A Roadmap for AgARDA at USDA

United States agriculture needs AgARDA

Agriculture and agricultural research need new strategies, tools and additional resources that are nimble, flexible, and unconstrained by precedent to meet the growing challenges to agriculture. These challenges are not allocated neatly into standard academic disciplines, so the U.S. agriculture research enterprise requires a funding mechanism that can support collaborations between multiple life sciences and engineering disciplines. Transdisciplinary and convergent research is needed for the United States to maintain its position of global leadership in agriculture, research, and intellectual property development and as a key player in discovering solutions to global agricultural and environmental challenges.

Funding agencies in the U.S. Department of Agriculture (USDA) are largely committed to existing missions defined by stakeholders and Congress, and the necessity of continued support for these missions leaves these agencies with few resources and little opportunity to address new needs or respond to new opportunities. Additionally, while USDA's National Food and Agriculture Initiative (NIFA) and the Foundation for Food and Agriculture Research (FFAR) are both extramural funding agencies that support valuable research programs, they operate under constraints that limit their capacity to invest deeply in a single or limited set of problems.

The Agriculture Advanced Research and Development Authority (AgARDA) is a pilot effort for a new, Advanced Research Projects-style research agency (ARPA) in the USDA authorized by the 2018 Agriculture Improvement Act (Farm Bill) to focus solely on agriculture. Through AgARDA, USDA can enable the research necessary for engendering transformative impacts and the development of new industries and partnerships. AgARDA will be instrumental in overcoming gaps in the stability of the U.S. food system, and it will help the United States maintain a position of global leadership when new challenges, or science and engineering opportunities, emerge.

The 2018 Farm Bill gave AgARDA three broad goals: the development and deployment of technologies that address challenges related to growing, harvesting, handling, processing, storage, packing, and distribution of agricultural products; plant disease or plant pest countermeasures; and veterinary countermeasures to intentional or unintentional biological threats. These goals remain scientifically and politically important and should remain the focus of the AgARDA pilot; however, additional agricultural priorities, such as efforts to mitigate climate change and its effects and food chain stability and infrastructure have risen to the fore. A true ARPA-like program leverages world experts as program managers to nimbly address what is needed far beyond what could have been anticipated at the program's inception.

A key benefit to the Biden administration is that AgARDA is ready to go and primed for success. The program is authorized, features a strong conceptual model, and has considerable stakeholder support. What is needed are appropriated funds and the selection of leadership and staff.

This document assists an AgARDA implementation plan effort

This report was prepared in direct response to the Farm Bill's mandate for USDA to develop an AgARDA implementation plan. Because this important document has not been published, we, a group of scientists and policy experts from a variety of agricultural disciplines, formed a study group to assist. This document is intended for internal use at USDA and is not meant to be used in advocacy.

AgARDA was conceived in the model of the Department of Defense Advanced Research Projects Agency (DARPA), which was successfully duplicated with high degrees of success in other federal departments, including at the Department of Energy (Advanced Research Projects Agency-Energy, or ARPA-E), the Department of Health and Human Services (Biomedical Advanced Research and Development Authority, or BARDA), and the Office of the Director of National Intelligence (Intelligence Advanced Research Projects Activity, or IARPA). As with these other ARPA models, AgARDA will complement, not replace, other USDA research agencies. It will provide the operational flexibility inherent to ARPAs to quickly address developing issues and explore new or risky program areas beyond what is available to other agencies in USDA Research Education and Economics (REE).

AgARDA projects would not otherwise be funded by USDA, FFAR, or other ARPA agencies

REE research programs cannot support ARPA-style projects

REE agencies, such as NIFA and ARS, support low-risk, high-reward research. For example, the Agriculture and Food Research Initiative (AFRI) at NIFA issues broad Requests for Applications from the research community, researchers pose questions they wish to answer, and then their peers determine the value of those proposals. Risky projects are purposely weeded out, and the awards are small. This is fundamentally unlike an ARPA-style Request for Proposals (RFP), in which the answer is provided and it is up to the researchers to propose methods for how to achieve it, often with budgets two orders of magnitude larger.

Another major difference is that all REE agencies are overseen by an advisory board with Congressionally mandated seats for industry and academic stakeholders. As a result, these agencies are advised to support research programs that benefit the agricultural stakeholders on the advisory board. In contrast, ARPA Agency Directors report solely to their respective Secretaries, who retain only minimal oversight. This model ensures AgARDA's independence and is crucial to maintaining its focus on its immediate research objectives.

FFAR requires matching funds

The Foundation for Food and Agriculture Research (FFAR) was created to advance the USDA mission through agricultural research investments focused on addressing key problems of national and international significance through cost-sharing and leveraged Congressional funds – FFAR is mandated to match its funds with non-federal partners one-to-one. Despite the constraints this requirement has posed, FFAR has continued to identify unmet and emerging agricultural research needs and support the development of research tools and products.

However, some challenges are outside of what private industry would undertake and so are outside of FFAR's focus. Also, it is time-consuming to identify private partners to invest in challenges with social value but perhaps little business value. Further, perceived competition with partners also means that FFAR's projects tend to remain pre-competitive. While FFAR consistently identifies innovative research gaps and white spaces ripe for investment, less attention is devoted to the longer-term investments and technology transfer that is essential for the United States to remain a leader in global agriculture research. These FFAR limitations, however, should not preclude AgARDA from seeking input and collaborating with FFAR when AgARDA projects require partnership with the private sector, as FFAR's connections and ability to leverage private sector funds would be highly valuable to the new organization.

Other ARPA agencies do not invest in the agricultural questions USDA needs answered

ARPA agencies focus on significant, transdisciplinary questions requiring substantial investments to solve; as DARPA's motto explains, the challenges must not just be hard to solve, they must be "DARPA hard." Similarly, the goal of an AgARDA program is to develop field-tested systems that combine science and engineering in novel ways to generate innovative solutions to national and global agricultural and environmental challenges. While DARPA and ARPA-E sponsor agriculture-related programs, these are tightly bound by departmental missions. Neither is authorized to focus on solving critical challenges to food, nutrition, or climate impact on agriculture, challenges that must be solved for the United States to maintain its capacity to feed people at home and worldwide while maintaining stewardship of the natural resources required to sustain food production.

AgARDA will need to embrace the signature characteristics of successful ARPA agencies

ARPA budgets are large but targeted

Success in ARPA programs comes from several essential features that enable powerful, targeted, and nimble responses to ambitious questions. Project budgets are large and laser-focused on ambitious and highly-specific challenges. RFPs are thoroughly researched documents that pose a hypothetical and transformative solution and solicit proposals that de-risk or identify potential paths to that solution. As in "Jeopardy!", the answer is given, and the question is sought. In shaping programs, most ARPA agencies use the Heilmeier Catechism, a series of questions defined by George Heilmeier, an early DARPA director. The questions serve to ensure a narrow focus and high level of impact such that seemingly small solutions broadly enable a research field.

With ambitious goals and tailored RFPs, ARPA programs encourage high-risk projects. To mitigate this inherent risk, ARPA agencies fund projects forming a well-rounded portfolio; the projects are different enough that a failure of one will not mean a failure for all and will produce knowledge that will guide future project ideas.

Program directors and projects have strict term limits and specialized staff

Another distinguishing feature of ARPA problem solving models are the short programs, short tours of duty, and fresh viewpoints. ARPA agencies remain evergreen by avoiding long-term commitments to program directors (PDs), who serve in temporary roles, and to research programs, which run for fewer than five years. As former ARPA-E PD Joe Cornelius explained, "Term limits achieve two key things: they ensure we have new, provocative, risky ideas cycling into the agency and they amplify the sense of urgency that we have to move deliberately and quickly. That causes the agency to strip out bureaucracy, redundancy, and other non-essential behaviors. The combination of your clock being set (three to five years), and that the magnitude of the problems is enormous, requires you to be aggressive."[1] Similarly, technical staff with expertise that matches the PD's ideas can be quickly hired as contractors and enable PDs' to efficiently stand up new programs.

ARPA agencies are autonomous

The deliberate mode of operation at USDA's current funding agencies can, in some cases, hinder transformative improvements. AgARDA's autonomy and PD influence are critically important for

[1] Cornelius, J. ARPA-E: A Great Place to Expand Your Horizons and Make a Lasting Impact. *CSA News*, *64*(5), 20-21.

transformative programs outside of consensus views. In particular, the decision to fund an award is made by the PD, with input from the Agency Director, and authorized directly by the Secretary. The agency solicits expert panel reviews (in DARPA and IARPA's case, from within the federal government, in ARPA-E's case from anywhere; security clearances are part of the differentiation), and these views are considered by the agency. However, the PD's vision typically has multiple aspects, and it is critical to form a complete portfolio, not simply select the highest rated projects as judged by expert panels. This flexibility and autonomy free the agency from learned bias of a discipline and enable experimentation with unorthodox ideas to stimulate discoveries.

AgARDA-funded projects should have large budgets and be heavily managed

Following the example of other ARPAs, large AgARDA program budgets would be allocated into three categories of funding: initial research, plus-up or opportunistic follow-on funding, and program management/indirect costs. Most of the funding would be allocated to a set of research teams that directly answer the RFPs. ARPA project teams are usually interdisciplinary, and each aspect of a project may have a budget of $500,000 per year. A three-year program may have three or four full system projects that receive $3-6 million each and comprise the bulk of the funding for the full program. RFPs solicit large, multi-team awards, and it is common for one aspect of a proposal to be much stronger than other components. Unique among research funding agencies, ARPA PDs typically reserve the right to select only certain parts of a proposal and even combine different researchers' proposals. AgARDA projects should, ideally, follow this model. Research priorities for AgARDA's pilot program were outlined in its authorization (see above), but moving forward beyond its pilot, AgARDA priorities should be informed by science and stakeholders, and a rubric should be developed to ensure that proposed projects conform to these priorities.

AgARDA should also follow the ARPA lead in taking advantage of in-depth technical management from program staff. For ARPAs, this leads to relatively high (10%) internal costs at the funding agencies. To manage risk, ARPA PDs and their technical staff employ frequent progress reviews (monthly or quarterly) and site visits to ensure projects are meeting technical milestones. The PD is given broad authority to pivot or rescope projects based on consideration of the full portfolio of projects. Functionally, the PD becomes the laboratory head or "principal investigator" for the funded research group heads. This relationship is rooted in the shared success of the researcher and the PD, a key distinguishing feature that enables the agency to engage in high-risk research. By being engaged in all projects within a portfolio, the PD can often identify opportunities to leverage technical advances or resources from one project to assist another or to wind down aspects of projects that are no longer promising.

The research community that receives awards from ARPA agencies is not significantly different from most federally funded research communities and includes universities, large and small private sector entities, and national labs or other dedicated research facilities. (Unless there is no domestic capacity, funds are not often distributed to international groups.) However, ARPAs operate with an assumption that truly novel solutions often come from research communities outside of the core academic area or discipline traditionally dedicated to the challenge at hand. Through unconventional programs (e.g. high risk, blue sky, transdisciplinary), ARPA programs deliberately attract new communities of researchers to a field, broadening the diversity of ideas and technologies that are proposed for challenging questions. In addition to benefiting the program directly, this intentional, hands-on solicitation of outside input will bring novel expertise to AgARDA problems that can be sourced by other USDA agencies.

AgARDA should embrace the ARPAs' flat organizational structure

There are only three hierarchical levels in a typical ARPA agency. PDs, as mentioned above, act as the "lab head" or "principal investigator" for funded programs and employ a staff to help manage the multiple projects running in a single program. Directly above the PD is the Agency Director, who typically reports directly to the Departmental Secretary. This structure is somewhat loose, however, and staff are empowered to speak freely, collaborate, and share information with all PDs and with one another, even when working for different PDs. This is in direct contrast to typical federal agency protocol, in which staff in one agency can be actively discouraged from collaborating with staff in other agencies, requiring literally dozens of approvals from supervisors and managers moving up the hierarchy to the chief of staffs of each agency. There are no chiefs of staff in ARPAs, and collaboration across the agency is encouraged. Finite terms for PDs and their staff are key to preventing baked-in agency philosophies, hierarchies, or bureaucracies from developing. This flat organizational structure is essential for the success of AgARDA.

Program Directors

There are a few essential characteristics common to PDs at DARPA and ARPA-E. First and foremost, DARPA and ARPA-E PDs rotate in from outside of the federal government. Their position is not on the federal career ladder. While it will be essential for AgARDA PDs to coordinate research programs with ARS and NIFA Program Leaders, the PDs should be recruited from outside USDA to bring in new ideas and recent research experience, whether from academia or industry. At the end of their three to five-year term, AgARDA PDs should expect to find a new position outside of USDA. Second, AgARDA PDs should be passionate about solving real and immediate problems in agriculture, and they must demonstrate a willingness to achieve this by pushing the forefront of knowledge and applications driven by the newest technologies. Third, they need to have outstanding management and interpersonal skills as they will be relying on and interacting with funded investigators on a weekly basis.

ARPA PD interviews are conducted in a "pitch" format. Ten slides are shown to the Agency Director that define a problem, the tools that might be used to solve it, and potential performers (PI's) who might apply. This would occur fewer than six months before starting a contract, which requires special hiring authority outside of federal human resources to maintain tight schedules. Once on board, the PDs might choose to host a workshop with research leaders and potential performers to gain additional ideas before developing an RFP. The finalized RFP would be released within six months of their start date. Each project has one PD, but PDs may choose to oversee multiple projects during their short tenure. PDs should have a 100% appointment with AgARDA in the pilot phase, taking leave from their existing job and be strongly encouraged to relocate to the Washington, DC area to collaborate and build a community with other PDs at the agency. PDs frequently travel, and many day-to-day interactions would be with the performers around the country.

Agency Director

The AgARDA Agency Director should be a political appointee and the only layer of administration between the PDs and the politically appointed Secretary (or the USDA Chief Scientist/REE Undersecretary, as the 2018 Farm Bill is currently written). Given the relatively small scope of the pilot phase, it is conceivable that the Agency Director could also serve as a PD for the duration of the pilot. The AgARDA Agency Director's three primary roles are to hire and insulate their PDs from outside influence and barriers, to protect and improve the reputation of the Agency, and consequently, to

increase resources to the Agency to solve more and bigger problems in agriculture. One key early goal of the Agency Director should be to obtain a line item for AgARDA in the federal budget to ensure the independence of the new agency. The AgARDA Agency Director must have scientific, managerial, and political gravitas and outstanding moral character. Program approvals under a certain amount ($10 million) should remain at the sole discretion of the Agency Director, while Secretary approval should be required for programs requiring higher levels of funding as AgARDA expands, which is typical of ARPAs.

Staff

As in other ARPAs, each PD will be supported in research by one to three staff members who are nearly always Ph.D.-level contractors serving at the behest of the PD. These staff assist in developing RFPs, organizing scientific review panels, enabling frequent communication with performers, and supporting the PD in day-to-day operations. In some cases, these staff may serve as an institutional memory of ARPA programs, should their expertise apply to subsequent projects. Additionally, at least one support staff would be needed for accounting and billing across the agency to ensure financial accountability.

The constraints of a $50 million pilot must be considered

Because ARPA agencies specifically court high-risk projects, it is expected that AgARDA-funded projects may fail at higher rates than projects supported through traditional funding agencies. A relatively high failure rate is acceptable at other ARPA agencies because there are enough total projects to yield some important successes. However, considering a medium-sized ARPA program has a $35 million budget, even two programs of this size could outsize a $50 million pilot.

The only tenable option will be to temporarily reduce the project size to fund multiple projects and to reduce the riskiness of the funded projects to ensure some important early successes. With an independent Director, innovative projects, and an empowered staff, the AgARDA pilot will undoubtedly prove effective enough to warrant investments in a true ARPA-style agency at USDA moving forward.

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