USDA-ARS National Program 104 – Veterinary, Medical and Urban Entomology Assessment Report

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Executive Summary

Panel members:

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The Review Panel (RP) met on January 29-30, 2013 to conduct a retrospective review and assessment of USDA-ARS NP 104 Veterinary, Medical and Urban Entomology research conducted in the period from 2007-2011. The Chair, along with panel member, Capt. Mark Beavers, traveled to Beltsville for the meeting while the other 4 panel members joined by teleconference and webinar. The RP was comprised of five university scientists external to the ARS and a representative of the military. The panel members were hand chosen for their demonstrated knowledge and experience in the five disciplines (components) being reviewed encompassing (1) medical entomology for the public, (2) medical entomology for the military, (3) veterinary entomology of livestock and poultry, (4) pests that damage structures, and (5) fire ants, other invasive ants and household pests.

The RP was provided with an Accomplishment Report (AR) 2007-2011 prepared by USDA-ARS in advance of this meeting that focused on the five major components within National Program 104. The charge to the panel was to

assess the 5-year performance and impact level of the Program. We were asked to consider the overall National Program and determine if the National Program had met its customer/stakeholder needs or solved their problems since the last customer workshop. The ARS guidance was that individual projects were not to be assessed. Rather, the RP's report should provide an overall assessment of progress made in each of the Component Problem Statements using the Anticipated Products from the Action Plan as a yardstick.

Each Component of NP 104 was assigned a primary and secondary reviewer. Prior to the meeting, RP members composed a document on their primary and secondary component assignment. RP members were asked to provide feedback in seven basic areas (but not limited to) as follows:

- ✓ Component impact - Low, Medium, High (as per ARS scoring guidelines)
- ✓ Relationship to Action Plan
- ✓ Quality of research - i.e. how well did we do it?
- ✓ Relevance to customers' needs - i.e. were customers' needs met?
- ✓ Technology transfer and adaption - were the products of NP 104 research delivered and adopted?
- ✓ Impact - did NP 104 research impact the scientific community, agricultural producers, and/or regulatory agencies?
- ✓ Based on the impact of NP 104 research, should ARS continue the kinds of research listed in NP 104?

The RP thoroughly studied the 5-year (2007-2011) Action Plan and AR relating to National Program 104. The RP is in complete agreement that the ARS research scientists continue to pursue and complete important research projects that are critical to the improvement and furtherance in developing more effective methods of preventing or suppressing insects, ticks and mites that affect animal and human well-being. NP 104 scientists should be extremely proud that they have made significant contributions to integrated pest management (IPM) and biological knowledge of these types of pests.

The RP was impressed with many aspects of NP 104. ARS scientists are clearly doing critically important work on topics of great national interest that no other group of researchers is doing. In many areas, it is clear that if ARS scientists were not conducting this work, there would be critical gaps in veterinary, medical and urban entomology with significant deleterious impacts on animal and human well-being.

Although the overall tenor of this Review Report is positive, the RP has identified a number of areas for improvement of the AR and has also made suggestions for future reviews. In brief, the AR did not provide the information needed for the RP to effectively address the ARS charge to the RP. It would have been considerably easier for the RP to evaluate the two years of the five-year period covered by the AR, if the RP would have been provided with fully

documented statements of the needs, previous accomplishments, objectives, anticipated impacts, progress (accomplishments) and future directions of key projects within the program.

Component 1: Medical Entomology for the Public

Executive Summary: Medical entomology for the public is an important area that has in recent years fallen through the cracks of other federal agencies' research portfolios. ARS has a long history of research and product development on mosquitoes, flies and ticks. As medical entomologists have developed and implemented effective interventions against arthropod vectors of major diseases in the U.S., research efforts in medical entomology have turned to globally important arthropod-borne diseases such as malaria and dengue. The challenges of addressing emerging diseases such as West Nile virus and Lyme disease require concerted research efforts to improve the effectiveness and safety of entomological interventions. ARS medical entomologists are conducting high quality research and products development, generally with high scientific and applied impact, addressing domestic problems within the U.S.

Within this component, most research and product development efforts involve the Asian tiger mosquito, the black-legged tick, and the house fly. Research on mosquito olfaction and predictive models on Lyme-disease ticks and Rift Valley fever activity in Africa is of exceptionally high quality, and it uses modern, cutting edge techniques. Several technology transfer products have come out of this component, including the 4-poster treatment bait station for control of ticks on deer and better traps for house flies. Several projects in this area reflect excellent collaborations between ARS scientists and scientists in other federal agencies and universities. ARS scientists also contribute to the Environmental Protection Agency's activities by serving on task forces and providing advice on testing methods for repellents and public health pesticides.

Activities in medical entomology for the public are intricately linked to activities in other components, namely veterinary entomology and military medical entomology. Because the insects targeted in Component 1 (mosquitoes, flies and ticks), the disease-causing pathogens they transmit, and pest management techniques in the public arena broadly overlap with those in the military entomology and veterinary entomology (food animals) areas, there needs to be much greater communication/coordination and reduced fragmentation among these three components. It is imperative that ARS scientists who are experts in medical entomology communicate and coordinate their efforts with experts in veterinary entomology and military medical entomology. For example,

high quality research by ARS scientists on house flies is fragmented among three Components. Better integration of efforts in this area would better highlight the accomplishments and impact of house fly research.

Some projects in Component 1 and their products and impacts were well documented, but others were only marginally addressed or poorly documented. While this is an inherent problem with comprehensive reports by large organizations, the panel urges NP 104 scientists and administrators to better prioritize action plans within each problem statement, and better integrate the needs, past accomplishments, research objectives, anticipated impacts, and future directions. This action will greatly facilitate the panel's assessment of productivity and impacts of complex and dynamic projects.

Component 2: Medical Entomology for the Military

Executive Summary: Exceptional research is being performed within Component 2 with a good mix of basic and applied research. While the AR was at times difficult to follow due to projects crossing over into other Components, the accomplishments and anticipated products appear to be in general alignment with the Action Plan and the efforts are addressing the needs of the Department of Defense (DoD). Having a DoD representative on the panel was helpful in explaining a number of these projects and their benefits to the other panel members. Without such a representative, an accurate assessment of this Component would have been problematic.

The quality of basic science performed is high with the RNAi efforts leading the way. While the RNAi work is of high quality, there was insufficient information presented to make a clearer assessment on the potential adoption of this technique for controlling arthropod vectors. It is unknown if intellectual property issues impacted the availability of that information. Other examples of high quality fundamental research include the arthropod toxicology and odor reception physiology efforts involving olfactory genes, transgenic mosquitoes, etc. Such work is providing a better understanding on how mosquitoes are attracted and repelled by odors. This research might someday result in new ways to develop and screen potential repellents as well as attractants. Other areas, including the discovery and screening of new insecticide and repellent chemistries and evaluating existing insecticides, formulations and spray systems are addressing questions that have direct applicability to the DoD and its overseas operations.

There were two projects in the AR that were not described in the Action Plan: (1) A preliminary report showing the loss of repellency to DEET in mosquitoes infected with arboviruses; and (2) Research working towards personal spatial repellents for potential incorporation into military uniforms. Continued research in these areas, as well as developing spatial repellents for larger scale applications, is strongly encouraged.

While many of the questions being addressed in this Component are not necessarily unique, no other agencies or institutions are making such a significant effort (and progress) in answering them. This is why the DoD comes to ARS as a partner and a customer: the ARS listens for what the DoD's needs, understands them, and addresses them.

Component 3: Veterinary Entomology of Livestock and Poultry

Executive Summary: Veterinary entomology of livestock and poultry represent the largest investment and most diverse pest complex in the NP 104 matrix. The historic and current strengths of the veterinary entomology component reside in ticks, higher Diptera and biting midges. Pests in each of these areas directly threaten American agriculture and ARS is positioned extremely well to contribute to the major issues raised by their customers. The Action Plan included in the veterinary component was ambitious and it remains to be seen if each objective can be adequately addressed in what remains of the 5-year project cycle.

Research directed toward cattle fever ticks and the screwworm carry considerable value to the protection of American livestock from reestablishment of these pests. Furthermore, ARS is positioned as the only group that works on these pests given not only the quarantine issues involved, but also the breadth of their expertise and available resources. Most customers of ARS will recognize the value of efforts targeting the house fly, stable fly and horn fly, as these are important pests of many animal agriculture commodities and invariably present the greatest threat to their production capabilities. ARS efforts addressing biting midges and their associated viruses, bluetongue and vesicular stomatitis, are strengths presented within the report. These aforementioned programmatic areas include high-quality research and efforts targeting clientele needs. Although much of the research effort in the veterinary component targeted applied research, some areas had strong linkages with basic research enhancing both knowledge and practical application. ARS scientists are rightly positioned at

multiple laboratories in major livestock production areas and have demonstrated strong collaboration with both academia and industry partners.

Efforts associated with mosquitoes, sand flies and invasive species appear to be of lower priority in the AR, and thus represent areas in need of improvement or readdressing prior to the completion of this 5-year cycle. Although each of these areas may present future challenges for veterinary entomology, the documented approach taken to address the concerns in each area lacked direction and are unlikely to provide the many desired outcomes listed in the Action Plan. The AR structure and resultant limited information hindered the overall assessment of the veterinary entomology component. In the future, it is strongly suggested that the AR not only highlight the two or five prior years of research, but that an account of both current and planned research efforts to be conducted in the projects' remaining 2 years be included. Such an addition would allow for a much stronger retrospective review of the program. Given the lack of specific information or documentation in the AR, it was quite difficult to determine if customer needs and impacts were being met, particularly only two years of the current project.

Component 4: Pests that Damage Structures

Executive Summary: The large number of projects undertaken by the ARS teams addressed both immediate and long-term needs in managing FST populations on an area-wide scale. Overall, the work performed was critical, and ARS scientists are uniquely positioned to conduct this research. The most significant accomplishment was the development and implementation of a successful area-wide IPM program for FST in the French Quarter of New Orleans. This was a large, complex undertaking that no other agency or research group could have performed. In addition to addressing immediate management needs through the area-wide program, the ARS teams made good progress in areas of intermediate and longer-term needs, including the discovery of potential new toxicants and repellents, the identification of several intrinsic and extrinsic factors regulating termite development and behavior that could open new avenues of control, and the identification of potential new gene targets. The research teams produced several high quality publications in this area, and the RP viewed this work as high impact.

Sequencing and annotation of the FST genome is clearly important work and the RP was excited about this accomplishment. However, the RP was concerned that this work, which has been terminated but not yet published, may

not be made available to the greater scientific community, thus preventing other researchers from making use of this valuable genomic resource. Work on the origin of invasive FST populations is important, but the research by the ARS team was of limited scope and lacked a clear strategy; this work would have benefitted from collaboration with other researchers working on the genetics of invasive populations.

Given the current economic impact of the FST and its continued spread throughout the southern U.S., as well as the constant threat of the introduction of other invasive termite species, the work outlined under Component 4 is important. The RP understands that this project has been terminated by ARS but also hopes that USDA can continue to support this critical work through other channels, e.g., via competitive grants programs. Given that the program has now ended and that ARS has expended considerable effort on the FST problem, the RP feels that the stakeholders would be well served by ARS publishing the guidelines for the area-wide IPM program for FST so that this program could be replicated elsewhere, and by ARS making the FST genome available to the research community in some fashion.

Component 5: Fire Ants, other Invasive Ants, and Household Pests

Executive Summary: The design and implementation of the fire ant work under this Component generally is well-suited to the need areas, and the results generated make significant progress toward solving important problems in fire ant biology and management and thus addressing customer/ stakeholder needs. The Gainesville ARS group, in particular, has shown the ability to take basic discoveries and translate them into promising new tools for fire ant management. The research of this group uses cutting edge technology that it is having a strong impact on both basic and applied entomology and has resulted in the production of a large body of high-quality publications. Highlights involve the development and deployment of genomic resources for *Solenopsis invicta* to reconstruct the pathways for the worldwide spread of this invasive species, to describe in detail its mating biology, to characterize the odorant-binding protein gene family, to characterize PBAN/Pyrokinin and PBAN receptor genes and develop RNAi constructs for these genes, and to characterize pathogenic viruses. Also important have been the release and documented spread in the southeastern US of five species of phorid flies that parasitize *S. invicta*, molecular characterization of this species' microsporidian parasites, and discovery of novel compounds and technologies for fire ant control based on genome sequence mining.

Fire ant work of less obvious importance or impact includes studies of the Black Imported Fire Ant (and its hybrid with the Red Imported Fire Ant) that extensively duplicate previous mtDNA work, development of a putative RNAi insecticide against fire ants that reduces expression of a G-protein gene, and the effort to develop methods for detection and quantification of fire ant mounds using aerial photography. The RP formed the impression that the Stoneville and Gainesville fire ant groups appear to work largely independently of each other.

The recent emphasis of ARS on emerging/potential invasive ant pests should provide important information on their biology and management that will be highly relevant to customer/stakeholder needs, once this research is fully underway. Evaluation of commercial ant bait/toxicants to identify products that kill colonies of such invasives, and genomic analyses to discover their viral pathogens, are useful contributions toward managing these pests. Surveys to monitor the status of invasive ant species must incorporate more rigorous designs in order to yield comprehensive and up-to-date data on the appearance and distributions of such species in the U.S.

The RP is most grateful to Associate Administrator Dr. Chavonda Jacobs-Young, National Program Leader Dan Strickman, and members of the ARS staff including, Tracy Havermann, Kathryn Vickrey, Derald Everhart and Jill Stetka for all their assistance in planning and conducting this review. The RP considers it an honor and a privilege to have been a part of this very important ARS endeavor.

Suggestions for Future Accomplishment Reports:

- ✓ Careful authoring by NP leaders is needed to be certain that the action plan, anticipated products, AR, including stated impacts (i.e. meeting their customer/stakeholder needs), are all well integrated.
- ✓ To evaluate the 2 years of the five-year period covered by the AR, provide the RP with fully documented statements of the needs, previous accomplishments, objectives, anticipated impacts, progress (accomplishments) and future directions of key projects within the program.
- ✓ With the current ARS process of RPs having access to only one Action Plan (in our review, covering 2009-2013) and one AR (covering 2007-2011) that actually addressed only 2 years of the stated 5-year review period, ARS is receiving a scientific review and not the programmatic review it desires. The RP recommends that all future panels be expected to review the final 2 years of the previous Action Plan as well as the first 3 years of the current one. How are the accomplishments being reported/reviewed for the last 2 years of the current NP 104 Action Plan?
- ✓ Careful authoring by the NP leaders to make certain that if the documentation provided for one component is relevant to other components in the AR that these be referenced in all other appropriate components.
- ✓ Because of the repeated overlap/cross referencing between components in the AR, the RP recommends that the NP leader should consider organizing the AR by arthropod, disease or some other category for NP 104 as opposed to the components included in this AR. If the AR continues to be written as is, perhaps electronically linking the related sections/projects would help.
- ✓ Provide the action plan and the panel report from the previous 5-year review to the RP at the same time that the AR for the current review period is provided.
- ✓ Provide sample documents and reports from reviews of other programs very early in the process.
- ✓ Provide specific and more extensive technology transfer and customer/ stakeholder impact information in the AR.
- ✓ The review panel was not aware of the limitation of 2 publications for each reported accomplishment until the debriefing session. In addition, the review panel remains confused as to the purpose of those citations. The panel believed that they were the best ARS publications related to the work described in that section and/or problem statement. However, the AR had articles from trade journals and articles that were unrelated to the topic.

- ✓ Provide additional documentation for all scientific claims, either by referencing specific papers or by providing relevant summary data.
- ✓ Provide fewer anticipated products for individual component problem statements. A number of component problem statements had a dozen or more anticipated products but the documentation provided for the problem statements only dealt with one or two of these. In some cases, none of the anticipated products were addressed in the documentation provided. This could lead to extremely unjustified conclusions that ARS research on these anticipated products was not being conducted.
- ✓ Limited resources often preclude accomplishments that correspond to all the anticipated products. Prioritization of anticipated products would allow the RP to assess progress and accomplishments within the context of ARS priorities.
- ✓ The RP believes that face-to-face meetings create more synergy and greater opportunities for effective reviews than methodologies such as extended teleconferences and webinars as used in this review. The RP strongly recommends that the ARS have panel members physically meet in one locale for these extremely important retrospective program reviews.

Suggestions for Instructions/Guidance for the Review Panel:

- ✓ If these reviews continue to be conducted by teleconference and webinar, recommend that the RP have a conference call among themselves a week or so before the formal review to deal with any issues and concerns that they might have.