safe and secure laboratory operations.

NBAF is the first maximum biocontainment facility in the nation to have Animal Biosafety Level-4 Agricultural (ABSL-4Ag) spaces. The ABSL-4Ag spaces at NBAF will allow scientists to design experiments to address critical mission needs and to work with appropriately sized animals. Many collaborations with international ABSL-4Ag laboratories are already occurring as these laboratories are looking to leverage the capabilities that NBAF will provide to expand the scope of the research they can accomplish.

The NBAF BSL-4 Team is leveraging each member's diverse skills and backgrounds to build a multi-disciplinary team capable of tackling complexity of laboratory stand–up. Current priorities include working closely with operations and facilities personnel to validate the material condition of the laboratory spaces, a process known as "fit and finish."

In addition, the team is collaborating with other BSL-4 and ABSL-4Ag laboratories to develop workflows and standard operating procedures (SOPs) to ensure the planned research can be conducted safely and efficiently once the laboratory is fully operational. As part of this effort, the team has begun implementing training programs that involve traveling to and working in national and international partner BSL-4 laboratories, including the University of Texas Medical Branch (UTMB), Galveston National Laboratory (GNL), the National Institute of Allergy and Infectious Diseases (NIAID), Integrated Research Facility (IRF) and the Australian Center for Disease Preparedness.

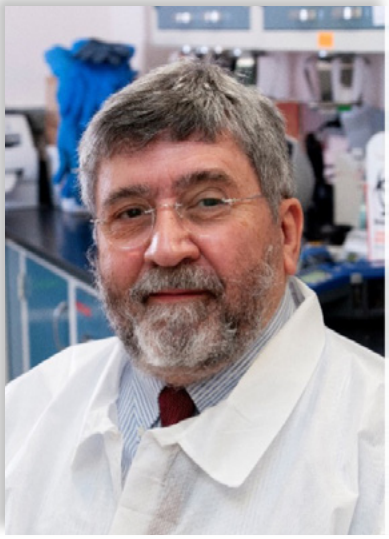
Working with these partner laboratories allows the NBAF BSL-4 Team to build proficiency and confidence working in a maximum biocontainment setting, as well as the opportunity to take the knowledge and experience to refine their own planned workflows and standard operating procedures. Besides providing training opportunities, work with these partner facilities includes developing highly technical procedures for specific laboratory tasks, as well as non-infectious control materials to be used in future experiments. These partnerships help ensure the NBAF BSL-4 Team is thoroughly prepared to conduct their work safely and efficiently.

Forging New Alliances to Tackle Emerging Biological Threats

Recent events, like the SARS-CoV-2 pandemic and ongoing ASF and highly pathogenic avian influenza (HPAI) outbreaks, have highlighted an ever-present threat that both new and existing pathogens pose to human and animal health. These events highlight the need for greater coordination between public health and infectious disease research communities, as well as enhanced collaboration between human and animal health entities. To confront these issues head-on, NBAF has partnered with Texas A&M University and its Global Health Research Complex (TAMGHRC) to form the **Research Alliance for Veterinary Science and Biodefense BSL-3 Network (RAV3N).**

This network is funded as a joint venture between both the USDA APHIS and ARS and is modeled on other successful international high-containment laboratory networks such as the **Biosafety Level-4 Zoonotic Laboratory Network (BSL4ZNet).** RAV3N seeks to bring together academic and federal laboratories across the United States that conduct biodefense research on infectious animal diseases in Biosafety Level-3, BSL-3 Agriculture (BSL-3Ag) and BSL-4 settings. With a focus on coordinating research, surveillance and diagnostics, laboratory biosafety and operations, workforce development and sharing best practices, RAV3N seeks to enhance collaboration and improve response capabilities to emerging infectious veterinary diseases in the nation and globally.

Tour of National Centre for Foreign Animal Disease in Canada during BSL4ZNet face-to-face meeting in November 2023.



(Left to right): Dr. Manuel Borca, Dr. Lisa Hensley and Dr. Chad Mire

WOAH Names NBAF as Collaborating Centre for Genomic Monitoring of Viral Swine Diseases

The World Organisation for Animal Health (WOAH) designated NBAF as the Collaborating Centre for Genomic Monitoring of Viral Swine Diseases in summer 2024. This designation is a high honor and showcases NBAF's extensive and diverse expertise of leading USDA researchers on a world stage.

All three of NBAF's research units contribute expertise to lead the center:

- Dr. Manuel Borca, Foreign Animal Disease Research Unit microbiologist.
- Dr. Lisa Hensley, Zoonotic and Emerging Disease Research Unit leader.
- Dr. Chad Mire, Foreign Arthropod-Borne Animal Disease Research Unit leader.

The collaborating center provides support and training to WOAH member laboratories in genomic characterization of viral pathogens causing disease outbreaks in swine, particularly from African swine fever virus (ASFV), classical swine fever virus (CSFV), Japanese encephalitis virus and Nipah virus.

Initially, the center will focus on ASFV and add similar services for additional pathogens affecting swine. Those services include:

- Performing next-generation sequencing of the full-length virus genome for laboratories that lack or have limited sequencing capacity.
- Providing protocols and training for sample collection, nucleic acid extraction, next-generation sequencing and sequence analysis for laboratories that are capable.
- Identifying other regional laboratories capable of receiving samples from other locations for genome sequencing.
- Establishing reliable bioinformatic pipelines and associated tools to deliver standardized genomic data, annotation and classification for archival and new viral isolates.
- Visiting sites to determine laboratory capabilities and their needs to process, analyze and interpret genomic data.

The center also will build a biorepository of well-characterized virus strains; aid in monitoring the spread of outbreaks; and provide support for vaccine matching in outbreak areas.

USDA ARS Center for Grain and Animal Health Research (CGAHR) Provides Critical Support to NBAF Through the Insectary and Cell Culture Laboratory (ICCL)

Operated by ARS, CGAHR has been a landmark in the Manhattan community for more than 50 years. Initially focused on grain research, the center expanded its scope of work to include research on insect vectors of animal diseases in 2010. During NBAF's construction, USDA used and expanded the existing capabilities at CGAHR to support research that was planned for the new facility. This capability expansion led to the joint design and construction of the **Insectary and Cell Culture Laboratory (ICCL),** which is located on CGAHR's campus beneath the iconic grain elevator as part of the Manhattan skyline. The laboratory includes expanded facilities for conducting clean cell culture, specialized rooms to house insects and extra space to expand and support research needs of NBAF and CGAHR. Construction of the ICCL was completed and the laboratory was turned over to USDA in February 2022.

Although it is a new facility, the ICCL has already provided critical support to the scientific research units at NBAF. Researchers from FADRU used the laboratory's cell culture capabilities to support the ASF Donor Program in preparation for the planned transfer of ASF research from PIADC to NBAF. FADRU scientists use the clean spaces at the ICCL to isolate and purify fresh macrophage cells from pigs' blood and then freeze them down for storage on-site. In addition to their work with FADRU, the ICCL uses its expertise to host "Cell School," a 6- to 8-week training program designed to instruct other researchers at NBAF in the techniques needed to perform cell culture work. This training partnership assists with developing NBAF's workforce. In addition to supporting NBAF, the ICCL maintains hundreds of additional mammalian and insect cell lines that can be supplied to researchers across the USDA, as well as to collaborators in academic and commercial institutions.

Much like the cell culture unit maintains cells, the insectary team at the ICCL maintains breeding colonies of mosquitos, house flies and biting midges for use in disease vector research projects. These colonies include a colony of biting midges that was initially cultivated at a USDA research station in Denver in 1973, making it the oldest such colony in the entire world. Additionally, the insectary team has been establishing a stable colony of wild type Culicoides sonorensis, a species of midges found in the local area.

Joint efforts between NBAF, the insectary team and the cell culture team at the ICCL are establishing a colony of black flies and a black fly cell line for anticipated VSV research at NBAF. With a deep bench of expertise and the ability to expand its capabilities to meet customer requests, the ICCL is an invaluable partner capable of supporting the NBAF's future research needs.

K-State Veterinary Research Symposium students visit and tour NBAF in June 2024.

WORKFORCE DEVELOPMENT

One of the major challenges associated with moving USDA's foreign animal disease research and diagnostic mission from Plum Island to NBAF is the inherent risk of losing the institutional knowledge and experience from seven decades of operations on Plum Island. Over that time, PIADC has developed a highly skilled workforce that is well-versed in the scientific and operational hurdles involved in researching high-consequence pathogens in a high-containment laboratory facility.

Despite NBAF's location in the Animal Health Corridor, a Midwest region with the largest number of animal health companies in the world, there is little match for the level of expertise and skilled local personnel to readily support high-containment veterinary research as currently resides in the areas adjacent to PIADC. To help mitigate these challenges, NBAF is funding and supporting several workforce development efforts such as **internships, fellowships and training programs** in conjunction with partner universities or other institutions — including the introduction of the nation's first biosafety/biorisk management certificate program. These programs are designed to help recruit, retain and equip NBAF's personnel with the technical skills and experience necessary to continue and advance the facility's scientific mission.

HACU

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ORISE

ORISE Fellowships Provide Opportunities for Recent Graduates at NBAF

The U.S. Department of Energy's Oak Ridge Institute for Science and Education (ORISE) program was developed to recruit and prepare the next generation of scientific professionals. Though initially focused on the scientific fields related to nuclear energy, the ORISE program has expanded to support scientific research positions within other government agencies.

Recent graduates in relevant Science, Technology, Engineering and Mathematics (STEM) fields who apply and are accepted to the program receive a year-long, full-time fellowship where they work side-by-side with federal researchers to receive hands-on training in their chosen field. Upon completion of the program, most ORISE fellows secure employment in critical scientific positions, including those within the USDA units at NBAF. Over 30 ORISE fellows currently work in NBAF's research, diagnostic and operational units, including FADDL, FADRU, FABADRU, ZEDRU, BDM and the Quality Assurance and Biorisk Management sections.

Ediane Silva and Gisselle Medina from FADRU present an award at the NBAF Science Fellows Symposium in June 2024.

From 2022-2023, NBAF provided more than $600,000 to the ORISE program and continues to leverage the opportunities provided by the fellowship to develop and recruit highly trained and technical personnel to fulfill critical scientific roles within the facility.

NBAF Scientist Training Program (NSTP) Provides Workforce Development Through Educational Assistance and Training

The APHIS NBAF Scientist Training Program recruits highly qualified scientists to fill key positions within the unit. The competitive application process attracts qualified candidates pursuing an advanced degree in a field that supports FADDL's mission. Once accepted, NSTP fellows receive funding to cover their tuition and fees, health benefits, materials, supplies, travel, publication costs and a stipend for a period of up to five years. In exchange, upon graduation, the NSTP fellows are offered a full-time federal position within the USDA FADDL and must complete a service commitment for a set number of years, which is based on the amount of assistance they received throughout the program.

FADDL hosted an NSTP Symposium at PIADC in 2022.

This program was established in 2018 and has supported more than 25 MS, PhD and DVM/PhD students in laboratory-based fields such as bioinformatics, diagnostics, entomology, immunology, microbiology and virology. Seven program fellows completed their education in Fiscal Year (FY) 2022 and began working in key positions within FADDL. Another three joined FADDL in FY 2023, and 11 will join FADDL in FY 2024.

Onboarded NSTP fellows have assumed responsibilities in leading the development of FADDL's scientific program, including supporting active surveillance efforts in multiple duty stations, deploying to the Dominican Republic for the ASF outbreak response and to various locations for the HPAI outbreak response, establishing the BSL-4 diagnostic program at NBAF, leading an international vector-borne project for ASF and being a clinical instructor for the USDA FADD Training Course. NSTP fellows onboarding with FADDL at NBAF are conducting research at their respective institutions on projects including ASF and rabbit hemorrhagic disease, which are a part of FADDL's current mission scope. Along with FADDL's mission expansion at NBAF, NSTP fellows' research also includes ebolaviruses, henipaviruses, RVFV and JEV. These scientists are key members of the new facility's workforce and are instrumental to supporting FADDL's stand-up operations as the laboratory transitions from PIADC to NBAF.

Dr. Chuck Lewis, pictured above, is an NSTP graduate and is now the APHIS BSL-4 Team Lead for FADDL at NBAF.

NBAF Laboratorian Training Program (NLTP) Provides Pathways to NBAF

The APHIS NBAF Laboratorian Training Program provides opportunities for highly trained technical staff who understand the environment of high containment laboratories to be more competitive for positions at NBAF. The NLTP is a partnership between NBAF and universities and colleges with expertise in the biological sciences. NLTP began with a local university in Kansas in 2019 and has been expanding to historically black colleges and universities and non-land grant Hispanic service institutions across the U.S.

NLTP provides courses and lectures to students to introduce them to the basics of high containment facilities, laboratory procedures, animal handling and promote safe work practices including the use of personal protective equipment in the high containment environment. Although NLTP is a FADDL–hosted program, the program benefits all scientific and operational units at NBAF, as NLTP fellows are more competitive for positions within FADDL's diagnostic laboratory, ARS research units, biorisk management, animal resources, training and other units with a connection to the biological sciences.

NLTP students from Kansas State University visit and tour NBAF in June 2024.

NLTP consists of annual cohorts of fellows at each respective institutions. Each institution creates a unique program to best meet the development needs of their students, with a focus on high containment laboratories. From 2020 to 2024, institutions engaged in laboratory training programs including introductions to molecular biology techniques, immunohistochemistry, serology, geographic information systems and wind-borne modeling of disease and research. The program also provides support for non-laboratory training in areas including federal resume building, interviewing skills, navigating the federal hiring process and career development and planning.

NLTP students from Tuskegee University visit and tour NBAF in July 2023.

Roland Mboma, a technician working for the Laboratoire Vétérinaire Centrale de Kinshasa, removes a tick from a cow involved in a study surveying the prevalence of CCHF and other viral zoonoses in humans, animals and ticks across the Democratic Republic of the Congo. (Picture Credit: Paige Kinzie)

USDA/Boehringer Ingelheim Veterinary Scholars Program

According to the American Association of Veterinary Colleges and American Veterinary Medical Association, veterinary medicine remains small (124,069 veterinarians in 2022) and is one of the least diverse professions in the U.S. Despite the need for veterinarians in different fields, most graduating veterinarians pursue small animal clinical practice with few veterinarians pursuing advanced training to prepare them for non-clinical practice jobs like those available in research and government. This has created an acute shortage of veterinary researchers. Currently, veterinary schools struggle to recruit and train veterinarians for advanced degrees with livestock and poultry expertise due to the expense and need for specialized expertise and facilities.

In FY21 through the NBAF Partnership and Workforce Development funds, USDA ARS entered a 5-year public-private partnership with Boehringer Ingelheim (BI) Veterinary Scholars Program (VSP) to develop summer research internships at ARS facilities for veterinary students to have hands-on experiences in the unique research conducted by USDA ARS to encourage more veterinarians to obtain advanced research degrees. Through this single partnership, ARS gains access to students at over 35 veterinary schools around the globe. The program targets first and second-year veterinary students for summer research experiences. At the end of the summer, the students are invited to attend a research symposium with talks by academicians, industry, government scientists and others and to present their research. In 2023, over 700 students attended the symposium.

Two years into the partnership, the program has hosted 24 individual students from 13 different veterinary schools at 7 different ARS animal health units. Last year, two students were able to work internationally with ARS NBAF partners in West Africa to better understand the role that veterinarians and ARS scientists play in OneHealth, capacity building and control of the most dangerous diseases such as CCHF. Others have been able to work at other specialized high-containment research laboratories such as the National Animal Disease Center (NADC) and the Southeast Poultry Research Laboratory (SEPRL). The feedback captured from survey results has been overwhelmingly positive with most students explaining they had been previously unaware of career opportunities at ARS and were now considering research careers.

BioKansas Interns Support Units Across NBAF

USDA and NBAF are committed to building and developing a workforce that leverages the broad array of skillsets found throughout the nation's large and diverse population and within NBAF's home state of Kansas. To reach communities that have been historically underrepresented in the STEM fields, NBAF has partnered with BioKansas to develop an internship program focused on NBAF's unique scientific work and opportunities. Undergraduate and graduate students accepted to the program complete a 10-week summer or 15-week fall or spring semester internship under the supervision of an NBAF employee who serves as their mentor.

These internships give students hands-on experience in diverse career fields supporting high-containment research, including animal and veterinary science, biology, chemistry, engineering, computer and data science, communications and cybersecurity. The program was initiated in summer 2023. From January 2023 to May 2024, 13 individuals participated in the BioKansas NBAF internship across three cohorts.

NBAF plans to continue the program to provide interested students with an opportunity to gain hands-on experience to develop skills to become invaluable members of the scientific workforce.

A May 2024 Impact Report provided by BioKansas shared insights from interviews with eight interns:

- All interns reported they enjoyed the people and the environment at NBAF.
- Multiple interns said they gained skills in the internship they would not have through their coursework.
- Multiple interns said that the certifications (e.g., Lean Six Sigma) they got through the internship gave them an advantage in applying to other opportunities.
- In addition to increasing skills, 50% said the experience increased their awareness of different career paths, leading them to want to explore more options.

NBAF presented and exhibited for the BioKansas Innovation Festival in August 2023.

USDA

NBAF