United States Department of Agriculture

Agricultural Researcher Support Services:

A Study Conducted by the National Agricultural Library in Cooperation with Ithaka S+R

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Scott Hanscom, MLS, Adam Kreisberg, Ph.D.,
Emily Marsh, Ph.D., MLS, and Cynthia Parr, Ph.D.

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Executive Summary

Recent advances in information and communication technologies have fundamentally changed many of the work and research practices for scholars and other professionals. As organizations whose history is rooted in pre-digital modes of communication such as books but whose philosophy pushes them to respond to changing information needs, libraries have taken great strides in developing a new generation of information products and services. However, resources are limited and libraries must prepare to make evidence-based decisions on which technologies and service improvements will meet the current and future needs of their users.

This report describes the findings of a needs assessment involving U.S. Department of Agriculture (USDA) researchers. Conducted in 2016 by the National Agricultural Library (NAL), this assessment is part of a larger study involving Ithaka S+R and eighteen other libraries on the research practices of agricultural scholars. Ithaka S+R is creating a final report based on an aggregate analysis of a subset of interviews from participating institutions. This local report reflects what NAL learned from USDA researchers and how it can better serve one of its core audiences.

In June and July 2016 NAL's research team interviewed eighteen USDA scientists: three Agricultural Economists from the Economic Research Service (ERS), one Research Forester from the U.S Forest Service (USFS), and fourteen scientists from the Agricultural Research Service (ARS). The ARS participants came from a wide, representative spectrum of agricultural domains, ranging from agronomy to zoology. Interviews were transcribed and analyzed using standard qualitative methods. Three themes emerged:

Information Seeking: Researchers employ mixed strategies to keep up with trends in their field, including traditional search methods, conference attendance, and other personal networking and service to professional organizations. However, like non-academic researchers and everyday people looking for answers, they rely heavily on Google, or the Google Scholar platform linked to USDA resources to support basic research-related work processes like literature searching.

Researcher Collaboration: Collaborative relationships exist within a researcher's home agency as well as across the country and around the world. Most participants were satisfied with their collaboration processes, but noted challenges when moving across research communities and organizational boundaries.

Data Management: Many participants recognize the importance of good data management for their research. Additionally, some called out the potential for big data to impact their work and the possibilities of data re-use by themselves or others. However, few feel they are fully capable of keeping up with evolving data-intensive

techniques or conforming to best practices. Researchers are generally unaware of what they will be asked to do in this area in the future.

Several trends are especially notable. Researchers are especially concerned about their ability to manage, analyze, and share data as volumes of data increase. They need to navigate an increasingly complex landscape of professional literature. They desire better access to digitized historical materials. They seek increased opportunity for networking and research collaboration.

NAL should continue to engage with its users in order to understand their agricultural research practices. Additional studies will help the library pursue its mission and better serve its user community.

Summary of Recommendations

The following list is a summary of strategic recommendations for how NAL can build on its strengths to address key concerns emerging from the study. These recommendations build upon the themes explored in the following sections of this report.

1. Create tools that help scientists discover and judge the value of resources other than the peer-reviewed journal article. This would include trade journals and grey literature. NAL can provide real added value within this domain since librarians have a unique understanding of the role these kinds of resources play in the scientific endeavor.

2. Develop new web-based and in-person trainings to support the use of scholarly network tools and other platforms for keeping up with current trends in research. With expertise in information management and experience working with diverse research communities, NAL is the logical organization to facilitate the use of these platforms for information seeking.

3. Expand upon researchers' facility with Google through trainings and/or targeted alerts. These trainings could include issues such as: creating profiles, alerts, and citation lists. Again, this kind of service taps into NAL's strength as an information gateway between recorded knowledge and the scientists who work to create that knowledge.

4. Foster networking and collaboration across ARS and USDA and with university and industry researchers. Include in-person events held at the library, online resources including policies and laws for certain types of research, social media highlighting successful partnerships, and webinars or other activities designed to stimulate conversation between researchers that could lead to collaborative relationships.

5. Assist researchers in improving their data management and analytics skills, including where, how, when, and what to share, and how to find data that is fit for use or re-use.

6. Develop expertise in data science and data journalism to better communicate research results to broad audiences and to help researchers understand their data's impact with both narrow and broad audiences. This is a natural complement to the library's long history of curated information centers.

7. Continue to digitize and add value to published data and consider data rescue consultation.

8. Seek regular input from USDA researchers to identify high-value content missing from the DigiTop portfolio, to determine digitization priorities, and to improve and streamline workflows they use for manuscript approval and submission.

9. Better support ARS reporting, for example, by collaborating with ARIS developers to ensure accurate and comprehensive metadata for publications and data

10. Improve interaction between NAL and the agricultural research community by developing an outreach and engagement program with ARS labs that raises awareness of public access initiatives, especially PubAg and Ag Data Commons, and identifies and promotes the other platforms that they most want to use.

NAL's Research Team consisted of Scott Hanscom, Adam Kriesberg, Emily Marsh, and Cynthia Parr. The writing team included Paul Wester.

Introduction

In Spring 2016 the National Agricultural Library (NAL) of the U.S. Department of Agriculture partnered with Ithaka S+R and eighteen other libraries to study the research practices of agricultural scholars. Ithaka described the study as an examination of "the research activities of agriculture scholars":

> *. . . the participating libraries assembled research teams and conducted semi-structured interviews with faculty and visually documented faculty information practices through photography. The participating libraries will author local reports and Ithaka S+R will create a publically available final report based on aggregate analysis of the data collected from the participating institutions* (Ithaka S+R, 2016).

This is the local report written by NAL's research team: Scott Hanscom, Adam Kriesberg, Emily Marsh, and Cynthia Parr. The team interviewed eighteen USDA scientists seeking to determine how NAL can better serve its core audience. The interview participants were three Agricultural Economists from the Economic Research Service (ERS), one Research Forester from the U.S Forest Service (USFS), and fourteen scientists from the Agricultural Research Service (ARS). The ARS participants came from the following specialty areas: Agronomy (2), Botany (2), Chemistry, Ecology, Entomology, Genetics, Molecular Biology, Plant Genetics, Plant Pathology (2), Plant Physiology, and Zoology. At least eight participants could be considered senior scientists.

The in-person interviews, each roughly one hour in duration, were conducted in participants' offices in June and July 2016 using questions provided by Ithaka S+R (see Appendix). The responses were transcribed and analyzed using standard qualitative methods within the Grounded Theory paradigm (Corbin and Strauss, 2007).

A close reading of the transcripts revealed three main themes each with discrete sub-themes, leading to corresponding recommendations for NAL service areas. The main themes were 1) Information Seeking (how researchers look for and access relevant information for their work), 2) Researcher Collaboration (how participants engage with their colleagues), and 3) Data Management (competency across the research data life cycle).

Following detailed discussion of each of the three main themes, the report concludes with a discussion of key insights that are especially relevant to NAL. These cross-cutting results include the growing importance of data management capabilities, discoverability of the current professional literature in a complex technological landscape, access to digitized historical materials, the need to develop and maintain research collaborations,

and the need for NAL to continue this type of user engagement and investigation in the future.

Information Seeking

There is a long history of scholarship in the information seeking patterns of scientists of many disciplines. To date, the practices of scholars in agriculture have not received as much attention. Not surprisingly, many studies of information needs in agriculture focus on practitioners, especially the farmer, instead of the scientist (e.g. Wood, Blair, Gray, Kemp, Kenyon, Morris, and Sewell, 2014; Duram & Larson, 2001; Gloy, Akridge, and Whipker, 2000; van Asseldonk, Huirne, Dijkhuizen, Beulens, and Udink ten Cate, 1999; Izah, 1996; Leckie, 1996).

The agricultural scientists who participated in this study shared many aspects of their information seeking and gathering processes. This section will look at the journey from environmental scanning for trends, to selection of information sources for research support and the methods used to search those sources, and the predominance of Google as a combined information source and service.

Environmental Scanning

> *So the information search, I guess…I have to say we're doing it constantly….You have to be viewing this constantly. Something will slip by if you're not doing it constantly.*
> -- USDA Molecular Biologist (ARS14)

The respondents reported many ongoing, intense efforts to keep up with research trends in their respective fields. The methods carried out for this work varied greatly. Some initiatives were reliant on the solitary methods of the researcher and others were more social, incorporating the efforts of colleagues and peers to stay abreast of their respective fields. On the solitary side, one scientist reported maintaining a personal, ongoing literature review of his central topic:

> *I keep an extensive literature review. I might say that if it has to do with bedbugs, I know what's going on, with anyone researching bedbugs.*
> -- USDA Entomologist (ARS15)

Another respondent relied upon publishers to provide him with up-to-date, relevant journal tables of contents:

> *I signed up for basically email alerts from a ton of journals that I'm interested in, so I just get emails with what they're publishing each month and I just scan the list.*
> -- USDA Economist (ERS03)

Actually working on peer-reviewed journals was also cited as a means of staying aware:

I also serve as a reviewer or associate editor [of a journal]. *And I'm putting together a special issue from a meeting that I organized—an international meeting. So serving as a manuscript reviewer for the hardcore genetics and genomics journals is helpful.*
-- USDA Plant Geneticist (ARS09)

Some participants engaged in intense searching to maintain their personal awareness:

The only way that I keep on top is by constantly searching with my own search engines and looking up the news constantly for what are the latest things being developed.
-- USDA Molecular Biologist (ARS14)

In contrast to those scanning in relative isolation, some participants relied upon interaction with colleagues to keep current. One socially-based method was regular telephone contact:

I'm on a lot of conference calls with other researchers about various topics…so there's a lot [of] *back and forth with them, so I can connect with their broader community through them.*
-- USDA Botanist (ARS17)

Conference attendance was cited as a useful, socially-based method for monitoring trends:

I've always thought going to conferences is a really good way to just get a crash course in what everybody's working on.
-- USDA Economist (ERS03)

Some scientists felt a need to engage in both solitary and socially-based activities. One respondent reported doing all of the following to keep up with current trends:

. . .attending meetings…[engaging in] *conversation with colleagues, serving on panels—grant review panels or program review panels*
-- USDA Supervisory Plant Pathologist (ARS13)

Information Sources

I think it always comes back to the literature, because you don't want to do something that someone has already done. You don't want to do duplicative research. You want it to be new.
-- USDA Entomologist (ARS15)

By far, peer-reviewed journal articles were described as the primary source of information for the scientists' main work projects. This echoes the stable finding in the literature that scientists rely on the journal article most often when they seek information (Brown, 1999; Tenopir, *et al*., 2004, Niu and Hemminger, 2012). The primacy of the journal article was taken for granted by most of the participants, although monographs were also cited as somewhat helpful. These resources can also be viewed through the lens of document structure with the published journal article being the most highly structured, monographs and trade journals being more loosely structured, and social networking sources, including conferences, the least structured. The participants reported varying levels and types of use for each of these information sources, along with the problems and potentials for access corresponding to their degree of structure.

It was not surprising that most participants reported journal articles, and the bibliographic resources that contain them (e.g., *SCOPUS*, *PubMed*, *Web of Science*), as the most useful of their information sources. They reported many strategies for searching this literature which are made possible by the standard structure of the typical scientific research article (*e.g.*, title, abstract, introduction and statement of problem, literature review, method, results, discussion, and bibliography). These multiple entry points, along with their corresponding metadata representations, make it possible to search in many different ways. The scientists commonly reported successful searches of journal articles.

Some attempts to locate timely and relevant research articles are executed through basic keyword searches:

> *I rely on AGRICOLA and Scopus because if you are smart enough to choose your key words and then look at 20 or 40 [records], you can almost always find something that will show you what you needed to know.*
> -- USDA Geneticist (ARS03)

Other methods include looking at the bibliography of a given article to locate citations to other works:

> *I use a combination of reading say highly cited papers or key reference papers. Then looking at their references to see what are the most important sources of argument in those papers. And to get those papers and slowly build up a full picture in my mind of what the arguments are.*
> -- USDA Agronomist (ARS04)

Once a relevant article is found, it can be used to discover other works that cite it:

> *But once you've found that really good paper you can see who's been citing it recently and get kind of caught up.*
> -- USDA Zoologist (ARS10)

Of course, both of these methods of citation searching can be used on a single source:

> *[When starting a research project I use] Google Search to start…try to find a couple of well-cited articles in the area, and then follow the citations backwards and forwards…[then] try to get a big list of major articles.*
> -- USDA Economist (ERS03)

Monographs were mentioned very infrequently by the scientists. The only notable feature pointed out by the participants was the possibility of having them in digital form and the value that form took:

> [T]*his whole having* [monographic] *PDFs pretty much has changed our lives because you can search for keywords. You can't do that with a printed book; you'll never find it. That's really terrific…*
> -- USDA Molecular Biologist (ARS14)

Because monographs are not as highly structured as journal articles, keyword searches are seen as the only possible means of access, in contrast to journal articles which allow for this method among many others.

The scientists reported several problems with other information sources that could be traced to their fundamental lack of standardized structure and quality control. For example, the researchers struggled to find and judge resources such as trade journals:

> [T]*here's a world of agricultural specific literature that might not be published in an economics journal and it's published in a trade journal. And I have a very hard time understanding how to get at that information and I have to rely on my colleagues, here, to help me with that, but I don't know what journal to look for, I don't know if this thing is reputable, you know?*
> -- USDA Economist (ERS03)

One participant voiced concern over disreputable, "predatory" journals that do not adhere to accepted standards for publication:

> *And one of the things I think is really bad these days is all of these journals that are not journals.*
> -- USDA Chemist (ARS06)

Social networking resources such as Twitter and ResearchGate are structured in a way that encourages users to search by personal name, rather than topic:

> *I have found ResearchGate to be tremendously helpful, because I can follow now the people – and also Google Scholar, because you can plug in somebody that you're interested in.*
> -- USDA Economist (ERS02)

This means of personal connection can function in two ways, so participants can give information as well as receive it:

> *I'm a member of ResearchGate so that is a – I both receive notifications about people doing things that are related to what I'm doing and I can also get access through ResearchGate to a number of publications that I get can't get through…other mechanisms.*
> -- USDA Chemist (ARS06)

Twitter updates from colleagues were also seen as a useful form of interaction and source of trend information. This quote shows that social media can play a meaningful role in the advancement of science, and not just for the creation and maintenance of personal relationships:

> *I recently signed up for a Twitter account and I've been trying to keep the Twitter, the subscription or the people I follow, to only science. And it's actually very useful because I think proportionally I've found more I would say slightly off-topic but very pertinent information through Twitter.*
> -- USDA Ecologist (ARS12)

The Dominance of Google

> *In terms of how I find literature, I usually start with Google.*
> -- USDA Botanist (ARS17)

Google was cited more often than any other single information discovery and retrieval service. It has become the *de facto* starting point of the information discovery process. While NAL services may have played this role in the predigital and early digital eras, it has been supplanted . The reasons for this displacement, and the values of Google and Google Scholar services were described at length. On the whole, Google has become the default resource of choice because no predetermined source selection needs to be made. In essence, it is perceived as a "one-stop shop" for everything digital. There is also no requirement for extensive search strategy preparation. Most any search of any term will result in either some relevant results, or at least a starting point. For example, searches can be formed using simple keywords and publication dates:

> *In Google Scholar you can your search by the year of publication. I do that all the time. I put in maybe a scientific name. I'll put in maybe a couple of terms like phylogeny, phylogenetic. I'll put in a date range and I'll see what comes back.*
> -- USDA Botanist (ARS05)

Personal names can be searched as sources of authorship and then expanded upon as sources of citations:

[Y]ou can plug in somebody [to Google Scholar] that you're interested in. If you're read a paper you think is really worthwhile, then you can see who cited that paper. That I find very helpful.
-- USDA Economist (ERS02)

Finally, scientific terms such as gene names can be searched using Google:

I get asked a lot of questions off the web, then I delve into, I usually, like I said, I use Google Scholar. I may have to look at our classification say of a particular genus. Or if I'm dealing with something in a particular genus, I may decide to look at all of the names we have in that genus. And look at it in a more current context. So then I would go to Google Scholar.
-- USDA Botanist (ARS05)

Conclusion

Our interviews demonstrate that USDA researchers deploy a variety of strategies to find and retrieve information sources to aid them in their research process. They seek to stay on top of trends in their field through regular literature scans, serve on editorial boards to remain engaged with new work, and attend conferences to hear from colleagues. They mostly seek and use articles from peer-reviewed journals, deploying a range of search strategies to query the available access systems with varying success. Overall, the dominant method for discovering relevant literature was Google. Scientists appreciated the ability of Google Scholar to help them find relevant materials while searching a number of information sources. These lessons should inform NAL, and all libraries, as they seek to support their users in pursuit of relevant information. Behaviors and expectations for search are shaped by Google, but library systems still have an important part to play in the agriculture information seeking environment.

Researcher Collaboration

The sunflower was brought to me by a woman who had been a Masters student who I had advised while she was doing her Masters at the University of Maryland. And who works as a landscaper and with a local nursery so she gets plenty of opportunity to see a wide variety of plant material. And she's brought a number of things to my attention. The maple samples were brought to us, were sent to us by the person whose property the tree is growing on. But we were identified as having a potential interest through a graduate student, I think at University of Florida, and has also sent samples or arranged for samples to be sent to a number of other researchers working with trees or ornamentals.

-- USDA Plant Pathologist (ARS06)

The previous section demonstrated that USDA researchers view professional meetings and other interactions with colleagues as vital to their information seeking behaviors. This section focuses on collaboration and social interaction between agricultural

researchers and the ways in which the participants in this study work with others in their social networks. The importance of collaboration and its many manifestations across participants' professional experience came up repeatedly during our interviews. Nearly every participant engages in collaborative activity, whether in their typical research practice or more generally through their social networks. The results presented in this section reveal ARS scientists, who are deeply embedded in social networks, collaborating with colleagues inside USDA and across the wider scientific landscape.

Collaboration on Specific Projects

Some participants collaborate in order to achieve their primary research goals. For these scientists, collaborative science is essential to generating new knowledge and contributing to the research mission of USDA.

Within USDA

The USDA research ecosystem is diverse, spanning the full range of agricultural domains. Participants discussed how they collaborate within USDA during their research workflows; for ARS03, collaboration is central to his work. He related the scope of collaborative efforts in his lab to include:

> *. . . 70 different researchers out there that are doing projects with us…I work with people who are ecologists, people who are geospatial analysts, people who can do statistics, people who can do…landscape modeling and economists. And I kind [of] almost view myself as kind of like the hub of that wheel that tries to bring all of the spokes together.*
>
> -- USDA Geneticist (ARS03)

Beyond their own research groups, participants also discussed interacting across USDA agency lines. Two ARS researchers reported working with colleagues in the Animal and Plant Health Inspection Service (APHIS). ARS17 explained how she worked with APHIS staff and the benefits she gains through the collaboration:

> *We have two USDA APHIS mycologists collocated with us in this lab. So there's a lot of back and forth with them, so I can connect with their broader community through them.*
>
> -- USDA Botanist (ARS17)

Another participant, ARS06, recounted an example of working with APHIS and international partners to study a virus in lilies. In the excerpt below, he describes how his relationship with APHIS allows him to bridge the gap between research and impacts on agricultural products:

Three years ago we identified a virus in lilies that had not previously been reported in this country and it was found in lilies imported from the Netherlands. So after I found and identified that, I contacted APHIS to notify them and eventually received some farm bill funding from APHIS to do further work …I've also been working on that in collaboration with my colleague in Italy and with colleagues in the Netherlands who had approached the two of us to develop an infectious clone of the virus to label with a fluorescent protein and then use that to track the progress of the virus through infecting lilies.

-- USDA Plant Pathologist (ARS06)

Research Leaders (RLs) articulated their roles in interactions across ARS research units. ARS14 described her work as a facilitator of the team she leads:

I am a strong believer in team research and having more assets and/or people involved on projects can lead to a more creative or innovative or better solution to a problem, or more information.

-- USDA Molecular Biologist (ARS14)

In these collaborations, our participants described activities which they see as central to their work and expected by their peers. They take advantage of their colleagues in USDA to leverage different types of expertise and execute their research projects.

Outside USDA

Our participants also reported engagement with a wide network of collaborators outside USDA. The reasons for these collaborations range from the general to the specific. ARS17 outlined her vision for collaboration which extends beyond ARS and USDA to other departments in the federal government as well as university researchers:

We work with university professionals. We work with extension people that are of course intimately involved in agriculture. I've worked with people at the CDC, in medical schools. So yes, I do work with a broad diversity of other researchers in different disciplines unrelated to agriculture.

--USDA Botanist (ARS17)

ARS10 also mentioned working with researchers at the CDC:

[I'm]…working with colleagues at the Centers for Disease Control who bank serum from large numbers of Americans…

--USDA Zoologist (ARS10)

For other participants, they obtain research materials through collaborative relationships. These researchers rely on their social networks to provide materials for them to analyze. In the quote beginning this section, ARS06 explained how she was provided multiple samples to analyze by a former student. Others also mentioned being sent or given physical samples to analyze. ARS14 explained that she also may provide information to these contacts upon request:

> *[when] researchers become aware of certain things that we work on -- a particular kind of bacteria, or they have received information that we have biopesticide strains available…they will contact us.*
>
> --USDA Molecular Biologist (ARS14)

For ARS12, his work at ARS and the reputation he's built as a scientist leads to new collaborations:

> *I have had situations where people call me up and say …I read this paper that you wrote and I want to do those techniques with my experiment but I don't have those skills. Is there a way to collaborate on this or could you help me on my project? So, I've had those types of interactions…once you start to get established and have publications and meet people at meetings, there's a lot of people that will want to come and work with you. . .*
>
> --USDA Ecologist (ARS12)

ARS 14 explained that one of her collaborations arose out of a specific methodological expertise which was absent in her lab:

> *Sometimes the projects come out of a recognition of [expertise] that we're lacking in this laboratory… if we wanted to do [a specific type of analysis] in chemistry research, we had to find someone who had that equipment…would need to seek a collaborator outside of our lab group . . .[we have] loads of university collaborators…of course, obviously related to our mission to control the insect or the broader mission of the USDA.*
>
> -- USDA Molecular Biologist (ARS14)

Other participants highlighted international collaborations as important components of their research. ARS03 explained that he's hosted many international colleagues at his lab in Beltsville and gathered materials from other international scholars in service of comparative analysis:

We have collaborators here at Beltsville, who are from all over the world. I've got people who are in China, some in Israel. We've got somebody here from Mexico, Brazil, Canada . . . South America, Central America. We've got a group from Italy, from Switzerland, Netherlands, all over the world people send materials to us because we're trying to collaborate as to what we're seeing here in the United States.

-- USDA Geneticist (ARS03)

ARS01 has worked extensively in other countries during his career, and recounted a few of his challenges using different online systems to collaborate with non-USDA researchers in other countries. He has employed multiple techniques to get international collaborators the data they need to do their work.

They really limit what you can use. [Systems] that people in Ecuador and Brazil can access, USDA says it's illegal to use. So, getting data was a matter of getting Excel files attached to an email and then trying to build a data sets, because -- and trying to -- USDA Connect is great. When that came out, that was . . . SharePoint access by non-USDA people SharePoint, they say it's easy but it's not.

-- USDA Agronomist (ARS01)

General Collaboration and Social Interaction

While much of the collaboration described by our participants was focused around a specific research project or situation, they also touched on more general interactions with colleagues that affect their work in various ways.

Within USDA

Most of our interviewed participants work in the Agricultural Research Service but the sample also included employees from the Forest Service and Economic Research Service. Collaboration happens on many different fronts regardless of agency. ARS12 reported work with other agencies on more applied projects as a complement to her primary research agenda:

I've collaborated with other agencies in different ways, not necessarily on research . . . within USDA my collaborators, interagency collaborators, would be in NRCS. That's probably the most closely aligned agency to the work we do.

--USDA Ecologist (ARS12)

ERS01 talked about how he works with scientists from other agencies even though he is an economist by training:

I'm in an area where over the course of my career I've worked more closely with scientists. I'm more likely to occasionally want to look at something in a scientific publication as opposed to an economic or social science publication.

-- USDA Economist (ERS01)

Participants from ERS commented on the general collaborative environment at the agency. ERS03, a relatively new employee, praised his colleagues for helping him solve challenges encountered on the job:

I've had issues where computer programs take a very long time to run…there are other people here who have recently been hired, who are really computer savvy. And I feel like if I had similar problems again, I could talk to them and they would help me surmount them pretty easily.

-- USDA Economist (ERS03)

Some participants expressed more nuanced views of collaboration, such as ARS09 who related difficulty in finding collaborators:

I am not a plant physiologist. See, a breeder has to kind of wing it sometimes. If you don't have a collaborator sometimes you just kind of have to try it and see if it works.

-- USDA Plant Geneticist (ARS09)

Libraries can function as organizational hubs, bringing together researchers from different disciplines to forge new collaborations. This represents a unique opportunity to strengthen both the research outputs resulting from collaborative science as well as the relationship between NAL and USDA scientists.

Outside USDA

Many respondents noted that their social networks extended well beyond USDA into a range of academic disciplines. As members of specialized research communities, the researchers we spoke to felt connected to their broader disciplines in addition to their colleagues at USDA. Many reported going to conferences, professional society meetings, participating in conference calls and other events to meet colleagues and keep up with trends in their field. Some, such as ARS06, have been members of these communities for decades. She related her experience in a professional society:

The network that comes through that meeting has been an important resource for me over the years. I've been participating in that group since 1984.

--USDA Chemist (ARS06)

Other participants explained how they remain involved in their research communities in different ways. ARS09 explained that reviewing grants is especially valuable for her:

> *I serve on grant proposal committees at a couple of levels and I find that that is the most helpful. I used to go to big meetings but I find that the current trends in genetics are based on organisms that are very dissimilar from [mine] and would be difficult for me to use.*
>
> -- USDA Plant Geneticist (ARS09)

University researchers are most helpful to ARS12, who enumerated:

> *Strong ties to University of Maryland, North Carolina State University, Cornell, Penn State and University of Maryland Eastern Shore, as well as the Lower Eastern Shore Research and Education Center, which is [in] Salisbury.*
>
> -- USDA Ecologist (ARS12)

ERS02 finds it most helpful to seek conversations both in and outside of his home agency:

> *I find it's very good if I can speak with people that don't work at ERS. It's wonderful working at ERS, because you have somebody working here who knows just about any question connected agriculture – economic question connected to agriculture. Somebody's going to know how to answer, or they're going to know who to ask how to answer it. That's harder when you get outside of here, and it's harder when your contacts start retiring.*
>
> ---USDA Economist (ERS01)

Sometimes, collaboration and data sharing arise out of a serendipitous meeting. ARS12 recounted an example of this:

> *At a society meeting in Minneapolis . . .I went to a bar to eat dinner and I didn't know anyone up there at the time. Sat down next to a guy, started talking to him. He asked what I do. He said oh, I do some of the same stuff but the people in my lab really do that plant genomic stuff. Gives me his name, I write to him. He connects me with his collaborators at Clemson and so I mailed the hard drive with the genome down to them and they started analyzing it for me.*
>
> -- USDA Ecologist (ARS12)

Here, we see the value of conference attendance playing out in research activity. Through this chance meeting, ARS12 gained new collaborators and the ability to conduct new analysis on existing data.

General Opinions on Collaboration in Science

While explaining their experiences and research practices, participants shared their impressions and views on collaboration in science and what they would change to make collaboration easier in ARS. Participant ARS09 wished for more:

> *Mentoring, networking not just for socializing because I can't stand socializing, but working together on a common vision of the world as being a better place even if it's just my little corner.*
>
> --USDA Plant Geneticist (ARS09)

ERS02 echoed the sentiment that more communication between agencies would be beneficial:

> *In general, I wish I had more awareness of what goes [on] – I wish there was better communication between the agencies within REE.*
>
> --USDA Economist (ERS02)

ARS09 pointed out the importance of collaboration and social relationships outside the scientific community. She felt these relationships made her work easier and were positive influences on the workforce morale. She wondered how she could generate:

> *. . . an expansion of the camaraderie that I have with several people here at BARC. Our research support services, our facility services . . . All kinds of people that you wouldn't think a scientist would turn to.*
>
> --USDA Plant Geneticist (ARS09)

Finally, ARS06 shared additional views of collaboration and the benefits of research conducted in partnerships. He pointed to international colleagues as sources of positive collaborations and expressed his hope that others within ARS would embrace the benefits he's reaped through this mode of research:

> *Over the years I have worked with some people who very much wanted to keep their own hands on the projects and didn't want to cooperate on certain things. And that hampered research. I think when people open up and share with their colleagues a lot more gets done. It enables you to have your finger in a lot more pies and contribute more broadly . . . I get so much out of my interactions with my colleague in Korea and my colleague in Italy and then with some of my other*

colleagues here that allow me to do things that there's no way I could do just by myself.

-- USDA Plant Pathologist (ARS06)

Conclusions

The USDA researchers we spoke with throughout this project engage in a range of collaborations which aid their work and expand their research communities. Within the agency, across the country, and around the world, USDA researchers work with colleagues to develop research ideas, expose themselves to cutting-edge work, access international communities to conduct research, and to continue innovating in their work. The diversity of collaboration was a hallmark of our interviews; many participants had stories of engaging with their colleagues which were unique.

One primary takeaway that emerged was the sentiment that many researchers sought additional infrastructure to help them find collaborators and establish new relationships. This could be an opportunity for the library to define itself as a hub for researchers seeking partners in their work.

Data Management: The Importance of Data

Twenty years ago when they started this study, they probably never thought of where it might go in the sense of, you know, how complex storing, archiving and accessing that data would be. And it's really a project unto itself. And I think the scientist realizes this. He's not stupid. He knows that this is an issue.

-- USDA Ecologist (ARS12)

Many organizations recognize that the next frontier of digital library services is support for the data management life cycle. Two trends are converging: the rise of data-intensive approaches to research (e.g., genomics and other big data methods) and the increasing expectations of openness (including open data) in the research process. It is therefore no surprise that digital data management was a hot topic for the agricultural researchers that we interviewed. As NAL makes major investments in resources or systems, it makes sense to understand how researchers feel about data now and where they hope to be in the future.

What kinds of data, tools, and repositories are familiar for NAL users? Do they feel ready to comply with requirements to make their scholarly data available? What do they need to thrive in the new data-rich landscape?

This section reports on researcher experiences and challenges in five broad areas: data types, data skills, data sharing, access to and use of data (including big data), and impact of data.

Data Types

Our researchers mentioned a wide variety of data types and tools and methods for working with data: images (of plant or animal microscopic structure for example), databases (of collections information, of genetic sequences, of biological taxonomy for example), spreadsheets of experimental results, and computer models:

> *So we're all about the pictures, you know, we're all about the visual arts, is what we are. And all of the electron microscopy images are all black and white, so we add color to them after the fact. We use Photoshop.*
>
> -- USDA Geneticist (ARS03)

> *Excel files, Excel files, Excel files. Yeah, so Excel is my best friend and the more I learn about it the better friend it becomes.*
>
> -- USDA Plant Geneticist (ARS09)

> *There's qualitative interviews, for example. . . . And then, with computer models, you end up with, you know, tables of data points that you can say, "If you do this, then this happened. If you did this, then this happened," and so forth.*
>
> -- USDA Economist (ERS03)

> *We do genotypes, RNA-seq and we have huge data sets and we have a database that is restricted access for this XXXX host genetics consortium that we work on.*
>
> -- USDA Chemist (ARS08)

Data Skills

While all researchers talked about their data, there was a major split between those who eagerly adopt new technologies and techniques for working with data, and those who lamented their lack of skills or the lack of help. For example, one researcher is an avid user of electronic lab notebooks (ARS01), while others are skilled at modeling or using data or text mining:

> *We have a summer intern who's using text mining programs to try and pull data out of these documents. And so that's something that I'm exploring a*

lot more and using text mining software to basically get a lot richer information about these areas.

-- USDA Economist (ERS03)

I have my own program that mines published data from weather stations around the world. So I use that as my own dataset.

-- USDA Research Plant Physiologist (ARS11)

This group often cultivates their own skill set, in part because no other help was available:

I have also used computer simulations of more complicated models that you can't solve by hand. And I have plenty of experience . . . [but] not as much experience as a person who - that's their main livelihood.

-- USDA Economist (ERS03)

Well how can I modify the data? I got to write a program. Do you see anybody around here who's going to write it for me?

USDA Agronomist (ARS01)

However, many researchers feel they simply don't have the right skills. For example, one research group set up a master database but lacks the skill to extract just some of the data for publishing:

I don't think the scientist has the capacity to parse the dataset and say we've published on this yield or the weed competition. . . . Let's take that portion of the dataset and make it publicly available.

-- USDA Ecologist (ARS12)

They struggle to keep up with changes in techniques:

I have lost my ability to do sophisticated statistical analysis as I've gotten older.

--USDA Economist (ERS01)

I wish that we had more capacity for bioinformatics and for staying on top of the data analysis. . .. we're sort of mid-ish career kind of folks and so this whole computational biology and bioinformatics era . . .. It's not our

native tongue, our native language to be doing these things. That's created some challenges for us. We're having to try to learn.

-- USDA Supervisory Plant Pathologist (ARS13)

Some are frustrated, especially with respect to federal security requirements or the ARIS database:

My developers were like, "Why is this my job? . . .. I'm not supposed to be the security assessor kind of auditor." . . . Then . . . the actual bench research people, they're like, "My, gosh. How many jobs am I supposed to have here, and try to do a decent job at any of them."

-- USDA Supervisory Plant Pathologist (ARS13)

We force all of this information through a secretary or a program support assistant in order that it get into ARIS . . . And then we generally restrict querying that information to those same people who know how to use this Oracle database which is very clunky.

-- USDA Zoologist (ARS10)

At the same time, there is concern that increasing specialization in data may cause researchers to lose sight of the field and laboratory context.

Since farming is a smaller and smaller activity - it seems like lots of new hires, like myself, have no direct experience in agriculture.

-- USDA Economist (ERS03)

We're having to spend more time sitting here at my computer doing analysis of data that was generated by a machine maybe then 20 years ago where I would have been in a laboratory or greenhouse doing a lot more of the data generation.

-- USDA Supervisory Plant Pathologist (ARS13)

Data Sharing

There is general recognition of the value of sharing and providing public access to data. A number of existing repositories were mentioned, including NIH's GenBank, Dryad, CyVerse and a variety of domain-specific databases and repositories managed by USDA or by academic collaborators. Several researchers knew that journals may require them to share, but most are apparently unaware that public access mandates will soon require them to deposit their data someplace:

> *Journals are increasingly asking people to send their data along with their manuscript and so it's becoming increasingly common in one form or another.*
>
> -- USDA Economist (ERS02)

One researcher understands that there are not yet specific repositories for all kinds of data:

> *I do not believe that there are standardized repositories for the sorts of data emerging from those projects.*
>
> -- USDA Zoologist (ARS10)

Several researchers familiar with NAL's Ag Data Commons (https://data.nal.usda.gov) were supportive *("I want that Ag Commons thing to work."* ARS14) and many agree that data sharing and archiving is a good thing:

> *I think we will need something . . . that is a long term repository*. . . . *I really think a repository, a centralized resource, could really help ARS.*
>
> -- USDA Ecologist (ARS12)

However, many researchers did not think of data when asked if they make their research products available in a repository. Interestingly, some researchers think that datasets have to be particularly significant or large in order to be worth sharing:

> *I think there's probably more value in doing that with these very large datasets where a particular researcher . . . writes an interpretation of a very small fraction of that data. There's a whole lot there to be analyzed . . . So I think having public access to data is probably . . . more important with these larger scale sort of datasets.*
>
> -- USDA Ecologist (ARS12)

Moreover, there are concerns about how to deal with follow-on requests from exposing their data:

> *The whole increasing our exposure and raising our profile is a double-edged sword for us. We certainly want the scientific community around the world to know about our collections here. . . . We're more than happy for the general public to get the information. [But] We are overwhelmed now with requests for this particular tomato or this particular watermelon or this particular peach from the general public*.

-- USDA Supervisory Plant Pathologist (ARS13)

Additional concerns relate to unpublished or sensitive data, or the potential for misinterpretation:

> *Although I reported some of the data, some of it I have 20 papers I can write on this. Some of it was so sensitive I didn't want to release it.*
>
> -- USDA Agronomist (ARS04)
>
> *His fear is well, you know, once it's out there, it's out of my control in a lot of ways . . . . And it's a real fear in the sense of that long-term study it compares organic and conventional systems. Even though it's not really designed to be a comparison of those systems . . . . You know, so interpretation of that data can be a very sensitive issue.*
>
> -- USDA Ecologist (ARS12)

One researcher understood the importance of capturing administrative data about their research, but was frustrated when submissions must be manual and submissions were rejected for formatting inconsistencies:

> *I see that the web pages are automatically populated and various reports to Congress go up from ARIS. And so you don't want some things that are all caps and some things in title case and some things in … But I'm guessing there's a 12-year-old out there who could probably figure out how to convert things.*
>
> -- USDA Zoologist (ARS10)

Access to and Re-use of Data

Why re-use data

Some researchers already make good use of existing data either to do their research or to plan an efficient research strategy:

> *There's a lot out there so I can rely on NASS. I rely on some of the PubMed datasets. I look at UPA datasets. I look at USGS datasets. USGS is the National Phenology Network. That is very useful. Whatever sources that are available in the context of addressing the specific hypotheses, that's what I'm looking for.*
>
> -- USDA Research Plant Physiologist (ARS11)

I've used those databases to get information about genes . . . basically even doing research in preparation for experimentation.

-- USDA Ecologist (ARS12)

So you have to do a statistically relevant number of animals and ethically you don't want to use too many . . . by using a master database we've been able to . . . keep going back to things [re-use old samples rather than sample new animals].

-- USDA Chemist (ARS08)

One researcher understood the value of raw data (as machine readable as possible - "tidy data"), processing code, and a data dictionary (code book):

Do you put in what you need for reproducibility? Do you have to put the code in that you analyze? . . . I say, "If not a tidy data set with a code book, send it back."

-- USDA Agronomist (ARS01)

Challenges with finding and re-using data

Researchers acknowledge that NAL has begun digitizing scholarly literature:

On the bright side, I used to spend many, many hours at NAL photocopying but now I don't do that anymore because I can simply download the data on my computer.

-- USDA Research Plant Physiologist (ARS11)

but still face challenges finding and re-using data from NAL and other sources:

I'm interested in climate change. Well, what was the climate here at BARC in 1920? . . . You're not going to find it. . . . And yet understanding climate change, understanding what changes that have already occurred as a means to project what will occur in the future is incredibly important. Too bad. You don't have it. Or we do have it and it's sitting in a file somewhere in a building that was abandoned 20 years ago.

-- USDA Research Plant Physiologist (ARS11)

Probably ten to 15 percent of the time, if I want to get some data, I have to pay a fee. So there's an obscure journal that has a really interesting

dataset that is imperative for me to find out about. I can't get it unless I pay the publisher $10 for downloading it.

-- USDA Research Plant Physiologist (ARS11)

In some cases, like 1993, the PDF is so smudged that . . . I have a hard time telling the difference between six, three, zero, and nine.

-- USDA Economist (ERS03)

You can get data off the PDFs and you can get data off the web, and we're trying to get everything we possibly can off the web because it's a lot easier.

-- USDA Economist (ERS03)

Data interpretation remains a particularly difficult task. Participants described finding and combining data from multiple sources as well as approaches to analyzing large datasets:

It's accelerating; we are at an era now where we can generate the data a lot faster than we can make sense of it.

-- USDA Supervisory Plant Pathologist (ARS13)

So we actually do a lot of massaging to try to pull together what's there and see if we can make it more meaningful in a way where we don't violate, don't say something egregiously wrong, because we're just interpreting something incorrectly.

-- USDA Economist (ERS02)

One researcher would like to see automated linking of related data sources maintained by USDA, NIH, and university-based organizations. This could be an opportunity for library expertise in metadata to have an impact on data access and interoperability:

One of the things that we'd love to be able to do is have . . . more automated connections between gene banks, between NCBI and GRIN so that people can see that there's information. There's genetic data, molecular data, sequence data on an accession that we've got the material.

-- USDA Supervisory Plant Pathologist (ARS13)

Two researchers raised concerns about community data entry or annotation, but weren't ready to rely on purely automatic error checking approaches. However, data quality remained important for some:

> *Sometimes you put work into [massaging] data and then find there's better data already available.*
>
> -- USDA Economist (ERS03)

Almost half of the researchers see the promise of big data and ARS's high performance computing and high-speed Internet2 network, SCINet:

> *I love having electronic access to things and it's important to have good internet access and ways to handle big data sets. [We need] good ways to handle the data efficiently in terms of data transfer.*
>
> -- USDA Chemist (ARS08)
>
> *I would be interested to see what happens with essentially big data applied to agriculture. So there's going to be multiple aspects of this. There's the use of big data . . . . as a new technology to help them run their farms. . . . if that big data that's used as part of that technology becomes available to researchers, that opens up all sorts of new research technologies - data mining, you know, machine learning.*
>
> -- USDA Economist (ERS03)
>
> *. . . we need some software for the purpose of data crunching at a rapid rate instead of over the course of months which is what it takes now to do a transcriptome. And we just can't afford it.*
>
> -- USDA Molecular Biologist (ARS14)
>
> *We have the blessing – the curse of all of this data and it's certainly in the sequencing projects. The price base is approaching zero asymptotically and so then when we do it's becoming more expensive to store the old information than to run the experiment again.*
>
> -- USDA Zoologist (ARS10)
>
> *We have 14 to 18 projects coming along, limited only by the capacity of the computers to crunch data. So we're building our own team.*
>
> -- USDA Molecular Biologist (ARS14)

Despite the energy and attention on big data, there remains appreciation for "small data" among some participants. ERS02 expressed an affinity for smaller datasets, given their research needs and scarcity of available sources of data. Not all research questions can be answered using big data techniques and infrastructure:

> *Now you hear a lot of talk about big data. And certainly here, not from me as such, I'm just happy to get hold of whatever small data I can find that I need wherever it is.*
>
> -- USDA Economist (ERS02)

Motivation and the Impact of Data

As expected, scientists were concerned about credit when others use their data. For many, their motivation to share is dampened by the perception that they would not receive a benefit:

> *I had a request for the data from another researcher. So it was a big spreadsheet with ones and zeros like, you know, but useful information for them. And I didn't see any result of that.*
>
> -- USDA Ecologist (ARS12)
>
> *Because it is public domain, there's no requirement if you use the information or the material from our system beside it. We encourage to cite that in the publication. . . we keep trying to come up with ways to better measure our impact.*
>
> -- USDA Supervisory Plant Pathologist (ARS13)
>
> *One of the biggest questions or problematic issues related to data is how will that data be used? Will I get credit for this? Will this help my career? Will this help science? And often those questions are either not addressed or ignored. It comes down to you either do this or you don't get it published.*
>
> -- USDA Research Plant Physiologist (ARS11)

As shown in that last quote ("Will this help science") it is clear that researchers recognize that their data should have impacts beyond themselves. The following two quotes, both from the same researcher, demonstrate this desire to collaborate and increase the impact of USDA research:

> *One of the biggest challenges is trying to work between silos, between individuals to sort of synergize the data that are being discovered and to*

synergize in a way so that the impact of that data will be greater than the sum of its parts.

-- USDA Plant Physiologist (ARS11)

We can't be seen as being ivory tower theoreticists who have no interest in . . . the data that we generate or the science that we do being independent of its impact with respect to things like basic food security or food quality. There has to be an enhanced effort from the scientists' point of view to communicate the importance, the imperative of that science, to the public at large.

-- USDA Research Plant Physiologist (ARS11)

Conclusions

Researchers had a lot to say about data management, and expressed sophisticated perspectives on a complex set of issues facing the research community. Many recognize the potential power of re-using data. Some know what is required to make it truly usable, whether that is good metadata, the machine-readable raw data, or the programs used to process the data. While a few may be naive about the coming era of open data, many are well aware of both the opportunities and the challenges of big data. Most seemed eager for help with data management and improving their skills and seemed open to NAL's assistance.

Finally, this researcher said it best when he noted that times have changed in the world of research information and the role of libraries:

I have three older sons and they're all in the digital world. They're all spending their time looking at YouTube and these short and funny videos, or these science videos that they see, and that's how they're getting their information. And the generation of pulling out a journal off the shelf in a library and kicking up your feet with a cup of tea next to you and reading through the journal to find the latest thing is just not happening anymore.

-- USDA Geneticist (ARS03)

NAL is in an excellent position to work with researchers to multiply the impact of their research data by promoting sound stewardship and modern data management and analytics tools.

Discussion

This study represents a new effort by the NAL to better understand the needs of one of its primary audiences -- USDA researchers. The sample was focused primarily on ARS

researchers working in close proximity to the National Agricultural Library so that rich, meaningful interviews could be conducted in person, eliciting more detailed responses that those which could be collected through other methods, such as a survey.

These interviews yielded a significant amount of data that have been coded and summarized in the three themes presented earlier in this report. While this means it is not a random sample across the USDA, participants were diverse in their research domains. By focusing on three themes the team was able to identify patterns and needs across research domains and recommend ways the library could address them. Below we summarize key insights from the analysis and how they lead to strategic recommendations.

Information Seeking and NAL Tools and Services

Keeping up with the professional literature is increasingly complex, with researchers working in a complicated landscape that combines traditional library and non-library services, and in-person and digital social media. Individual approaches varied but many participants suggested that they don't fully understand the connection between NAL services which provide access to the literature (e.g. DigiTop, Navigator) and the tools they use to access articles such as Google Scholar. This represents a challenge as well as an outreach opportunity for NAL. The library can increase and expand outreach services providing training and explanation of what it provides and strategies for searching the contemporary professional literature. It will be important to explore how existing NAL literature discovery services can adapt to changing needs and perceptions of their users. This challenge is one shared widely across academic disciplines in the current era of ever-increasing numbers of academic publications, and NAL is well positioned to support USDA researchers' access to relevant literature moving forward.

Collaboration Support

Collaboration was a common thread across our three themes. Many respondents discussed specific collaborative projects or relationships they maintain within USDA as well as in the university research community. They noted that attendance at relevant meetings and conferences is an essential component of their work, as it both exposes them to potential collaborators and helps them stay up to date on trends in their field. Participants also explained how they collaborate on data management and analysis. NAL can facilitate more collaboration and interaction between USDA researchers by hosting cross-cutting events and by hosting and promoting interactions between researchers on rotation from the various National Programs and agencies. It can also embrace new ideas from the university library community, such as the concept of embedded librarianship (i.e. Dewey 2005). This philosophy suggests that libraries and librarians should reach outside of their institution across the organization they serve to have a greater impact on research in their constituent communities. Embedding, or

sending librarians outside the walls of the library, will improve library services based on new insights gained about users but will also help researchers who can benefit from the perspective information professionals bring to research settings. These are some ways that NAL can help shape transformative and collaborative research in USDA.

Data-related Services

The importance of data and activities surrounding its creation and management are a vital part of research. This is not new, of course, but our results suggest that the fast pace of recent technological and policy change is having an uneven impact on agricultural researchers. Though many researchers are not yet aware, NAL is already beginning to offer data-related services. Indeed, NAL is well positioned to provide leadership and support around data skills and best practices. The library can offer expertise, guidance, and services to the research community as well as to department leadership, especially as the Office of Science and Technology Policy's 2013 memorandum on increasing access to federally-funded research (Holdren, 2013) is translated into a Departmental Regulation. Additional surveys and interviews are needed to better characterize the underserved communities in need of support so that NAL can facilitate good data practices across USDA.

Historical Content

Beyond current professional literature, participants shared their experiences accessing and using digitized historical materials from the NAL Digital Collections. (NALDC). For those researchers who use these resources, they view them as unique and valuable tools for facilitating their research and enabling new analyses. However, other respondents suggested that they had difficulty navigating and locating materials in NALDC and were not clear on how NAL staff prioritized digitization activities. Again, this represents a challenge and opportunity for NAL and other institutions supporting agricultural research. Historical content is a vast, mostly untapped resource for comparative analysis, research, and educational uses but requires significant descriptive and metadata work to become broadly useful to USDA researchers. NAL will have to weigh the costs and benefits of this work when seeking to increase access to these materials. Future research could explore more efficient ways to digitize historical USDA materials, and demonstrate how new technology (e.g. text mining and crowdsourcing) could increase its impact.

Future Research

Finally, the research team recognizes that the conclusions of this study are necessarily limited. As this project connected to the larger Ithaka S+R study of research practices of agricultural scientists, the questionnaire was designed to be broadly applicable to agricultural researchers, not specifically to USDA employees. This study yielded many insights but raises additional questions that merit further study. More detailed

investigation into subsets of researcher behavior such as deposit of publications or data management practice is needed. NAL and the wider library community stand to benefit greatly from regular study of the changing behaviors, work practices, motivations, and needs of their communities.

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Appendix: Interview Questionnaire

The following is the text of the questionnaire, developed by Ithaka S+R and used in this local study. These questions were used in interviews across all 19 participating libraries in the Ithaka study.

Research focus

1. Describe your current research focus and how this focus is situated within the broader agriculture discipline and the academy more broadly. [Probe for whether/not they see themselves as located firmly within agriculture as a discipline or located across/between disciplines]

Research methods

2. What research methods do you currently use to conduct your research?
3. What kinds of data does your research typically elicit?
4. How do you locate the primary and/or secondary source materials you use in your research?
5. Think back to a past or ongoing research project where you faced challenges in the process of conducting the research.
    a. Describe these challenges.
    b. What could have been done to mitigate these challenges?
6. How do you keep up with trends in your field more broadly?

Dissemination Practices

7. Where do you typically publish your research in terms of the kinds of publications and disciplines? How do your publishing practices relate to those typical to your discipline?
8. Have you ever deposited your data or final research products in a repository?
    a. If so, which repositories and what has been your motivations for depositing? (i.e. required, for sharing, investment in open access principles)
    b. If no, why not?

Future and State of the Field

9. What future challenges and opportunities do you see for the broader field of agriculture?
10. If I gave you a magic wand that could help you with your research and publication process – what would you ask it to do?

Follow-up

11. Is there anything else about your experiences as a scholar of agriculture and/or the agriculture discipline that you think it is important for me to know that was not covered in the previous questions?