EXAMINING THE RESEARCH PRACTICES OF AGRICULTURAL SCHOLARS AT THE UNIVERSITY OF MINNESOTA - TWIN CITIES

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INTRODUCTION

During the spring and summer of 2016, the University of Minnesota Libraries joined 18 other institutions to participate in Ithaka S+R's Research Support Services Program to explore agricultural scholars' research focus, research methods and publishing practices. This report summarizes our local findings, resulting from 16 interviews with University of Minnesota faculty from the College of Food, Agricultural and Natural Resources Sciences on the Twin Cities campus. It also offers suggestions for agriculture libraries and librarians based on the data we have gathered.

THE COLLEGE OF FOOD, AGRICULTURAL AND NATURAL RESOURCE SCIENCES

The College of Food, Agricultural and Natural Resource Sciences (CFANS) at the University of Minnesota was formed in 2006 with the merging of the College of Agriculture, Food and Environmental Sciences; the College of Natural Resources; and the Department of Food Science and Nutrition. The college's mission is to "find ways to provide food, fuel, feed and fiber that is healthy, safe, accessible and sustainable while protecting our natural resources and improving soil, air, and water quality to benefit and sustain communities."[1] CFANS is the primary college that drives the University's land-grant mission and is comprised of 12 academic departments:

- Animal Science
- Applied Economics
- Agricultural Education
- Agronomy and Plant Genetics
- Bioproducts and Biosystems Engineering (joint with the College of Science and Engineering)
- Entomology
- Fisheries, Wildlife and Conservation Biology
- Food Science and Nutrition
- Forest Resources
- Horticultural Science
- Plant Biology (joint with the College of Biological Sciences)
- Plant Pathology
- Soil, Water and Climate

Within these 12 departments, there were 240 tenured and tenure-track faculty, 704 graduate students, and 2,021 undergraduates as of December 2016.

RESEARCH METHODOLOGY

Our research team consisted of two librarians: Shannon Farrell (subject specialist for Entomology; Fisheries, Wildlife and Conservation Biology; and Forest Resources) and Megan Kocher (subject specialist for Animal Science; Food Science and Nutrition; and Soil, Water and Climate). Ithaka S+R designed the study and methodology (focused on qualitative interviews) as well as the research protocol, which was approved by the University of Minnesota Institutional Review Board on February 17, 2016. The University of Minnesota research team attended two trainings organized by Ithaka S+R: an online training in March 2016 which discussed how to sample faculty for inclusion in the study and an in-

[1] From CFANS website: https://www.cfans.umn.edu/about/about-college/strategic-plan. Accessed on December 20, 2016.

person workshop at the University of Minnesota in April 2016 which discussed how to conduct, code and analyze interviews.

Interview invitations were sent out to 102 faculty members in May 2016, with 16 agreeing to be interviewed. Sixty minute one-on-interviews were conducted throughout June and July 2016 and took place in faculty offices or departmental meeting rooms. Interviews were all audio recorded and recordings were sent to an outside vendor for transcription.

The sample of faculty that we interviewed included many more full professors than any other rank. Of the 16 participants, 11 were full professors, two were associate/tenured professors and three were assistant professors on the tenure-track. Interview participants represented a wide range of departments and disciplines, but did not represent every department within CFANS (see Table 1).

Table 1. Distribution of interview participants across CFANS departments

Department	Number of Interviews
Agronomy and Plant Genetics	1
Animal Science	2
Applied Economics	2
Bioproducts and Biosystems Engineering	1
Entomology	4
Horticultural Science	1
Plant Pathology	2
Soil, Water, and Climate	3

The interviews covered four broad areas: Research Focus, Research Methods, Dissemination Practices, and the Future and State of the Field. Our local report summarizes what we found within these categories.

FINDINGS

Research Focus and Research Methods

The interview participants studied a wide range of topics within agriculture, including (but not restricted to) crop resistance, animal nutrition, soil contamination, water quality, climate change, food security, agricultural policy, plant breeding and genetics, pollinator health and insect pests. Most of those interviewed (12 people) believed that their work crossed numerous disciplines. Various research types were identified (see Table 2), with the largest amount of research occurring among participants in field research, lab experiments, and plant and animal growth facilities.

Table 2. Research types among participants

Research Types	Number of Participants Using
Field research	11
Lab experiments	10
Plant and animal growth facilities	7
Computer modeling	5
Molecular research	5
Historical data analysis	3
Qualitative research	2
Behavioral studies	1

Participants were asked what kinds of data that their research elicited and our researchers spoke both about the specific types of data they generated (e.g. soil data, DNA sequence data, and behavioral data) and the specific programs and file types they used to store and analyze data. By far, the most commonly mentioned program for storing and manipulating data was Microsoft Excel (13 people). A variety of statistical programs were also mentioned by many, such as R, JMP, SPSS, Stata and Matlab; no one program was preferred by a majority. Four of our researchers talked about using or producing GIS data in their research.

Six of our interviewees brought up their data management and storage practices. Of those that did, most preferred digital formats — external hard drives (three people), network drives (two people), and flash drives (one person) — but three also mentioned keeping paper copies of data. As one interviewee stated: "*It's just too much data and we've had too many data failures electronically — we've dealt with the risk. I'm an old fashioned paper copy person. So it's saved me many times. Old things crashing or other systems or computers or files or things like that you could never extract them and open them again, they were gone. So we always have backups stored electronically, but I never trust anything. I always have hard copies. It's good to be a little bit paranoid I think. If it's your data, you don't want to lose it.*"

Locating Primary and Secondary Sources

All 16 of the participants spoke about using journal articles and located them primarily through research databases, including the library's discovery system (eight people). The most frequently mentioned databases were Google Scholar (seven people), Web of Science (five people) and Agricola (four people). Other ways that participants located the articles they used were through personal networks, mining references from articles, conferences, database and journal alerts, and subscriptions to society publications. Secondary sources were not as widely mentioned (six people). Of those who utilized books in their research, three of them were using titles from their own collections rather than the library.

Challenges in Conducting Research

When asked to speak about challenges they have faced in conducting their research, our participants identified a wide range of barriers — some that could be faced in any field and some that are specific to

agricultural research. Not surprisingly, the largest portion of our responses aggregated around the challenges associated with obtaining funding, especially grants. Participants expressed frustration around the undependable nature of grant funding. There were challenges in obtaining grant funding: "*Grants are also competitive and in part it depends on the likelihood of success, on who's on the grant panel on any given year. Being good plus lucky is usually the best formula for success.*" There were also challenges with maintaining funding long enough to complete research: "*You have to be the best in the group to get funded, but the second best doesn't get it. So what happens is, I cannot have security for the program and I cannot have security for my students. So, creating an ongoing program is very challenging because you do not know if you are going to have money for your second year or the third year or the fourth year. If your grants come year by year it's actually very restrictive.*"

Bureaucracy also posed significant challenges for our participants who faced issues ranging from purchasing supplies, to politics, to permits and visas, to equipment use: "*Use this printer but not this printer because this one we get charged for toner and, believe it or not, the university does not provide toner to print the research papers that we produce.*"

Researchers expressed having difficulty managing their time, both between administrative and research duties and in having enough to complete all of their work (e.g. having too many competing projects). One researcher stated: "*If I have one frustration with my day to day job, it is that I wish there was less tyranny of the urgent and things that need to get done and I can just take a week to get back on top of where the whole field of literature has moved.*"

Several people also discussed issues related to problems with either technology or equipment. For example, technological infrastructure problems included encountering a data server being down, having computers that could not process their data, and not having access to data ports in the laboratory. Problems with equipment included equipment failures, equipment being stolen or vandalized, or old equipment that was too expensive to replace.

Participants also mentioned problems related to hiring and finding reliable people to work with and issues associated with clashing personalities on a research team: "*I have frustrations because I sometimes have students that it just doesn't work with them. I had one student that quit just a few months ago. So that's for us a frustration too. That's luckily pretty rare.*"

Several sets of challenges arose that applied specifically to agricultural research. These included issues related to working with biological specimens (e.g. insects that refused to mate and chickens that rubbed barcodes off their tags) and issues working with the public on distributed experiments that required installing and checking equipment in people's back yards and recruiting farmers to plant flowers on their own land. Climate also affected researchers' ability to perform. The weather wreaked havoc on experiments, destroying cages in storms, overheating cows, and staying too warm thereby preventing an overwinter freeze. "*There are frustrations with doing fieldwork I guess everyone knows. I'm sure last night one of my experiments got ruined because I have cages out there and they are probably gone. I think we can salvage it this year because it's early enough in the season and we can basically redo it.*" In addition, the climate in Minnesota dictates that some agricultural research is seasonal which may or may not align with the timed nature of grant funding.

Very few participants mentioned research problems that aligned with library resources or services. Only one person discussed problems having to do with interlibrary loan taking too long and another mentioned the frustration with the library not having an electronic version of a journal.

Mitigating Research Challenges

When researchers were asked to speak about how they mitigated challenges encountered in the research process, they offered numerous solutions. Many spoke about their planning and process to anticipate challenges. Five of the participants described planning that could be done at the outset of their projects to mitigate challenges. One researcher described conducting a thought experiment to systematically think through potential sticking points. Similarly, another expressed setting goals and rules for their research projects from the beginning of the process. Three researchers described how they continually have multiple projects running at the same time in order to ensure that if setbacks or failures occur in one, there is ongoing work to fall back on. In some cases, multiple experiments are required as scaffolding to get one well-done experiment: "*You could learn from that process because it shows you that you don't know everything and that you might need to do a different experiment just to find out how to do your original experiment.*" One researcher stated that they had a project that they picked up and put down over the course of several years because they did not have the knowledge to move forward and had to consult with experts; in the meantime, they completed work on other projects. Finally, another researcher explicitly noted the need to have a plan for backing up data to mitigate the risk of losing it during the course of the experiment.

In some cases, researchers offered no real solutions to their problems other than delaying, re-doing, or avoiding a project altogether. Accepting mistakes and learning from them was seen as a part of the scientific process: "*They're all part of life. … It comes with experience that you sort of get ahead of some of these things and go okay, we've done this before, we've had this problem. But again, if you're working with a graduate student or you're doing something new or with another student or something, you're going to expect some mistakes along the way.*"

Time and money were ever-present challenges for our researchers and they expressed a range of strategies for addressing these issues. Time constraints were dealt with by increasing automation in their processes to get things done more quickly, blocking out uninterrupted time to work on projects, and simply acknowledging that their work would take a large amount of time and planning for that. In terms of money, two practical solutions that emerged were equipment sharing and improving grant-writing skills to secure more funding. Other participants saw money as a means in itself of solving some of their challenges and wished for better facilities and more unencumbered funds to run their research programs: "*I could probably run my program really well if I had $5000 a year, which is peanuts really in the grand scheme of things, but yeah even that amount of money seems to be hard to come by*."

Another solution that researchers offered was to increase efficiency by working with other people. In some cases, this meant talking to experts so that they did not have to build their own expertise. In others, this meant partnering with organizations to utilize their staff and resources. In still others, it meant hiring more people to perform the work. One researcher noted that it would benefit them to learn how to manage their students and staff more efficiently.

Three of our researchers mentioned that library services about, or support for, literature searching would help address some of the challenges in starting their research or moving through setbacks.

Literature searching support would be particularly helpful if it could save researchers time or make their searching more efficient.

Keeping Up With Trends

When asked about their methods for keeping up with broader trends in their fields (see Table 3), the majority (12) of our participants cited conferences as important places to learn about new and emerging research: "*It's when I hear things totally out of my field and get connections between them — that's really stimulating to me.*" Six of the participants cited journal alerts as helpful in learning about trends in their field. One stated: "*I need the e-mail reminders. I still get 150 emails a day or whatever and then I occasionally forget.*" Database alerts were also mentioned as a way to keep up with research trends. Three people mentioned using Google Scholar alerts while one mentioned using Scopus alerts. Other common methods are listed in Table 3.

Table 3. Methods for keeping up with trends

Method	Number of researchers (%)
Conferences	12 (75%)
Journal alerts	6 (37.5%)
Database alerts	5 (31.3%)
Personal networks	5 (31.3%)
Reading journals	4 (25%)
Community group events	4 (25%)

Some lesser-used methods mentioned by one or two participants included departmental seminars, emails from industry, collaboration with other researchers, serving as a peer reviewer, and going to the physical library to browse. Mentions of social media from our participants were small but mixed. One researcher was a very strong advocate for using Twitter: "*What I wasn't prepared for though was how connected I would get with that platform and how much it would benefit me personally. … Some of the folks are here on campus. Most of the people I interact with are other institutions in the US or around the world.*" Others were not impressed. One stated that "*None of us care if anyone is tweeting about it or on social media. I mean a lot of us belong to LinkedIn and ResearchGate and all that. All that's really good for is people asking for pubs [publications] from you or something.*"

Dissemination Practices

Publication of Research

Every participant cited peer-reviewed journals as their primary means of disseminating their research. Five participants mentioned publishing their work in their relevant society journals (e.g. American Phytopathological Society) whereas two researchers explicitly mentioned attempting to publish in open access journals. Seven of the researchers also discussed professional meetings as a place to share their research findings and five people described giving presentations to the public (including industry) as another method. Two participants described writing extension publications as part of their extension appointment. Two others recounted publishing their work in various kinds of grey literature, including

government documents, research summaries, and working papers. Only one person described publishing their research either as a book or a book chapter.

Some researchers described what they considered to be the motivating factors for where they decided to publish their work. Impact factor was mentioned by four people and open access was mentioned by three people. Other factors influencing publication venue included: scope and reach of the journal, cost to publish, where the publication was indexed, and ability to render color illustration.

A small number of people mentioned the importance of publicizing their work beyond publication. One researcher was working to create videos to highlight his work on a public blog. Another worked with local news organizations and used social media to raise awareness around a project that had popular interest in her community. One researcher even described having a student tweet any time that the lab's research was mentioned or cited in another publication.

DEPOSITING AND SHARING DATA

Over half (10) of the participants have shared their data in some format. Six people have provided supplemental data to a journal when publishing an article. Six participants also recalled depositing their data in subject data repositories, such as GenBank. Three participants said that they would share their data on request. Two participants had shared specimen samples (e.g with the United States Department of Agriculture (USDA) Germplasm Resources Information Network (GRIN)) and one had shared code on GitHub. One person said that they kept their data on a personal website, available for download. Four participants stated that they had not yet shared their data, but had plans to, mostly because of future funding requirements.

Five themes emerged around reasons for sharing research data:

- Grant requirements: "*The motivation largely is because it's a requirement of funding agencies and publications but probably we do it anyway because it's good practice and we want the data to be out there and accessible and useful for others.*"
- Journal requirements: "*I know some journals require it and it's pretty easy to do and I feel like it gives you some kind of legitimacy if you're publishing something and saying 'hey this is the GenBank accession number'. So I feel like it would be almost bad to publish genetic data and not also have it in GenBank which feels like it'd be wrong.*"
- Organization and findability: "*I have been convinced about what a great idea it is. Because having multiple Excel files hither and yon there's no way to search for things. If we put it all in, in the proper format and then I can just search.*"
- Reproducibility and new discovery: "*But on the flip side there is a lot of meta-analysis going on right now. And so, I think finally getting back to that you do a study, that's one study in a certain set of conditions. Can somebody actually take and replicate that — would your result replicate if you repeat it again.*"
- Community expectations: "*I mean some people might feel differently, but I feel like now it's almost expected. It's almost like you're hiding something if you don't put your raw data out there and I just feel like there's times when I've looked at other people's papers and I really wished there was an easy way just to grab the raw data file out of the supplementary.*"

For those who had not shared or deposited their data, their reservations were centered around four large areas: security, access and trust; time and organization constraints; community norms; and lack of motivation and understanding.

In terms of security, access and trust, concerns were varied. Some respondents worried about hacking: "*I have to send it somewhere else and then kind of like okay is it safe there? Is that data storage facility going to get hacked tomorrow because of a big sign on them that says data storage?*" Another major concern for researchers in this area was wanting to have control of who accesses their data and wanting credit for its use: "*It's a person that generates the data that knows the most about it, and if somebody wants my data I'm more than willing to say here have it, but I'm going collaborate with you on what you are doing with it.*" Other researchers who were new to the concept of data sharing simply did not feel comfortable with it: "*I get a little bit uncertain when you publish a paper then you send the data somewhere else. It just doesn't feel right.*" Still others worried about issues of plagiarism, being "scooped", divulging trade secrets, and having their data used against them: "*I've seen good people do bad things with their data and the last thing I want to do is collect raw data and then hand it over to somebody who doesn't have the skills to even know what they're looking at and do a good job summarizing it and getting inference out of the study that you designed, crafted and executed*."

Several researchers expressed that they were not motivated to take the extra time required to share their data: "*The thing is I feel like with data you have to get cleaned up and organized so that somebody can know what the heck is there and I'm not proud to say this, but you just… when you're doing stuff you just keep going and you don't really think about getting it organized and then when you're done you're done and you don't want to go back and spend time doing that.*" Some people described being so busy that cleaning and organizing their data after a study was complete was not part of their process and it was easier to just wait and see if another researcher contacted them about it. Others faced challenges in being organized enough to share their data and get it in the necessary formats to be accessible to a wide variety of people: "*I think part of the reason is that I'm not a very clean person in organizing data, developing my concept. So it's jumbled up data. It takes three, four months to clean it up and put it on a repository.*" One person stated that it was just easier to send files directly to another researcher rather than worry about meeting strict repository requirements.

Two of our participants did not see a need for sharing their data in a repository because there were already norms around asking for and sharing data within their fields. As one researcher put it: "*The community is not so large that we can't just ask each other for our data.*" Both people expressed that their research communities were too small to benefit from broad public data sharing and that they did not think anyone outside their field would be interested in it.

Three researchers were uninterested in sharing data, stating that either they had not thought about it or they were not required to do it: "*But I admit I haven't done it just because I haven't been required to and I only have so many hours in a day, but if this grant were to be funded then that will probably be my first project where I would deposit my data in a repository.*" Three people additionally expressed some confusion related to data copyright, finding appropriate places to share data, and believing only "big data" sets were worthy of being shared. One person discussed not thinking about data sharing due to a looming retirement.

Future and State of the Field

Challenges

When researchers were asked what future challenges they see for the broader field of agriculture, responses fell into numerous categories. Many spoke about global challenges that will impact and be impacted by agriculture. Primary among these concerns was future food security and the cluster of issues contributing to projected food shortages. These issues included climate change, lack of clean water, reduction in arable land, global population increases, surges of pests and diseases in food crops, fewer pollinators, and balancing needs for biofuels and food in crop production.

> *"I'm genuinely concerned about the future in food security. So we have a growing world population. We have diminishing natural resources, we have an increasingly volatile climate and so this is sort of a perfect storm for food insecurity components and it's almost cliché to say. I mean we hear these numbers all the time that by 2050 it's nine billion people. But as a scientist, I'm really concerned about where we're headed in terms of food security. Then, the challenge from a crop production standpoint is that the arable land is shrinking, the amount of water we've got for agriculture is shrinking and our crops are increasingly growing in environments that are more variable. So sometimes there's too much water for a crop to grow and it's not enough, we see temperature fluctuations. We see changes in pests and pathogens and that's really a key component because part of that, like the environmental stresses that our crops are going to face, we can anticipate that, we need crops that are going to be better dealing with low nitrogen inputs or with less water."*

Another large issue brought up by several participants was gaining trust or buy-in from the public by communicating their value and scientific results effectively. For example, one issue that was mentioned was related to genetically modified organisms (GMO) and food: *"I think that in the future our role will be to communicate the new technology as it affects food, from agriculture yields to consumer acceptance of new methods. GMOs were a big deal and wait until we get until in the world of gene editing, where you can go into a genome and gene by gene you can turn it off or on or replace it with something else*." Participants also spoke about global problems relating to human health, environmental pollution, and ineffective regulations.

In addition to global challenges, researchers also identified challenges their field faces on a more day-to-day scale. This, of course, included challenges related to obtaining and working with grants. Participants discussed that the amount of money required to do research keeps increasing and the grant awards do not keep pace. They also described how in order to be funded, research needs to be wide-ranging, expansive and groundbreaking which limits the amount of research they can do on important local issues. Another concern was related to the timing of grant cycles not aligning with research programs and funded graduate students. Finally, several participants noted the inherent difficulty with basing their work around grants: "*It's not that's it's a bad thing to write grants, because I think that keeps you very much more in tune with the current research and the current issues, but you're getting two, three, four percent funding rates on some of the federal grants and largely state grants are a little better, but still, you know, a lot of time and investment for not a sure thing.*"

Four participants described difficulties related to keeping up with their profession, saying they felt overloaded with information, technology, and too much data. "*It is probably just overload of*

information, being able to sift through it in a timely fashion. Trying to get the info you need now. I think that's going to be a continuing problem and I certainly think that my students or students in the future, are just going to be severely challenged on how to obtain information properly."

Five participants discussed issues related specifically to their situations that will be a challenge to them in the future. These included dealing with outdated equipment and facilities, feeling the need to produce products that make money, a reduction of lucrative jobs in their field, and producing graduates with a research focus that is too specialized.

OPPORTUNITIES

In thinking about opportunities, our participants largely focused on the global challenges they had identified and how their particular fields and sub-specialties could work to address these. For example:

- Using microbes as positive partners in plant productivity: "*So we're starting to see microbes as potential partners in crop production which environmentally is very friendly and appears to be a very sustainable approach and it really is a radically different idea.*"
- Using charismatic species to harness public awareness and drive change: "*Paying attention to these beautiful creatures and 'Oh what do they need', 'Oh and they are killed by pesticides'. So, the opportunity is to use the public's attention and focus on these marks to drive the change that needs to happen.*"
- Producing food: "*Twenty-five percent of the jobs in Minnesota are food related. That's not usual for some states, so it's just a huge part of what we do and I think that's exciting.*"
- Developing new products that can be implemented by farmers: "*So the industry has changed and some of the typically larger operations have resources to go and spend money to implement something if they decide they need to — and sometimes they do need to — so that's an opportunity.*"

Some participants mentioned opportunities that were not so specific to their particular research. One person saw an opportunity to solve big problems by collaborating with industry. Two people mentioned that improvements in new technology facilitated the ability to conduct research more quickly and for less money. Finally, two researchers listed as opportunities the increase in agricultural research jobs that will be precipitated by global challenges: "*Because of all the issues impacting agriculture right now, there's a lot of opportunities for students. There's a lot of career opportunities at either the B.S. level or Ph.D. level or master's level and I can say that theoretically, just based on if you look at all the issues impacting agriculture and invasive species, climate change, where farmers for crops have to apply more [pesticides]. … Then that creates a lot of opportunity for careers and graduates in our department, for example, for getting jobs fast.*"

What Would Help the Research and Publication Process?

When researchers were asked "if I gave you a magic wand that could help you with your research and publication process – what would you ask it to do?", a variety of responses were generated. However, seven participants all referred to unlimited funding as a desire. "*Give us more money is what everybody is going to say. It all gets back to money. Show me the money.*" One person specifically worried about funding for land grant university missions: "*I would increase research funding to the sciences, STEM [science, technology, engineering, and mathematics], agriculture, and especially for land grant missions.*

I mean it makes me a little bit sad, maybe I'm too much of an idealist, but I just don't know how the land grant mission is going to carry on in an environment where... well you might get an NSF [National Science Foundation] [grant]. But I'm not sure NSF is really supporting the land grant mission per se." Two other researchers discussed needing funding specifically for better facilities. One stated: "*I think having a phenomics center would be great. If you had a magic wand and you can make it appear right here. And that takes a lot of money.*"

Five of our participants expressed that they would like the magic wand to help them with writing of either grants or their scientific papers. With regard to grants, faculty expressed irritation with the time it takes to write them and the low success rate:

- "*Make it so I never have to write another grant proposal. I think our faculty spends so much time chasing resources to do their work. And the national scale for agriculture that the funding rates are just abysmal. I've heard of like NSF or USDA grant competitions with like seven or eight percent success rates and that's a pretty tough hurdle. It actually eats up a lot of quality time. This is a time where they could be training students, talking to farmers, solving problems, doing research.*"
- "*Write proposals. I just think proposals are always a challenge because you sink as much time into them as you would writing a paper, but in the end if you write a paper you get credit for it. If you write a proposal you kind of maybe only get a little bit of credit, like yeah you tried, but if you don't get it then it's kind of like… but then if you don't write them you're never going to get the money.*"

One person discussed the difficulty in responding to grants with short turnaround times and how having a full-time grant writer would help solve that problem: "*We're always trying to look for funding but it's so hard for us to stop and react to these quick turnaround grants and things like that. So, like a professional grant writer who would know the science — And that's a rare thing because it's hard to know the science and to be a good writer also.*"

Other participants expressed the desire for more staff with specialized skills such as data curation, administration, and graphic design to help with their research and publication process: *"It takes me a lot of time to perfect figures and graphics and all of that which I'm not trained to do as a scientist. We all struggle with putting a nice publication together and don't have training in graphic design and really we need to have a graphic designer to talk to and say, 'Well, here is my data and here's how I'd like to present it' and the graphic designer to say, 'We can do this' and I'll say, 'Yes, that's beautiful' or 'Yes, I like it, but it doesn't exactly show what I am trying to show' and being able to work with that. So far I haven't had graphic designers knocking on my door to work for free.*"

Four people discussed how they would benefit from more time as time is one of the biggest constraints to completing their work. *"I would probably stop time and just catch up with everything. I think that would be one single thing I would like to do with the magic wand. Money is not scarce, you know, the ideas are not scarce, the access to data actually is not scarce. If you have money you can access data. It costs money, but if you have grants you can find a way to do that. The time is probably the biggest constraint in everything. So yeah, I'd stop time.*" Two researchers discussed how they also see themselves wasting time because of a lack of organization and that becoming more organized would allow them to be more efficient.

Three researchers referenced issues related to working with other people. One discussed desiring more autonomy and not having to focus their work on what others deemed important. Another described difficulties with collaboration: "*I just think that collaboration is really important and yet it's really hard to do and I mean it takes probably a certain personality and I'm not sure that a magic wand can fix that, but to be able to do that and have that work out well would be really nice*." The third mentioned issues with educating the public on environmental impacts related to agriculture and farming as they have witnessed conflicts between urban and rural populations.

Three people highlighted the literature review as a sticking point in their research process. One person was concerned that they were not being thorough enough and were missing key articles. Another discussed the amount of time that it takes to conduct a good review of the literature. And yet another wanted to make the process easier, by having more interactive and intuitive ways to search the literature.

Finally, one person felt limited by their computer's capacity in their work and wanted a computer with unlimited speed and storage space. Another called for an overhaul of the entire peer review process: "*I hate the review process, the length of it, the sometimes — frankly it seemed to be unfair — reviews that you get and sometimes there are great reviews and it really makes it better and then there are times when somebody is just like 'Wow you don't get any of this' or 'This was already explained' and there is no recourse or not a whole lot of recourse. So I've had some papers held up way longer than I should have and it gets painful for everybody because we couldn't get it published in the form that we think it should have been published, you end up watering it down and it's a frustration.*"

CONCLUSION

Based on the interviews we conducted with agricultural scholars at the University of Minnesota - Twin Cities, there are a number of implications for how the library can support them in their research and publication process:

Research Focus and Research Methods

- The researchers in this study used three primary databases to conduct their work: Google Scholar, Web of Science, and Agricola. They were also heavy users of MNCAT Discovery, our library's discovery system. Our agriculture librarians should be well-versed in how to use these databases and be able to talk to researchers about expanding their searches to other available databases in order to be comprehensive. Web of Science, although it is an expensive subscription database, is highly used and valued by our faculty.
- In staying abreast of trends and new developments in their field, our researchers appreciated receiving notifications in their day-to-day workflow. Email alerts from databases and journals were useful to them in having an automated way to do this. As librarians, we should emphasize the capabilities of our databases to do this while also noting the inherent security risks these usually present in terms of setting up accounts with database vendors.
- The writing and implementation of grants, as expected, was a huge part of our faculty's work. In terms of support, researchers appreciated anything that can make working with grants easier and more efficient. Our libraries already offer workshops in finding grant funding, but could augment services in this area.

- Researchers on our campus brought up concerns around data management and storage, illustrating that there is a need for services in these areas. Although our libraries already offer numerous services around data management, data curation, and data sharing, it is clear that there is still unmet demand.
- Literature searching is another area where researchers expressed that they would like to save time by becoming faster, more skilled and precise. Obviously, this is an area where librarians can provide expertise and, up to this point, we have not promoted our services as much to faculty as we have with our student populations.
- Many concerns arose around time management and project management. Although these are not areas that our libraries have developed services in, based on the needs that we have seen, it may be an area for development.

Dissemination Practices

- While open access was being considered by some of our faculty, they were all still beholden to the tenure model that prioritizes peer-reviewed journals and impact factor, and published accordingly. Given this, the libraries should continue our work in supporting and educating our researchers about various publication models and working with them when it is appropriate to push for change in their departments.
- According to our researchers, the impetus for sharing data largely came from requirements, either from journals or grants. Researchers were split on whether or not they do share within repositories. There was a considerable amount of concern around security and access when sharing data and a significant amount of confusion around the usefulness of sharing data. Given that there are more requirements from granting agencies and journals mandating data sharing, the libraries have a role in educating our researchers about how to streamline the process and do it in ways that do not compromise their goals for their data.

Future and State of the Field

- Based on the challenges forecast by our researchers, food security is going to be the largest challenge for the field of agriculture in the future. As a result, agriculture librarians can build collections around relevant and related topics.
- A theme that arose over and over again was researchers' need to become faster and more efficient. This developed in relation to: grant proposals, scientific writing, literature searchers, data curation, and graphic design. Libraries are already providing support around some of these areas, but there is room for growth in others.
- Our researchers struggled with information and data overload. We cannot stem the tide of information, but we can help our researchers be more focused and streamlined in their information gathering processes.

This study has been informative in assessing the needs of researchers in agriculture and has provided guidance on what services would be most needed and valued by faculty in the research and publication process. Going forward, we will use this data to expand upon and develop new services.

APPENDIX A: SEMI-STRUCTURED INTERVIEW QUESTIONS

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?