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Investigating the Practices and Needs of Agricultural Researchers at the University of Nebraska-Lincoln

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Investigating the Practices and Needs of Agricultural Researchers at the University of Nebraska-Lincoln

A study conducted in partnership with Ithaka S+R

by

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* Italicized text is a verbatim quote from an interviewee.

Executive Summary

University of Nebraska-Lincoln (UNL) Libraries was one of 19 libraries participating in a national study, initiated by Ithaka S+R, of the research practices and needs of agricultural researchers. Two UNL Libraries faculty members participated in this study by interviewing 11 UNL agricultural scholars during the summer of 2016. The ethnographic research approach revealed four core themes explored in this UNL-specific report: interdisciplinarity and collaborations; scientific communication practices; scientific research data; and challenges and opportunities. Illustrated by the sample of faculty comments presented here, the themes have direct implications for the UNL Libraries, while in other cases these point to concerns and opportunities for the university, the academy, and the nation.

The major points, and related implications and recommendations, found during our study are:

- Significant collaborative activity, much of it interdisciplinary. Even with challenges, each faculty member recognized the value of collaboration to their own research, and in addressing the current and future problems facing agriculture. As the UNL Libraries reinvent the liaison librarian model, it can learn from the collaborations of these researchers.
- Scientific communication: discovery of research literature, current awareness, publication venues, and deposit of publications in repositories. Google Scholar was the discovery tool of choice among most researchers. This evidence confirmed the need for better education and outreach about more robust discovery tools, and for additional research by the UNL Libraries regarding user preferences versus our recommendations for resources. Attendance at conferences and seminars was the primary method of keeping current. Librarians should thus consider either presenting, or at least interacting, with researchers in these venues. All of the faculty interviewed stated that peer-reviewed journals were their primary publication venue, with several emphasizing the importance of publishing in 'high-impact' journals. The UNL Libraries have opportunities in this area, including education about altmetrics and 'predatory' journals. All of the interviewees were aware of, and had at least some publications in, the Digital Commons @ University of Nebraska-Lincoln. Many also used ResearchGate, often misunderstood it to be a repository, and were unsure about copyright issues related to posting their publications there. Two immediate opportunities for the UNL Libraries are: information about what ResearchGate is (and is not), with accompanying clarifications about copyright; and a systematic approach to updating researchers' deposits in the Commons, as several reported that their posted publication lists were not up-to-date.
- Issues of scientific research data: organization, management, sharing, and preservation. The scientists were aware of federal and/or publisher's mandates regarding access to the raw data underpinning research publications. There is room for the UNL Libraries to expand educational outreach to researchers and their students with regard to data organization, management, and preservation. Some of the concerns reported – computing infrastructure, data analysis and storage needs, and training of students in quantitative methods and programming – are matters best addressed by the university and federal funding agencies.
- A view that the biggest challenge to agriculture is to feed the current population, to work towards feeding the future world population, and to do so while protecting the environment. Professional challenges included a lack of time, reduced funding to sustain a research program and to train students and post-docs, and addressing scientific illiteracy through outreach to the

public. The UNL Libraries is currently involved in efforts to increase science literacy, and should consider expanding these efforts.

With the completion of this study, the UNL Libraries now have a cadre of faculty with experience in qualitative research that can be applied to investigate specific library-related questions and evaluate various Libraries services and resources.

Rationale and Background

In October 2015, Ithaka S+R's[1] Libraries and Scholarly Communication Program announced a new research effort: a study of the research practices and needs of agricultural researchers.[2] Partnering with the librarians who serve these academics, as well as relevant professional societies, the study continues Ithaka's documentation of the scholarly practices and needs of various disciplines (e.g., art history[3], chemistry[4], and history[5]). Importantly, the study also provides a gateway for librarians to better understand the scholars with whom they collaborate in research support and instruction, and "make actionable recommendations for how libraries (and others) can best support [the scholars'] research."[6]

Agriculture is a major economic force in Nebraska. According to the state's Department of Agriculture, 92% of land is either farmed or ranched; agricultural dollars contribute significantly to the state's receipts; and agriculturally-related jobs make up 25% of the workforce.[7] Not surprisingly, agricultural research and related instruction and extension efforts are significant activities at the University of Nebraska-Lincoln (UNL), the system's land-grant campus. Several UNL Libraries faculty work with agricultural researchers based in Lincoln and at out-state Research and Extension Centers (RECs). The Libraries agreed to partner with Ithaka S+R, recognizing the value of interviewing and learning from UNL's agricultural scholars.

The Ithaka S+R study also fills a gap in the literature of librarianship and information science, as documentation of the broader research practices and needs of agricultural scientists is minimal. In 2006-2007, librarians at the University of Minnesota-Twin Cities interviewed multidisciplinary focus groups of university scientists about their research practices and needs; agricultural scientists were a small subset of the interviewees (Marcus, Ball, Delserone, Hribar, & Loftus, 2007). A brief review of the literature revealed multiple studies which examine the information-seeking behaviors of various STEM (science, technology, engineering, mathematics) and biomedical researchers, in part to design and/or implement improved services. Majid, Anwar, & Eisenschitz (2000) interviewed agricultural scientists in Malaysia, and discovered that researchers spent 16% of their non-laboratory/field time searching for and reading the literature, primarily journal and review articles. Hallmark (2001) interviewed

[1] "A not-for-profit research and consulting service that helps the academic community navigate economic and technological change" (http://www.sr.ithaka.org/)
[2] See http://www.sr.ithaka.org/blog/announcing-three-new-projects/
[3] See http://www.sr.ithaka.org/publications/supporting-the-changing-research-practices-of-art-historians/
[4] See http://www.sr.ithaka.org/publications/supporting-the-changing-research-practices-of-chemists/
[5] See http://www.sr.ithaka.org/publications/supporting-the-changing-research-practices-of-historians/
[6] See http://www.sr.ithaka.org/blog/announcing-three-new-projects/
[7] See http://www.nda.nebraska.gov/facts.pdf

meteorology researchers about their information practices, including current awareness. Writing in the pre-Google Scholar era, she documented that e-access to journal articles and data was critically important to these scientists; libraries must maintain well-designed websites for ready access to these resources. As internet access increased, reports in the literature soon began to change. Examining the URL referrals of Cornell University researchers searching the literature aggregated by the American Chemical Society, Davis (2004) reported that most scientists accessed the literature via the library catalog, its e-journal list, and online indexes (e.g., SciFinder Scholar and PubMed). However, an increasing number were using internet searches to discover information. In addition, researchers used personal web pages to access publications, presaging current information-seeking and sharing (e.g., ResearchGate and/or a Google Scholar profile). Three years later, a survey of 902 scientists at the University of North Carolina at Chapel Hill revealed that this multidisciplinary group greatly relied on e-communication and on e-resources for information, with decreased visits to physical library spaces (Hemminger, Lu, Vaughan, & Adams, 2007). A survey of more than 2,000 U.S. biomedical, engineering, and natural sciences researchers, representing 50 departments at 5 universities, further documented the preference for e-access to journal content, reliance on efficient interlibrary loan services, and a nearly equal preference for initiating literature searches from either the library website or Google (Niu et al., 2010). More recent studies of academic researchers in the areas of nutrition, food science and dietetics, engineering, mathematics, and veterinary science also found a preference for remote access to e-resources, particularly journals (both current and archived content), decreased reliance on access to physical library spaces and print content, increased utilization of internet searches at the initiation of information-seeking, and use of specific online indexes (Shpilko, 2011; Engel, Robbins, & Kulp, 2011; Sapa, Krakowska, & Janiak, 2014; Nel & Fourie, 2016). Studies mentioned librarians as providing important assistance, particularly in multidisciplinary information inquiries, or noted a desire to work more closely with a librarian specializing in their area (Engel et al., 2011; Nel & Fourie, 2016). However, Nel & Fourie (2016, p.51) pointed out that two of the most important expectations of South African veterinary researchers – "custodian of print-based and digitised archives" and "administrator for purchasing information services" – were ranked by librarians as among their least critical roles, a troubling dichotomy. Proactive and selective integration of the librarian and the library's services into the research and teaching processes of agricultural and life sciences researchers would benefit all parties, as Simonsen (2015) noted in an extensive literature review of the information needs of life sciences researchers.

Librarians and libraries are in the midst of an evolutionary, if not revolutionary, process. The focus on understanding the behaviors of specific user groups informs librarians about which existing services and resources are the most and least valued, and which new services and resources are in need of development. This study focuses on the practices of academic agricultural researchers – how they work, their information and research data practices – in order to identify needs, some of which have implications for the UNL Libraries. Other findings from this study, such as researchers' programmatic challenges and challenges for the field of agriculture, point to concerns to be addressed by the university, the academy, and the nation.

Methodology

The Ithaka S+R team chose an ethnographic approach for the study. The UNL study received approval from the Institutional Review Board (IRB) in March 2016. The authors attended an intensive 1.5 day training in April, led by Ithaka S+R analyst Danielle Cooper, offering practice with interview techniques, and coding and analysis of transcripts.

The authors created a list of 35 potential UNL faculty interviewees, working from known contacts as well as reviewing faculty websites and publications, with the intention of creating as diverse (e.g., faculty rank, research interests, and gender) a pool of researchers as possible. Ten departments appeared in the original interviewee list. The authors began several iterations of emails to subsets of these prospective researchers in mid-April, continuing through late July. The authors contacted each potential interviewee twice by email.

Eleven UNL agricultural researchers elected to participate in the study, from May through July 2016. After reviewing and signing an informed consent form (Appendix I), each engaged in a semi-structured interview with one of the authors. The staff of Ithaka S+R developed the interview questions (Appendix II). In four cases, photographs were taken of the faculty member's research area, taking care that no people or personally identifiable objects appeared. The interviews were recorded using a Tashcam DR-05 Linear PCM Recorder; a Canon Rebel T3i digital camera was used for the photographs. After each interview, the digital audio file and any images were downloaded and stored on an encrypted external hard drive (EEHD), and files were deleted from the recorder and camera. The EEHD was secured in locked storage when not in use by the authors. Signed consent forms were stored securely and separately from the EEHD.

One author transcribed all the interviews, and the transcript files were stored on the EEHD. Once an interview was fully transcribed, the audio file was deleted from the EEHD. Both authors independently coded each transcript, periodically meeting to compare and discuss the results. After several iterations of coding and analysis, four core themes emerged (discussed below) for this UNL-specific report.

A subset of the UNL faculty interviews will contribute to a national report, prepared by Ithaka S+R (anticipated February 2017). After all interviews were completed, Ithaka S+R requested an anonymized list of UNL faculty participants, and selected five anonymized transcripts for their report. The UNL Libraries are one of 19 U.S. libraries participating in the study (Appendix III). With each of these institutions contributing five interviews, Ithaka S+R will have the insights of 95 agricultural researchers to draw from for its national report.

Faculty Participants

The 11 UNL faculty interviewed represent 5 of the 10 departments contacted for participation. The interviewees' faculty rank and gender are categorized in Figure 1.

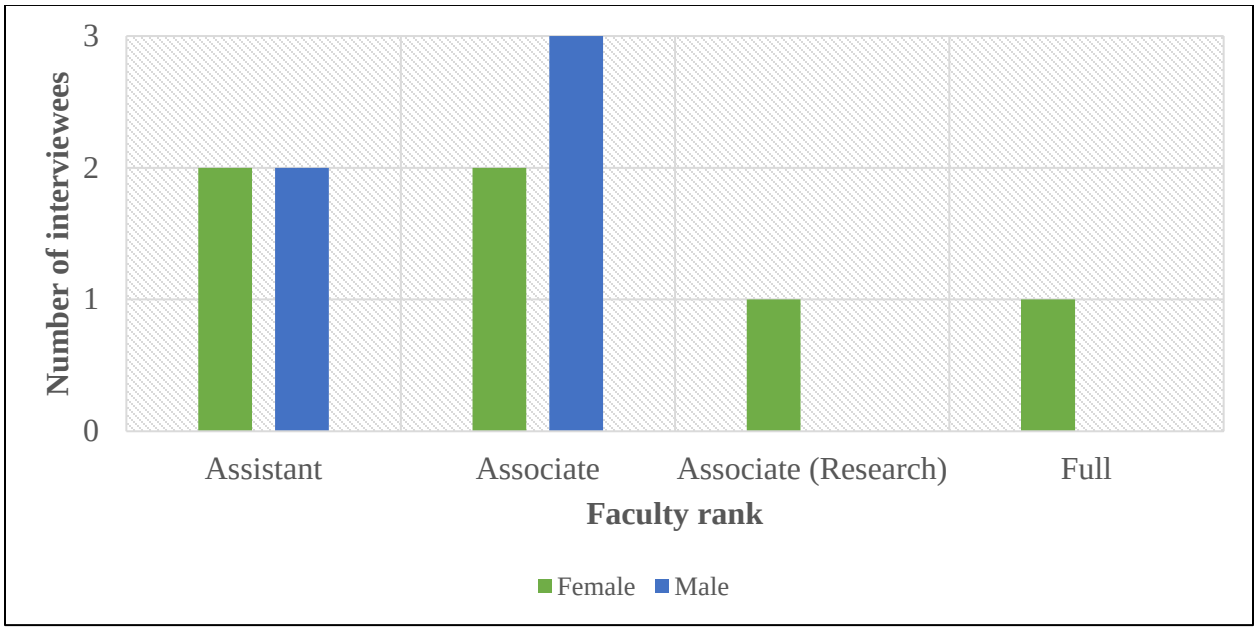

Figure 1. Rank and gender of faculty participants

The UNL faculty engages in a remarkable range of research under the broad multi- and interdisciplinary umbrella of agriculture. The interviewees are plant, animal, and soil scientists; microbiologists; and basic, applied, translational, or computational scientists. Some work regularly with farmers and ranchers, while others work primarily at the lab bench or computer. All 11 faculty are clearly enthusiastic about their work. As one researcher states:

> *Well, agriculture…well, I love what I do! Let me put it that way. Because it's, what we do is directly linked to people, in terms of, people need food! [laughs]…agriculture in itself, for me, it's an integrated applied science, and so you have to look at every aspect of the system. The soil, the water, the plants, the biota, the climate, the people, etc. So it's…I love it. I mean, I like it because, at the end of the day, it points to people, right? It's…all about improving people's lives. So both from the developing part, I mean, and globally, I just…I just like that profession. It's a noble profession, and I'm very happy that I am part of it, in terms of contributing with knowledge and training people as well. So…I'm in a good place, I guess. UNL and Nebraska is a place to be for agriculture!*[8]

Each researcher shares the conviction that his or her work, while personally satisfying, also serves a greater good, including adding to scientific knowledge and/or addressing needs of the state, the nation, and/or the world. Several researchers place their work in the context of "feeding the world" while caring for the environment.

[8] Italicized text is a verbatim quote from an interviewee.

These faculty use a range of research techniques and generate a variety of data types. All but one researcher applies molecular biological methods (e.g., DNA and RNA sequence analysis, protein analysis). Others combine 'older' techniques, such as plating microorganisms or counting organisms, with 'newer' (e.g., real-time polymerase chain reaction) as needed. The research data are most often quantitative, but several faculty also collect qualitative data (e.g., interview data) and/or images (e.g., microscopic), as well as physical samples (e.g., plant materials, soil).

While a researcher manages his/her individual research program, each describes using techniques for which they turned to others for expertise, and/or collecting and analyzing data with others' assistance – which leads to the first of the study's four core themes, interdisciplinarity[9] and research collaborations.

Four Core Themes

Interdisciplinarity and Collaborations

> *We can't look at ourselves as just islands of individual researchers anymore, or individual research projects.*

All 11 faculty spoke about the collaborative nature of their research work. Ten participants described collaborative relationships with faculty in their own department, college, or REC, given physical proximity and shared research goals. Three faculty discussed working with researchers based in other colleges at UNL; the researcher who did not report intracollegiate collaborations shared a research grant with a faculty member in another college.

> *…we've started collaborating with someone at UNL…so he's bringing his* [engineering] *expertise and we're bringing the biology. So there it's a case of two very different disciplines coming together as equals. We're not using* [the other researcher's expertise] *as any kind of service to provide us with new technologies. We're coming together as equals from different disciplines.*

Faculty also reported collaborations with those at other academic institutions, and with international non-governmental organizations. Seven UNL researchers actively collaborate with industry, farmers, or ranchers.

Some of the research being conducted in agricultural departments at UNL is interdisciplinary and of interest to researchers outside of the agricultural domain. One faculty member spoke of an invitation to present at a symposium in which most attendees were biomedical researchers. Several researchers commented on the importance of seeking out technical expertise and the increasing need to have cross-disciplinary technical skills and knowledge:

> *At this point, we're still able to* [store datasets] *in a spreadsheet, but pretty soon…we might be needing to work with some of our bioinformatics people to learn from them.*

[9] The quality or fact of involving or drawing on two or more branches of knowledge (https://en.oxforddictionaries.com/definition/interdisciplinarity)

> *If we are using something, or a method more sophisticated, maybe we'll have a collaboration with an expert in that area, somebody that uses that on a daily basis and can help us so the research doesn't get pushed back or it doesn't delay because of a learning curve.*

> *Well, you can't do it yourself. You have to have collaborators that have different types of expertise, because it is impossible to learn how to do every single thing by yourself.*

One researcher stated the high importance and need for researchers to work together to address complex challenges, and voiced concerns about the challenges in bringing together scientists from many disciplines.

> *The broader picture is about how are we going to feed the world come 2050 and beyond? And how can we continue to make improvements? And not all of it is going to be done by just one discipline like biotech, or management practices, or just phenotyping. It's…all these different areas coming together. …How do we integrate all these scientists, science disciplines together? Transdisciplinary work gets a lot of lip-service right now. [B]ut that's because we're at the beginning of it…So how do we successfully integrate that science, and how do we give proper credit to the different areas? I think that's one of the reasons why we have a hard time working with other disciplines, you know, a statistician that may provide a very valuable service to me…they can't succeed in their career just being middle author all the time. They have to have some corresponding authors, first authorships.*

Several researchers commented on the important collaborations that they have with non-academic partners: ranchers, growers, and industry. One researcher attributed a current research project to several ranchers and the observations they shared:

> *…a lot of our collaborations are also with ranchers. So the other laboratory are the ranchers themselves, which have been a nice laboratory to get us to ask specific questions. You know, they are doing these things, but we don't have an answer to why this is happening or why they are observing. So part of the idea incubation is the interaction with ranchers. So, when I talk about…this project, it was really an incubation between ranchers and us. …they're saying 'we're seeing this, we're seeing that,' and we started asking questions. And then, you know,* [it] *finally developed into a…scientific applied research project.*

A faculty member with extension responsibilities observed:

> *One of the things that…I think we need to do more of, is to have more…interactions with farmers. So if we look at our Institute* [IANR: Institute of Agriculture and Natural Resources] *now, maybe less than one out of three of the faculty we have will have interactions with farmers. Some don't even know where…whether there are farmers or not! [laughs] So, I think, because the ultimate goal of almost all researchers in the Institute of Agriculture is to have more food, less expensive food, more nutritious food, and so if our work revolves around that, then maybe it is good to have more interaction*

> *with the people that are producing the food! [laughs] So we can understand how they do their work, and how we can help. Which is one of the things that I think is good about the Extension system in the U.S. In many other countries, there is no organized Extension system like that. So it affords the faculty the opportunity to be able to interact one-on-one with farmers, know what they do, know what the problem is immediately. …as Extension people, we can link up with people on campus, and then be able to translate scientific information they generate, and provide this information in forms that the farmers can use. Because if that kind of interaction does not occur, some farmers cannot interpret the scientific data that is published in the manuscript. I don't think a lot of farmers will go and be looking for a manuscript,* [to] *see how that work impacts their production.*

Two faculty members described their collaborations with industry partners, in terms of providing direction to and/or feedback about their research.

> *We have a very close relationship with industry. And the industry moves perhaps at a faster pace than academia. So the research I do has to move faster or…they'll leave me. [laughs] They'll leave me behind. So to keep up with industry needs, we need to provide…prompt responses or answers to their questions. Like we need to be…a little faster in the projects. So our projects are not necessarily less important, but they have very short timelines, comparatively. So, a two-year project's already very long for the industry. It's usually a six-months, three months, nine months. …and it doesn't mean that we're not going to progress science further. But we do it* [in] *a more stepwise approach. So…that's how my research falls…like, OK, I'm going to try this, and if it works, then perhaps we can take that into another step, and then go on. But always with short goals in mind, because you need to deliver and you need to show the efficacy or efficiency of a certain technology or process to get the interest from the industry, to say, 'OK, you show me that it works, now let's see if it works in this case,' or 'let's see if we can apply in <u>that</u> case.'*
>
> [Our discipline has] *a pretty close contact with industry. Like at our national meeting, there's a lot of industry contacts, and we have a lot of alum that are out, into the industry. So that gives us a good…way to get feedback on what we're doing, provide some insight into what we have. We actually have one of our alum who's in industry, in research and development. He was an adjunct professor…so he's going to start serving on a graduate committee or two, really to provide that good applied aspect, relevance, to what we're doing.*

Implications and recommendations for the Libraries

Many of the faculty interviewed in this study spoke about interdisciplinary collaborations and the importance of students having skills that are beyond the discipline, such as being proficient in R, a programming language that is used in statistical computing. One faculty member stated, "*Because learning how to work in R is…it's just sort of a gateway to all sorts of analyses, sort of broadly encompassing ecology or genetics."* How does the library ensure that the collection (e.g., journals, books, citation indexes) meets the needs of those involved in interdisciplinary research, including research with growers, ranchers, and industry? The UNL Libraries currently uses a traditional model of having liaison librarians who provide research assistance, instruction,

and collection support for departments and programs. So, for example, an agricultural sciences liaison librarian may not routinely purchase materials about R, as that topic would fall under the purview of the computer science librarian. Similarly, there are faculty based in "traditional" agricultural departments but conducting biomedical research. For these interdisciplinary researchers, the current liaison model of assigning individual librarians to departments (e.g. animal science, food science) is no longer an effective way to support these researchers' information needs. These researchers are not using or publishing in the "traditional" journals of their home department. Integrating librarians with expertise in medical and biomedical information into the services provided to these researchers seems a logical change.

Just as the researchers expressed, one librarian can no longer do everything alone either. As the UNL Libraries faculty reinvents its liaison librarian model, can we model these scientists' collaborations? Can we identify disciplinary faculty who are co-teaching, and/or collaborating in research and on grant proposals, and join with Libraries colleague(s) to support these instructional, research, and grants efforts? Rather than working as "islands," the liaisons should consider formalizing our nascent collaborative style of librarianship. For example, the research faculty based at Nebraska's RECs are a multidisciplinary group. During these interviews, REC faculty expressed interest in having greater interactions with the Libraries. Specifically, they were interested in having librarians visit annually to exchange news, as well as having the Libraries arrange online sessions which their students also could attend (e.g., guidance in the selection and use of bibliographic citation managers, introduction to various online indexes). Several librarians working together – not exclusively agricultural librarians – could plan programming to improve the Libraries' connection with faculty, staff, and students at the RECs. Mastel (2011) described several interesting and effective outreach methods for extension personnel that the Libraries might evaluate for UNL's off-campus constituencies.

In another parallel, the agricultural faculty interviewed know their skill set, and know when to reach out for assistance. Can we identify the essential skills set of a liaison librarian: what should each of us be able to do on our own? What skills can be trusted to a 'collaborating' colleague, whose expertise can be called upon when needed?

Scientific Communication Practices

> *Also, I was just thinking about this this morning…how much I use Google Scholar, and how now I don't have to leave my office for anything – whether that's a good thing or a bad thing! Gone are the days that I had to walk over to the library to go pick up a hard copy of* [a journal], *and browse through it. Those days are forever gone. So, the neat thing is, then, I can get things so easily…and so rapidly.*

Discovering Research Literature

The faculty in this sample utilized many different tools and techniques to identify research literature. Items mentioned two or more times are shown in the table below.

Literature Discovery Tool/Technique	Number of Mentions
Google Scholar	7
Web of Science Core Collection	3
ILLiad (interlibrary loan/delivery service) to request articles through the library	3
PubMed	3
Google	3
Review article's bibliography	2
UCSC[10] Genome Browser	2
BLAST (NCBI[11])	2
Agricola	2
Review articles	2
Scopus	2
Tables of contents from selected journals	2
Conferences	2
ResearchGate	2

The major themes that emerged from the responses include the use of citation indexes/databases; browsing and accessing specific scientific journals; linking to research literature via the use of molecular biology/genomics tools; and interacting with colleagues at conferences or online venues, such as ResearchGate (https://www.researchgate.net/).

Some faculty reported using a variety of resources and techniques to identify scholarly literature, while others mentioned very few resources. The "library" was most frequently mentioned in the context of submitting article requests to the UNL Libraries' interlibrary loan/delivery service.

The Libraries subscribe to many citation indexes; many of these indexes are discipline-specific. Yet, the most frequently mentioned tool for finding literature was Google Scholar. One faculty member stated: "*Google Scholar is my number one source. . . . definitely Google Scholar is what I use for probably 90 to 95% of my work.*"

[10] UCSC: University of California Santa Cruz (https://genome.ucsc.edu/)
[11] NCBI: National Center for Biotechnology Information (https://www.ncbi.nlm.nih.gov/)

Others mentioned using Google.

> *Google is my friend. I'll type in something, a topic that I'm interested in, and then I'll look at the links and go, 'oh, this looks interesting, this doesn't look interesting,' and then I'll follow the links.*

The Web of Science Core Collection was the most frequently mentioned index among those provided by the UNL Libraries.

> *My preference is Web of Science. I kind of got started being shown that way when I was doing my graduate work. And so I've become pretty adept at it. And I think it has a lot of valuable sorting tools.*

> *The first thing I do is, I have a tool bar link, a bookmark to log into Web of Science. [laughs] That's the very first thing. That's usually my first stop…I'll do just a Web of Science search for things, and if I don't find what I…or I think I'm not finding enough there, I might do a Google Scholar search as well. You know…sometimes there'll be papers that I can't get necessarily, so I'll try then through ResearchGate, or contacting the person directly. I do a lot of requests through ILLiad* [interlibrary loan]*, I found that to be really helpful and quick.*

Other library-provided resources mentioned include: ACSESS Digital Library; CAB Abstracts; and Biological Abstracts. Librarians consider each of these resources as valuable parts of the online collection, yet most of the faculty interviewees do not report accessing these resources. It is important to note that although Google Scholar and PubMed are freely available to use as search tools, access to full-text articles may be dependent on library-provided or personal subscriptions to journals.

Implications and recommendations for the Libraries

Clearly, librarians must continue to educate UNL faculty and students about the advantages of using multidisciplinary indexes (e.g., Web of Science Core Collection, Scopus) and discipline-specific indexes (e.g., CAB Abstracts). Since Google Scholar was the most frequently mentioned resource, it is also important to make users aware of its limitations. Bibliographic indexes provide comprehensive indexing of literature citations and state what publications are included in the index. In contrast, Google Scholar is a search engine that does not use these standards. Because of these differences, Gray et al. (2012) recommended that Google Scholar be used cautiously. With regards to the research areas of faculty in this study, CAB Abstracts is noted for its coverage of publications, U.S. and international, in areas such as agriculture, the environment, veterinary medicine, and food science and nutrition. Yet, CAB Abstracts was only mentioned by one researcher in this study. One faculty member, with a plant science focus, mentioned using PubMed and receiving alerts to new research. A keyword search in PubMed for a key attribute of this faculty member's research retrieved 1790 citations, while the same keyword search in CAB Abstracts retrieved 9850 citations. When compared to Google Scholar, bibliographic indexes have more robust search capabilities, index publications not discovered by using Google Scholar, and allow users to save search strategies and create alerts, yet most of the interviewees

did not report taking advantage of these resources. The UNL Libraries should continue to research our users' preferences. If researchers are not routinely using our recommended resources, why? Is there a way the Libraries can make our 'better' resources as attractive as Google Scholar to researchers and students?

One researcher, who mentioned using Google Scholar as the sole method to find literature, expressed a desire to identify "*top papers*":

> *But I wish that researchers did have some way to sort of create collections of information that were more than just Twitter, and more than just popularity, but really sort of a running list of 'what are the top papers if you study XYZ.' And I don't know that anything like that exists. . . .*

Citation indexes, such as Scopus and the Web of Science Core Collection, provide researchers a way to quickly identify key authors and institutions with similar research interests. Both indexes also include citation counts for publications. The faculty's lack of awareness strongly suggests that the UNL Libraries should promote these (and other) online resources more widely, especially in regards to measuring an author's impact.

In addition to searching citation indexes, librarians should continue to introduce students to traditional methods, or as one faculty member stated, "*old-fashioned way*[s]" of finding literature (e.g. searching for review articles, mining article bibliographies for additional resources, and following the 'bibliographic trail'). Experienced researchers know who is doing work in their field of interest and will often search for specific persons:

> *I mean, I have a good sense of the literature. . . . I can just go straight to who I think might have done something similar.*

Novice researchers, such as new graduate students, do not yet have this inherent knowledge.

Current Awareness

Faculty use a variety of approaches to monitor trends in their research field. Faculty attend conferences and stay current with the research literature by a number of different methods.

Methods of Keeping Up with Trends in the Field	Number of Mentions
Attend conferences or seminars	9
Read the research literature	4
Receive journal table of contents automatically or scan journal table of contents	3
Receive alerts via *PubMed* or *Google Scholar*	3
Monitor and use Twitter	3
Monitor blogs or listservs	3
Read society newsletters	2
Monitor industry trends	2
Monitor the popular press (e.g. *New York Times* science section)	1
Serve as an editor on several journals	1
Read *Science* and *Nature*	1
Subscribe to RSS feeds from selected journals	1
Monitor pre-print services like *arXiv*	1

During the interviews, several researchers commented on the use of Twitter as a current awareness tool.

> *…I'm also on Twitter a lot. And not that I monitor it a lot but I use it a lot, in terms of being linked through to the journals…you know, Science and Nature and so on, to get the more broader information. …these days, I should say that I'm probably using Twitter more than anything else, to receive information. I'm also signed up for notifications from PubMed, so I get emails about things in my field. Yeah…I would say Twitter's probably the most important thing right now because it is so rapid. I can take a look, or have it running, you know, on one side while I'm doing something else.*

> *And now that there's so much online…I mean, literally, I can follow people's Twitter feeds at conferences instead of going to the conference myself. [laughs] Which is nice, if you don't have a lot of travel money, it's very convenient. Somebody else is there, tweeting for you, you know.*

One researcher expressed some reservations about the use of Twitter to announce and promote publications.

> *I see this happening with colleagues that use Twitter…they have formed networks where they tweet and announce their own work and the works of others that they admire, and I wonder if that puts blinders on people to what might else be out there that's quality work? Because there's lots of us that aren't really into doing that, to using Twitter to*

> *either announce ourselves or our work. I'm not sure yet what to think of it. I see it as a tool, but I also see it as a distraction.*

A few researchers mentioned creating alerts in PubMed or Google Scholar as a way to be updated about new publications.

> *I use Google Scholar alerts, and so I have a few of them set up, that will just shoot me an email with the top hits that have just come up. And I've really enjoyed using that. Sometimes I look through them all and I'm thinking, 'these are all not it,' you know, but I can see where they get it. But still it saves me that time of having to go to Google Scholar each day and submitting that search to see what's new. And so I try to use that as best I can, to keep on edge.*

Another researcher spoke of information overload magnified by the proliferation of open access journals, some of which this researcher described as "*junk*" (e.g. low quality publications without rigorous peer-review).

> *We need that filtering mechanism tremendously, because there's just so much literature out there, it's almost impossible to keep current. 'Cause there's so much junk out there – it's hard to filter out the junk!*

Implications and recommendations for the Libraries

As in the case of literature discovery, the interviewees' comments point out the need for greater outreach by librarians, to educate and to promote tools for current awareness. For example, depending on the researcher's information needs, Google Scholar alerts might be replaced by Web of Science alerts, providing for better specificity in the citations returned. Faculty did not recognize the Libraries as a resource for supporting their current awareness practices. Given the use of social media by these researchers, the Libraries might consider a more aggressive Twitter campaign, highlighting key resources and important services. Individual librarians might consider initiating a Twitter account and inviting faculty that they work with to follow them – and then follow through with relevant information for those faculty and their students. However, the comments of these researchers confirm that in-person communication, at conferences and seminars, is the primary method for staying current. As a result, librarians should seek opportunities to present, or at least interact, with faculty in these environments.

Publishing Venues

All 11 researchers reported that publishing peer-reviewed articles in academic journals was a key measure of their productivity as faculty. Three faculty members shared their awareness of the role of "high-impact" publications to their careers.

> *We try and publish as high-impact as we can. …One* [reason] *is to get funding, you really need to do that. You can get funded without publishing high-impact papers. I mean, they want a solid publication record, you don't need to be going necessarily for the high-impact ones that we go for. But it helps, obviously.*

> *It's about really trying to identify where the article would have the most impact. Who are the readers of certain journals? But it's also a balance with impact factor…and impact factor is such a flawed measurement, but you got to play the game, no matter how much you hate the number, you got to play the game because you know that's what admins look at.*
>
> *So, primarily I've published in…the journals out of the* [researcher's professional society], *so that's usually my number one target…. it's not necessarily that it's the best impact factor, but it hits the audience I want it to, which is other folks in my…in the nation…that are* [in the researcher's discipline].

Additional types of publications discussed by the interviewees are shown in the table below.

Types of Publications	Number of Mentions
Academic journals, e.g. peer-reviewed articles	11
Locally produced reports, e.g. *Beef Cattle Report*, *CropWatch*, extension circulars	6
Book chapter	2
Guide for Weed, Disease, and Insect Management in Nebraska	2
Abstracts and posters at national meetings	2
Commodity board newsletters	1
White papers	1
Trade magazines	1

The faculty did not consistently share opinions about publishing in open access journals. However, two faculty mentioned the high costs associated with making their publications open access.

> *But it's so expensive… financially, we've been on a shoestring budget, and so we just haven't been able to afford the open-access. …Because, you know, it's $3,000 on top of page charges…for some of the journals. Some of the journals that are purely open-access don't have page charges, because it's all online. There isn't any hard copy. But some of these others that do both, it – you know, you're spending $5,000 to publish an article, which is just an enormous amount of money. …the amount of reagents I could spend on for that amount!*
>
> *. . . [A]t* [the faculty member's former employer] *we had plenty of internal money, so…paying an extra $1500 for open access wasn't a big deal. Now that I'm here, I'll probably be a little bit more reluctant to do that, to pay that extra money. It's a budget thing. It's a cost…*

One researcher expressed strong concerns about the apparent ease with which new journals are started, and that many of these are not reputable publications.

> *…it's so easy for people to open up new journals and new articles. Just new journals…there's so many journals out there…obviously tons of them are just junk and scams. And so…it's really trying to figure out which ones aren't junk and scams.*

Implications and recommendations for the Libraries

Because of the importance of academic journals as a publication venue and as a means for researchers to keep up with current research, it is critical for the UNL Libraries to continue to assess the library's journal subscriptions to ensure that the UNL community has access to core journals that support research program needs. Liaison librarians may become aware of journals and other resources that are lacking from faculty queries, but there needs to be a wider sharing of information from the Libraries' interlibrary loan service regarding article requests. This information would help librarians identify gaps, particularly if there are repeated requests for articles from the same journals. In addition to journals, locally produced reports are important publication venues for some faculty. These publications are often produced by an academic department and Nebraska Extension. Some of these publications, such as the Nebraska Beef Cattle Reports, are present to some extent in the Digital Commons @ University of Nebraska-Lincoln, the institutional repository provided by the Libraries (http://digitalcommons.unl.edu/), while online Extension publications like *CropWatch* (http://cropwatch.unl.edu/), are captured from 1994 to 2003. What is the Libraries role in acquiring, preserving, and maintaining access to this type of information, and how can the Libraries partner and collaborate with other campus entities, like Extension, to ensure access to these types of publications? For some researchers, particularly those with significant extension apportionments, these publications are an important part of their academic portfolio.

Although few faculty specifically stated opinions regarding open access publishing, several mentioned that they had published their work in open access journals published by BioMed Central, PLOS, and Frontiers. All of these publishers have article processing charges. Some institutions have established open access funds, and some institutions have memberships with publishers or journals (e.g. Peer J, BioMed Central, *Nucleic Acids Research*) that offer discounts on article processing charges. The Libraries, in conjunction with the Office of Research and Economic Development, should explore how to provide increased financial support to faculty who wish to make their work open-access.

Another concern related to the proliferation of open access journals is the rising number of predatory journals. One of the researchers in this study specifically stated that it would be very helpful if the UNL Libraries provided more information and education to faculty, graduate students, and especially department chairs, about predatory publishing. Additionally, the Libraries can also provide additional information and resources for alternative measures of research impact. Some faculty referred to selecting journals with high impact factors as a consideration when publishing. However, other measures, such as altmetrics and article-level metrics, can provide additional information, beyond the journal impact factor, to help faculty more fully document and measure their research impact.

Depositing Research Publications

In response to the question of whether or not they had deposited publications in a repository, seven researchers specifically mentioned that they had deposited publications (e.g. scholarly articles, peer review of teaching portfolios, locally-produced reports) in the Digital Commons @ University of Nebraska-Lincoln. One of the authors of this report conducted a search in the Digital Commons and found that all 11 faculty had at a least one publication in the repository. The other most frequently mentioned answer to this question was ResearchGate (https://www.researchgate.net/). Six researchers stated they had "deposited" publications in ResearchGate, even though ResearchGate is not a repository.

> *But for the PDFs, I usually put them onto ResearchGate, make them accessible there, which I really used to like. I…currently I'm kind of drifting more towards Google Scholar…I like the idea that there's somewhere that someone can go to and to look and see what's being done.*

ResearchGate is a free, commercial service in which scientists can create personal profiles, share publications, network with colleagues, and ask/answer research questions via online discussion forums. It was noted by one of the authors that 10 of the 11 faculty interviewed have profiles on ResearchGate. Two researchers commented on the ease of using ResearchGate as a way to connect with other researchers and share publications.

> *…so I really, really like ResearchGate, and I guess I should go back and mention that ResearchGate is one way that I also am connected with researchers. So when you post a new article, it would I think notify some of your researchers, or you could send it to the ones you want. So, ResearchGate is another way that I would share an article with people. That one's really nice, just the way that it's set up, to be able to share publications.*

> *What I want to know is people's publications and maybe a couple of questions. So something like ResearchGate, I've got a blurb about what we're trying to do. Twitter's the same, actually. I link through from Twitter, so I've got* [a research statement]*, and got some images up. I think that would be good enough to draw someone in. And then they can go from there straight to ResearchGate and see the big list of the publications. And that's kind of a nice set-up.*

Several faculty expressed concerns about regarding copyright and the legality of making publications available in ResearchGate.

> *I know as part of some of the, like ResearchGate and some of those, we get quite frequent requests for full publications, and I guess, [laughs] one of the things I'm not sure about is, what is the copyright – what is our ability to do that? Because, you know…we sign over the copyright of those to the journals.*

> *ResearchGate, I have an account there, and I know that, from time to time, they contact me to say that, 'are you the author of this? We found it.' [laughs] If they are not asking*

> *me to upload, I can say 'yes.' But the moment they ask me to upload, I try to avoid that, because I don't want to go through the stress of finding* [out] *'can I do that, can I not do that?'*
>
> *I'm a little reluctant to put things on ResearchGate, as far as papers, because I have no idea what the restrictions are and the legality of that. That's got me really nervous. . . .*
>
> *Yeah, because they somehow post some full articles from places. I don't manually put there, because I never know if a particular one could or should be openly distributed, so I let the Gate itself, you know, find it. So when it populates there, it says, 'Oh, we found one that* [is] *open access,' and you know, I'm like 'OK', click yes. You can, I'm fine with that.*

Implications and recommendations for the Libraries

There is a need to educate faculty and students about what ResearchGate is and is not. In this sample of faculty, ResearchGate was viewed as a repository for their work. The faculty interviewed in this study were conscientious and concerned about the issues related to copyright, yet the responses indicate there is confusion with regards to what is allowed in terms of uploading articles. The Digital Commons @ University of Nebraska-Lincoln is a highly used and popular service and was mentioned by many faculty in this study. Some faculty commented that their publication lists within the Digital Commons probably needed to be updated. It would be an appreciated service to faculty if there was a systematic way in which the UNL Libraries contacted researchers to update publication lists within the Digital Commons.

There is clearly an interest and desire among researchers to have personal profiles that provide information about publications and research interests. Some faculty in this study mentioned setting up profiles, using Google Scholar. Based on the number of faculty who said they use Google Scholar, establishing a Google Scholar profile would be an easy way to have another online presence in addition to ResearchGate. There are other researcher identification systems, such as ORCID, ResearcherID (Thomson Reuters) and the Scopus Author Identifier (Elsevier) that were not addressed or mentioned in this study. All of these systems also permit researchers to create profiles. Liaison librarians need to be knowledgeable about the similarities and differences between the identification systems so they can advise faculty on how best to utilize them.

Scientific Research Data

> *'…we* [agricultural researchers] *have lots and lots of data, and data types that we've never seen before. And what do we do with those…when as faculty we're not trained, because those methodologies didn't exist* [earlier]*?'*

Related to scientific communication practices were faculty comments about research data practices, particularly deposit in repositories (e.g., NCBI GEO [Gene Expression Omnibus]). Scientists were aware of the federal mandate regarding data deposit, but the mandate was not the

only motivator for sharing data – assisting other researchers, transparency, and reducing redundant research were other motivations.

> *…it is mandated by federal agencies or by the journals. But also I think it's good practice to make that data available. …other people can re-analyze it in different ways and find things that we didn't find. Or, you know, if they're looking for things we weren't looking for. …I use those resources from other researchers, so I think it's a good idea to make those* [data] *available also.*

> *I think it's important to have the* [data] *out there. Once it's published…I think it's good for people to be able to access that…you know, it's, 'I don't have anything to hide,' right? And I want people to be able to…re-analyze something if they wanted to, or if I've moved on or my path's gone a different way, and they want to take something from that* [data] *and forge their own path, I think that's important. And there's no reason for them to replicate all that big data.*

A significant challenge for some of the researchers was analyzing and storing data collections. In one case, a scientist commented that while the university provided superior computer processing power, RAM and data storage options were not as well-configured:

> *…they want* [me to use the unlimited cloud storage of] *Box. I'm willing to give it a try to see how it goes. …I may just end up buying external hard drives for storage and go that route if need be, if Box doesn't work.*

Responding to a follow-up question about data management practices, the same faculty member shared an interesting comment regarding management, storage, and preservation of the program's digital data:

> *…it's almost cheaper to redo the experiment than to pay for all the storage needed. Especially long-term. …I'll probably buy enough of a hard drive to store data as we're working on it, but as soon as that paper's published, that data is going to be stored on Box... …for long-term storage, it's just cheaper to redo the experiment. …I think that's why all these journals are now requiring everything to be deposited in a public database, and going to raw data. So, if I do a run that's going to be a good paper, I'm going to have the original data. But it's also going to go into…NCBI, and that will be the repository of the data. … for about $5000, I can produce* [one] *hundred gigabases. So to reproduce that 3 gigabases, that's 3% of $5000, that's the cost to redo the experiment now, versus trying to maintain all the raw data. …the technology is advancing so quick…once you publish it, if five years from now you need to revisit the data, it's just cheaper…it's so much easier to redo the experiment.*

Another researcher shared concern about technology-driven data generation:

> *So we use a range of* [techniques]. *But none of them* [the techniques] *lead. We always have an hypothesis… We have to have strong rationales for doing the things that we do. …when I moved into* [the current research area], *I kind of looked around and said, 'well,*

> *nobody's doing* [the classical techniques] *anymore.' They've gone from doing that kind of thing, probably* [during] *the* [19]*60s, to sequencing genomes of 70, 80 isolates... I mean, they've got* [in one foreign country] *institutions that are only sequencing* [one organism's] *isolates, that's all they do! But I would say 'but what's the value? You've skipped everything in between.'*

One faculty member reflected on a recent discussion with a mentor. The mentor completed his master's degree in an agricultural field several decades ago; with the technology then available, his research took two years. Now, the faculty member estimated that a graduate student could complete the same research in a month.

> *So, while it's great that we've advanced the technology, our expectations are now very high for research output and its speed, for publication output and the amount of data expected to be found in a paper. And these increased expectations use up time.*

For scientists doing field research, there was the additional data management challenge of taking notes in the field and later transcribing the information into a digital format. One faculty member shared that program's best practices, which included versioning:

> *I think also it can be challenging going from field to digital…if I'm doing data collection in the lab, I try to have my computer next to me, and I just put it directly into my computer, just to avoid that other step of written to then someone has to type it in. And obviously, you have another opportunity for an error then. …but when you're doing, of course, the field data, a lot of times you have these like…[laughs] pieces of paper that have gotten all dirty and wrinkled, and they've been shoved in a clipboard in the truck while you're driving back! …sometimes we'll make little notes of things that we've observed…oh, little extra notes, here or there, that get written on the paper. And so we always try to incorporate a notes section for data entry…if we wrote it down in the first place, I don't want it to get lost in the transfer. …I like all of those written data sheets to get scanned, and then entered digitally. …So we do use Box, and have shared folders, like there's a lot that are shared between my technician and I. …And so, having that digital backup, then, makes me feel a lot safer. And I do Box sync for pretty much everything that's on my computer. …I really like having the Box sync and the Box apps on my mobile devices. …One thing I always…ask people to do, is I never save over old files. …usually for every file that exists, there's the current file with the current date, the last date it was updated. And then there's…a folder, called 'old files,' and* [there] *you put all the old ones. So there might be like twenty of different dates going back, but each time it gets updated, or new data gets inputted, I don't like to save over, I like to save it as a new one.*

One of the common threads in the discussions about data related to a knowledge gaps regarding new data types, larger data sets, new approaches to analysis, and concern about training and educating students in areas where the researchers had little to no expertise.

> [Ten years ago] *it was really about the wet lab, and it was about producing the data. …you did the analysis, but everybody could do it themselves, it was pretty basic,*

> *straightforward. In the last 10 years, that has completely shifted, to where now…what I hear from colleagues, and it is true, it's so easy to produce the data. …the problem is the analysis of it. The problem is just managing the data. …the sequencing run here, after it gets all processed, it produces about a 33 gig data file... And I'm doing one of those runs in 26 hours. And so, you can think about it…just the amount of data that you have to then manage…now, my students are all going to have to have programming backgrounds. …it's kind of interesting to see the people with the high throughput phenotyping facilities, now, how they talk about 'oh, we've got all this data now.' And they…they're getting that initial shock that I saw* [9 or 10 years ago].
>
> *On the microbial side, when we get into the sequencing, it…[laughs]…We get into massive amounts of data. We're, I'm learning my way through some of that with a couple of the students that I have working with me now.*
>
> *…like the whole field is becoming more quantitative. And so* [agricultural faculty are] *wondering, 'OK, how do we train our students? How do we give them experiences where they can see how the quantitative skills would fit into their research?' They're not going to be primarily quantitative scientists, but they need enough quantitative skill to be able to do their agricultural research.*
>
> *The current challenge is…on the data side. …I look back* [on] *my Ph.D., I took three courses of biochemistry, and I wish they were three courses of programming. And, in my current projects, that really is the challenge. …So, I was very eager to bring* [a current grad student] *on as a student, because that could complement my challenge of not being able to program. …I've got to just, for my self-improvement…learn to program.*

Implications and recommendations

Discussions with these agricultural scientists confirmed anecdotal evidence that the UNL faculty are aware of the current mandates from federal funding agencies regarding data sharing, and publish research articles in journals that require a link to the deposited raw data, and/or supplementary data 'files' (often PDFs) to accompany a publication (Williams, 2016). The UNL Libraries anticipate hiring a data curation librarian for the sciences; this educational piece is not likely to be a high priority for that individual. However, it seems likely that the need will continue for the data librarian to educate individual researchers and lab programs in best practices for data organization, management, sharing, and retention; for example, a few interviewees were unsure of what data to share/preserve, what format(s) to use, or were uncertain about repository selection. After interviews with agricultural scientists at The Ohio State University, Diekmann (2012) discusses some specific challenges regarding data management planning, data sharing, and data preservation. The UNL researchers echo some of the same comments and concerns four years later.

While the Libraries, in cooperation with the UNL's Office of Research and Economic Development, should continue educational outreach about data matters to faculty and their students (both graduate and undergraduate), other concerns are matters for the university and federal funders to address. The lack of memory necessary for genome assembly, for example, is

an infrastructure concern to be addressed at the campus- or university system-level. At least one of the scientists was aware of the UNL's Quantitative Life Sciences Initiative (QLSI; http://bigdata.unl.edu/about), but had yet to engage with this group, even though research methodologies, 'big data', and desire to provide quantitative training to students aligned well.

> *We do have the Big Data Initiative, and I've not dived into that enough to really know what is available there. …we talk about the cross-discipline and the needs, it's how do we create mechanisms so that, in computer science…we can get projects where, you know…'I need this visualization, is that a project that one of your Ph.D. students might want to work on, so they can do a software package?' To get that real cross-discipline, and making those connections…there* [are] *a lot of silos. What are the mechanisms to help break down those barriers to get us to interacting more with disciplines not within IANR?*

Several of the faculty mentioned the requirement by some publishers of scientific journals to deposit the supporting data for a research publication. In some cases, these data must be available to the peers reviewing the paper; in others, these data must be available in an open repository before publication and/or appear in supplementary data 'files' associated with the article at the publisher's site. Typically, these supplementary files are .pdf format, which are not machine readable, and not readily useful to those agricultural researchers trying to 'mine' published data (Williams, 2016). An increased benefit to data sharing and re-use would be instructions for supplementary files to be made available in a non-proprietary format – a matter to be addressed by federal funding agencies and/or publishers.

Challenges and Opportunities

> *That's why it's called 're-search'…not 'search'.*

The 11 agricultural researchers interviewed for this study reported several challenges, both programmatic and for the agricultural field in general, but there were always glimpses of opportunity, of persistence, in their remarks. In fact, when asked to discuss research challenges (see Appendix II), most responded that the challenges were expected, were to be solved, and often led to the next set of intriguing questions to try to answer – challenges were not negatives.

The most frequent overall challenge was the need to feed the world, now and in the future. Two scientists commented:

> *The broader picture is about how are we going to feed the world come 2050 and beyond? … Because if we stay on the current trajectory, of how…crop yields improve…we'll go from a food surplus to a food deficit relatively soon, with world population growth.*
>
> *So…going by the projections, world population will continue to increase. Now we are soon going to have about nine* [billion] *mouths to feed. So it becomes that agriculture will continue to be very relevant. We need to look for ways to improve efficiency, to maximize production, even with the limited resources that we have. And so, I think scientists in agriculture are going to need to play more important roles in designing...and developing*

> *systems that can provide that better efficiency of production. And that is where I see the future going. Though I have challenges that…as we try to maximize production, we also need to think about the concern for the environment. …And so, the challenge of how agriculture plays into the environment, how it could be negative to the environment, is a concern.*

Researchers reported that, in terms of their work, the major challenge was a lack of time.

> *Time. Time and specifically, you've got competing issues, you know. You have to write a proposal, but you still have to have thinking time, processing time* [for] *your data. And you just need that isolated time, which you don't have the luxury to have. To have a continuous time to really assimilate all the things that you've, you know, you've collected. …'I just got done with this project, give me a little bit of this time so I can assimilate all that information', a focus time where I can get away and not be trying to address everything, you know…So, an isolated time for research! [laughs] Writing…yeah!*

Sustaining a research program, specifically funding for supplies, equipment, and personnel, was also frequently named as a challenge. Three researchers explained:

> *…back when the lottery was up really high, I was thinking to myself, '…if I won the lottery, you know what I'd do? I'd fund my own research.' …I'd have that magic wand give to me a winning lottery ticket, so I could create an institute…so I could just keep doing what I'm doing, forget about, you know, this worry of funding, and just do research, and get it done and actually be productive, and give solutions to the people who need it. Right now, we're not able to efficiently do that, because of the funding.*

> *…funding is certainly a barrier…it's a big barrier. But then, how can* [we go about] *making sure that scientists are equipped or are able to have the opportunity to help influence the funding agencies? …mak*[e] *sure that, within our university, that we can maximize our scientists' influence on those* [funders].

> *But I think, ultimately, is provide more money for research and more money for staff. …to do the research, we need the money. Everything else is in place. …I don't want to complain or sound like I'm complaining. I am funded, and I'm in a better situation than most. …And I'm still looking down the line at making cuts in the staff, because it's still not enough…for me, there's a certain number of people and types of people I need in the lab to do the work. That's where my expertise really comes in…I really don't know what's down the road, but I know to get there, this is what I need. And I have that right now, but who knows how long I'll have it? So one ask[s] for stability…within the lab. …I know grad students will leave, and postdocs would leave, but the knowledge that I could replace them and pass the skills on, between now and 30 years or whatever, would be useful to have. [laughs]*

Those researchers who work with growers, ranchers, and industry reported on the tensions between industry as partners and as 'competitors', especially as sources of information:

> [A challenge is] *keeping pace with the technology, I think. Where the agricultural industry is faster in terms of delivering products, they are not specifically tested or what not. So, we tend to be behind the curve, just because we do have to do the research two to three years with that, and then, you know, disseminate that information on how it works. …You know, do we have ears that would listen to us…being able to really address ranchers' and producers' issues, but provide timely information. I think that's a challenge. There's synergy, but sometimes antagonistic, you know, between – delivering, at the same time having enough information to say, 'this is how it works.'*
>
> *…stakeholder advisory committees* [say] *'well, the university is not working fast enough.' But you know as scientists, we're like, 'well, I can't give you recommendations based on one year!' …part of being a good scientist is you're constantly questioning your results…if you just do it once, and come to this conclusion and give this advice to the farmer and move on, that's not being a good scientist. But yet…that's almost what they want…very quick, timely, straightforward, uncomplicated answers, and we don't have those. [laughs] That's not, unfortunately not how it works! So that's a challenge of balancing the timeliness and trying to get information out there, but with trying to be very thorough and careful and scientific about it.*
>
> *There's also, I think, the challenge of how do we work best with the different parties, like industry – how do we work best with the companies that…they obviously have products to sell and they have a company to run, and budgets to maintain as well. But how do we sort of find those common interests and try to work together? Because they're also people who are providing all…a lot of information and influence to the producers as well. …if you're getting money from industry and working with industry, how do you make sure that the public is not misconstruing that? Are you making sure that you're really maintaining that objectivity and the ethics of that relationship? And that the public understands the ethics of that relationship. And that it <u>can</u> be an ethical relationship! [laughs]*

Another researcher discussed the future potential in the intersection of academic, industry, and government interests in data and information:

> *…there are research units and companies who are just collecting a lot of data, and they don't necessarily know what to keep, what not to keep. …'what's the value of this information? What's the potential information in this data? Is it worth keeping? And what are the kinds of questions we could ask from it?' …that area is really a big challenge right now, and a big open space, particularly in agriculture, where, you know, there are agricultural companies collecting data, there are farmers collecting data, there are researchers collecting data, there are NGOs collecting data, and everybody is talking about all the data they're collecting. And we don't yet have sort of the standard infrastructure to support all of that, right? So even if I talk to people from National Ag Library, and they say, 'you know, we would love to be involved in this space, because that's kind of our job, but we don't have a billion dollars in our budget to support all this data.' And so it's, in some ways it's good, because it's pushing government and*

> *companies and all the different players in the field to work together, because they have to…where in the past, they didn't necessarily have to. …It's, 'oh, they're kind of working in the same space and so they need to figure out how to work together.' And so, big challenge, but big opportunity.*

A challenge identified by two researchers was the future of publicly-funded science and training the next generation of scientists:

> *But for me, I think the biggest challenge is: how are we going to generate the next generation of scientists? …mostly because funding has dried up so much. It's made it very difficult. …while it's been very hard on my generation, as far as accessibility of funding and being able to maintain things, I think where I see it the most is the number of graduate students I can have. It's so small. And therefore, we're not training as many students as we used to. And those students see how hard it is for us, and they're like, 'there's no way I'm doing that for a career'. And so, I, you know, I really question how we're going to generate the next group of scientists who are going to help to solve those really big-question problems. …I've been trying to get people to understand the importance of public funding for the science that we do, because it's unbiased and…not driven by what kind of product you're going to place into the marketplace. …I think that the public doesn't, the general public doesn't understand that quite as well…and some of that's on us, that we don't explain it very well. …you know, I write letters all the time to our congressmen, my congressman, and I've tried several different tactics. You know, the importance of science. 'Well, we get that but…the budget, the budget, the budget'. And I'm like, 'well, I'm like a small business. You know, and if I don't have this funding, I have to let employees go. I have to lay people off.' 'We know, the budget, the budget, the budget'. …I'm not sure what the right…words are for them? To make them see how important that funding is. …I think that's the biggest challenge, is how are we going to continue to be able to fund…public science.*
>
> *…how scientists here, with their research, how they interact with the public. How do they translate their science to the public? You know, outreach is such a big area of importance. And how do we engage lawmakers? On a positive note. You know, how can we facilitate so that we can have a bigger voice with the lawmakers which will then help guide the funding agencies, which helps enable us to do the science that we feel are important. And vice versa – we can get feedback from lawmakers and the public, so that we may need to adjust our science. …we see 'oh, this is what they perceive as real need, then it is,' so then we need to adjust our programs to that. So, really that guidance on making sure that we're doing relevant science? Because I love doing science…it's not a hobby. You know, we want to maximize impact…Keep us relevant. Because if the public doesn't perceive us as relevant, then they're going to cut funding, and then we're not going to be able to do science, and it's just a downhill spiral.*

Related to the challenge of being seen as relevant by the public and lawmakers, three researchers stated that outreach and education is especially necessary in order for agricultural research to progress and be understood and accepted by the general public:

…a couple of the challenges are pretty ongoing. You know, finding funding to continue the work is always a challenge. It seems to be getting worse. And then just having people understand what we do. …a lot of science is changing, with foods, GMOs for example – you know, there's a lot of fear about those in the general public, because they don't understand what it means. And now we have genome-editing coming along, that's both a challenge and an opportunity. …opportunity because we could really improve crops in a way that would potentially not be considered GMO. …But also a big challenge because it's facing the same hurdles as GMOs. So, yeah, just connecting with the public. …also certain people who don't think funding research is a good use of taxpayer money. And they will go and find titles of projects that sound strange, and make fun of it, and call it waste without really understanding the process of how these things are funded. I think if they would go sit on a grant panel and see how it happens, maybe they wouldn't say things like that. [chuckles] …I think it's a very good system, actually. …those are some challenges, but they're also opportunities because…I think, one trend in science is to pay more attention to public outreach. And try harder to connect with the public, and explain what we're doing and why.

…it's everybody's job in the field of agriculture, sustaining this planet, you know, and still being able to feed the people. Especially with our culture being pulled in so many directions. …it becomes very challenging to produce food that is acceptable. …just as [an] *example, you have the GMO versus non-GMO…discussion. Then you have the organic versus non-organic…I mean, I'm not saying that one is right, the other one is wrong. But…we have levels of poverty and food insecurity in parts of the world, that it's amazing. …We just don't know, until you travel and see, you know, the conditions where some people live…having to walk three hours, each way, to have a…gallon of dirty water. Until you actually see that with your own eyes, it's hard to…understand the complexity. And then you come back home, and there's people…*[p]*icking and choosing so much, while there's people that don't even have something to eat, like they're just hungry all day. So I think that's the challenge, is feeding the population with…the hurdles that our culture has put up. …so it's very difficult. You either…produce food that* [is] *still healthy, and still nutritious, and can feed a whole bunch of people. And you have a system that supports that. Or you start segmenting, like…GMO-free, organic, OK? So I think that's the challenge. And there is opportunit*[y] *as well. To be creative and try to comply with all those different expectations or comply with all those different lines of thoughts, so to speak.*

I think one of the challenges that we have to face is the global population. …And the US population doesn't seem to be as cognizant or aware that it's out there. …it just doesn't register with them. And so, ultimately, what we do is we're producing food for people to eat. And so, our responsibility – and I would say my responsibility in researching that – is that we need to make sure that the food is safe, first of all, because if it's not safe, it doesn't matter anyway for us. But then it needs to be as high a quality as it can. …And so we need to make it safe, and make sure we're utilizing everything that we have. I mean, if we look at the numbers where they say we have to double the food production by 2050…I

> *think from a big picture, we need to make sure that we're producing food for the world, and trying to…decrease the food insecurity that's out there. And it's going to be more of a challenge, but it takes money and it takes advances in technology to fund the research to allow that to happen. And then it's also acceptance from a consumer level. …And so, you know, it's – and that's maybe the challenge that I see, and maybe some of the pushback we get with the US consumers is, they don't look broader at that. …we can't, we won't be able to produce the food that we have without using technology. And that's a moral and ethic*[al] *issue that we have, and responsibility that we have, I think – is to provide – well, to try to prevent mass famine or outbreaks.*

Implications and recommendations

Librarians working with agricultural researchers and their students can ease some time issues by continuing to introduce efficiencies into their workflow (e.g., literature discovery, citation management). While the Libraries may not be directly solving the problems like that of world hunger, our attention to providing the needed resources and services can certainly assist in answering the 'big questions' in agriculture. While the Libraries presently are involved in some UNL science literacy efforts, librarians might examine the possibilities of integrating into other science literacy activities. For example, can the Libraries support the researchers who present at the State Museum of Natural History's *Sunday with a Scientist* series, or work more directly with Extension faculty or with 4-H educators?

Conclusions

The agricultural scientists interviewed in this study provided a candid view of their research processes, challenges, and opportunities, and where the Libraries might provide support.

A final product of the study is an evaluation, in a constructively critical way, of how this research study might have been improved. One difficulty of the study was its timing. Asking active researchers for time during the summer, when both bench and field scientists were working intensely, likely impacted the response rate negatively. However, when would be a better time? The busy fall and spring academic semesters might not have been better choices, since most of the faculty interviewed also teach.

There is one area that could change in future cooperative studies of this nature. Neither the librarians nor at least one of the sponsors (U.S. Agricultural Information Network) were able to provide any input into the semi-structured interview questions. The authors respectfully suggest that, as a result, Ithaka S+R missed an opportunity to hear from agricultural information specialists about their target audience of scientists, and thereby design a modified question set. For example, the authors were interested in how a scientist's literature discovery process changed (or not) over time, taking into account career maturity. Likewise, it was difficult, within the interview timeframe, to explore why researchers prefer Google Scholar over more robust online indexes for discovery and alerts. On a positive note, both of these questions are avenues for further study. Finally, with the completion of this study, the Libraries now have a cadre of

faculty with experiences in qualitative research which can be applied to investigate Libraries-related questions.

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Appendices

Appendix I: Informed Consent Form

Signed Consent Document

Title of Research: *Research Support Services Study for the Field of Agriculture*

Purpose of Research: This study will investigate the research practices of academics in agriculture in order to understand the resources and services these faculty members need to be successful. You must be 21 years of age or older and a faculty member engaged in agricultural research in order to participate in this research.

Procedures: Participation in this study will require approximately 60 minutes. You will be asked to describe the focus of your research, research methodology, how you disseminate your research, and your view of the future of agricultural research. Participation involves an audio-recorded interview about your research practices and support needs as an agricultural researcher. We also may request to take photographs to document your work space; you will not appear in the photographs. Participation will take place at your workplace on the UNL campus.

Risks and/or Discomforts: There are no known risks or discomforts associated with this research.

Benefits: The results of this study will be used to articulate the research activities and needs of agricultural scholars, including identifying improvements to pre-existing research support services at the University of Nebraska-Lincoln and opportunities to develop new research support services for agriculture more widely. This study also adds to the knowledge in library and information studies of user needs and activities by examining the specific needs of agricultural scholars, a group under-represented in this literature. Participants may experience benefits in the form of increased insight and awareness into their own research practices and needs.

Confidentiality: Your responses to this interview will be kept anonymous. Your name will not be linked to your interview responses or work space photographs at any time. We do not include your name on any of the interview data and there is no link between this consent form and your responses or photographs.

Compensation: You will receive no compensation for participating in this research.

Opportunity to Ask Questions: You may ask any questions concerning this research at any time by contacting Associate Professor Leslie Delserone (402-472-6297; ldelserone2@unl.edu). You may also contact Associate Professor Andrea Dinkelman (402-472-3004;

adinkelman10@unl.edu). If you would like to speak to someone else, please contact the Research Compliance Services Office at 402-472-6965 or irb@unl.edu.

Freedom to Withdraw:
Participation in this study is voluntary. You can refuse to participate or withdraw at any time without harming your relationship with the researchers or the University of Nebraska-Lincoln, or in any other way receive a penalty or loss of benefits to which you are otherwise entitled.

Consent, Right to Receive a Copy:
You are voluntarily making a decision whether or not to participate in this research study. Your signature certifies that you have decided to participate, having read and understood the information presented. You will be given a copy of this consent form to keep.

Signature of Participant:

_____ _____

Signature of Research Participant *Date*

Name and Contact Information of investigator(s)

Leslie M. Delserone (402-472-6297; ldelserone2@unl.edu)
Andrea L. Dinkelman (402-472-3004; adinkelman10@unl.edu)

Appendix II: Semi-structured Interview Questions

Research focus

1. Describe your current research focus. How this focus is situated within the broader discipline of agriculture? How is this focus situated in the academy more broadly? [*Probe for whether/not they see themselves as located firmly within agriculture as a discipline or located across/between disciplines. Ask about collaborations.**]

Research techniques

2. What research techniques do you currently use to conduct your research? [*Probe re lab- and/or field-based, population/organismal/cellular/molecular, basic or applied research*]
3. What kinds of data does your research typically generate? [*Probe re data re-use*]
4. How do you locate the research literature you use in your research? [*Probe re what tools are used for discovery, how literature is accessed*]
5. Think back to a past or ongoing research project where you faced challenges in the process of conducting the research. [*Encourage discussion of more than one scenario, if faculty member so indicates; encourage discussion of a specific scenario*]
    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? [*Probe re personal information management practices, does method work for researcher*]

Dissemination Practices

7. Where do you typically publish your research in terms of the kinds of publications and disciplines? [*include web publications as part of research output?*] How do your publishing practices relate to those typical to your discipline? [*Probe re specific journals or publishers; how sharing of research occurs; other research products-other ways of sharing research, beyond journal articles; open-access awareness/opinion; publication in OA journals*]
8. Have you ever deposited your data or final research products in a repository?
    a. If yes, which repositories and what have 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? [*Pick up on earlier themes*]

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?

**Notes for UNL interviewer; not included in original Ithaka S+R interview guide*

Appendix III: Participating Libraries and Study Advisors

Alabama
Auburn University
Arkansas
University of Arkansas
California
University of California-Davis
Connecticut
University of Connecticut
Florida
University of Florida
Georgia
University of Georgia
Indiana
Purdue University (West Lafayette)*
Illinois
University of Illinois-Urbana Champaign*
Kansas
Kansas State University
Maryland
National Agricultural Library
Minnesota
University of Minnesota-Twin Cities*
Nebraska
University of Nebraska-Lincoln*
New York
Cornell University
Ohio
The Ohio State University*
Oklahoma
Oklahoma State University (main campus)
Oregon
Oregon State University
South Carolina
Clemson University
Texas
Texas A&M
Virginia
Virginia Polytechnic Institute and State University

Advisors: American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, U.S. Agricultural Information Network

*Member, Big Ten Academic Alliance