USDA-NIFA Climate Portfolio: Project Director Survey Report

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Acknowledgements:

This project has been funded (award number 2016-67003-24895) by the United States Department of Agriculture National Institute of Food and Agriculture (USDA-NIFA). The contents of this document do not necessarily reflect the views and policies of the USDA-NIFA, nor does mention of trade names or commercial products constitute endorsement or recommendation for use. The authors would like to thank Ian Gesell for compiling data for this project.

Recommended Citation:

Getson, J.M., Church, S.P., Esman, L.A., Hatfield, J.L, and Prokopy, L. S. (2018). *USDA-NIFA Climate Portfolio: Project Director Survey Report*. West Lafayette: Purdue University.

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Acronyms

ARS	Agricultural Research Service
BMP	Best Management Practice
HBCU	Historically Black College or University
HSI	Hispanic Serving Institution
MSI	Minority Serving Institution
NA	Not applicable
NIFA	National Institute of Food and Agriculture
PD	Project Director
Q	Question
REEIS	Research, Education, and Economics Information System
USDA	United States Department of Agriculture

1 Introduction

The National Institute of Food and Agriculture (NIFA), within the United States Department of Agriculture (USDA), has funded a variety of research, education, and extension efforts that have focused on climate change and variability and agroecosystem research. It is essential to evaluate the impacts of these USDA-NIFA investments and learn what made some projects more or less successful than others to help determine the future trajectory of the climate program within NIFA.

The goal of NIFA's "Agroclimate Science Portfolio" (herein referred to as the Climate Portfolio) was to "develop sustainable agriculture and forestry based strategies" that support adaptation, mitigation, and climate change education and extension (Bowers 2014). One of the greatest challenges to ascertaining funding efficiency is identifying and quantifying measures of success for funded projects. NIFA contracted Purdue University and USDA-ARS to conduct a synthesis of the NIFA Climate Portfolio for projects funded between 2010 and 2015.

This synthesis project is designed to:

- provide a robust picture of the outcomes, knowledge, educational curriculum, outreach, and tools that were developed with USDA-NIFA support,
- determine gaps in research, education, and extension not addressed by USDA-NIFA programs,
- analyze impacts of research, education, and extension, and
- evaluate success of projects and how to create a successful project.
- analyze whether the portfolio projects achieved the stated goals of the Agroclimate Strategic Plan, which is to (as defined by its stated mission):
  "Support transformational discovery, learning and outreach programs that advance the development and delivery of agricultural science and optimize sustainable management, production, utilization and consumption of goods and services from working lands under a variable and changing climate."

The initial step of the Climate Portfolio synthesis was to conduct a survey of Project Directors' (PDs') to evaluate their perceptions of project success. This report presents the descriptive results of the NIFA Climate Portfolio PD Survey for capacity and competitively funded projects.

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2 Methods

2.1 Portfolio development

The Climate Portfolio is defined as the collection of projects funded by NIFA competitive and capacity grants that addressed climate change issues for the years 2010-2015. The list of projects was provided by NIFA as numerous individual files that were compiled into a single database by this project team. Data provided by NIFA included account number (also known as accession number), program type, proposal title, PD name and contact information, fiscal year, and funding type (i.e., capacity or competitive), and Knowledge Area, which was summarized by Knowledge Area Topic (USDA-NIFA 2013).

2.2 Project Director Survey

The PD survey was designed to inquire about each project's lessons learned, outcomes, leveraging, and synergies. The questions (Appendix A) encompassed the following key categories:

- project scope and scale,
- perceived project successes,
- how and to whom project results were disseminated,
- whether project results were utilized by stakeholders,
- project outcomes, and
- synergies generated or capitalized upon between collaborators and other NIFA and non-NIFA funded projects.

The survey was initially developed by Purdue University project staff building upon a similar survey developed for the NIFA Water Portfolio and success factors developed by Pinto and Slevin (1987). Feedback provided through a pilot test with the project's Advisory Group was subsequently incorporated into the final survey. Data collection occurred from November 2016 to January 2017 through Qualtrics software (Qualtrics, Provo, UT). First, Dr. Rachel Melnick, the National Program Leader, emailed Climate Portfolio PDs to invite them to complete the survey. Survey invitations were then distributed through Qualtrics emails; each email included a unique survey link. PDs with multiple projects received one additional email to notify them to expect one survey invitation per project. PDs were sent up to three email reminders (with the survey link). Research assistants called PDs who had not completed the survey after the third reminder.

The survey began with a set of introductory questions, followed by eight sections. Questions using future tense were used for ongoing projects, while projects that had concluded used future and past tense (indicated in the question with a forward slash). The survey included three broad question types: closed, Likert, and open. The following figures and tables are used throughout the report for closed answer questions:

- Frequency tables: single response closed questions.
- Bar plots (with inset table to indicate the number of categories selected by the PD): multiple choice closed questions.
- Bar plots: Likert scale questions; each bar plot includes the percentage of respondents and the mean Likert score.

Open answer questions were analyzed qualitatively. One researcher developed the initial codebook by coding a portion of the responses. Then, two additional researchers used the initial codebook to independently code each of the previously coded open responses. The research team then met to discuss and resolve coding discrepancies. Through these discussion, the codebook was finalized to the agreement of the research team. One researcher then reconciled coding discrepancies identified through the codebook development process. In this report, open answer question responses are provided in frequency tables (coding counts). Each code includes an example quotation taken from survey responses. To ensure respondent confidentiality, text was redacted to prevent respondent identification where necessary.

The corresponding survey question is referenced respective to the PD Survey provided in Appendix A (e.g., the first question of the survey is referred to as “Q1”). Note, Q55 requested personal information and is not included in this report. R Statistical Software (version 3.2.3; R Core Team 2015) was used to analyze the survey data.

3 Results

The results section is divided by funding type; capacity and competitive, respectively.

3.1 Capacity Funded Projects

3.1.1 Introduction

3.1.1.1 Response Rate

Capacity funded Climate Portfolio PDs completed (defined by responding to Q2) a total of 711 surveys. Each survey response is specific to a project (i.e., number of projects and not number of PDs since PDs could have multiple projects in the portfolio). Distribution consisted of 1,638 surveys, which included 51 bad addresses. Bad addresses include email addresses that bounced, were later identified as incorrect by receipt of an email from incorrect addressee, as well as respondents that indicated "No; I have no relationship to this project." The final response rate for 1,587 eligible recipients and 711 completed surveys was 44.8% (number of responses per eligible recipients by 100 [Vaske 2008]). Not all respondents answered all questions; therefore, response rates vary by question. Figure 1 presents the percent of projects within NIFA Knowledge Area Topic (as defined in USDA-NIFA 2013). The most frequent topics were "soil" (23.6%) and "general natural resources" (22.8%).

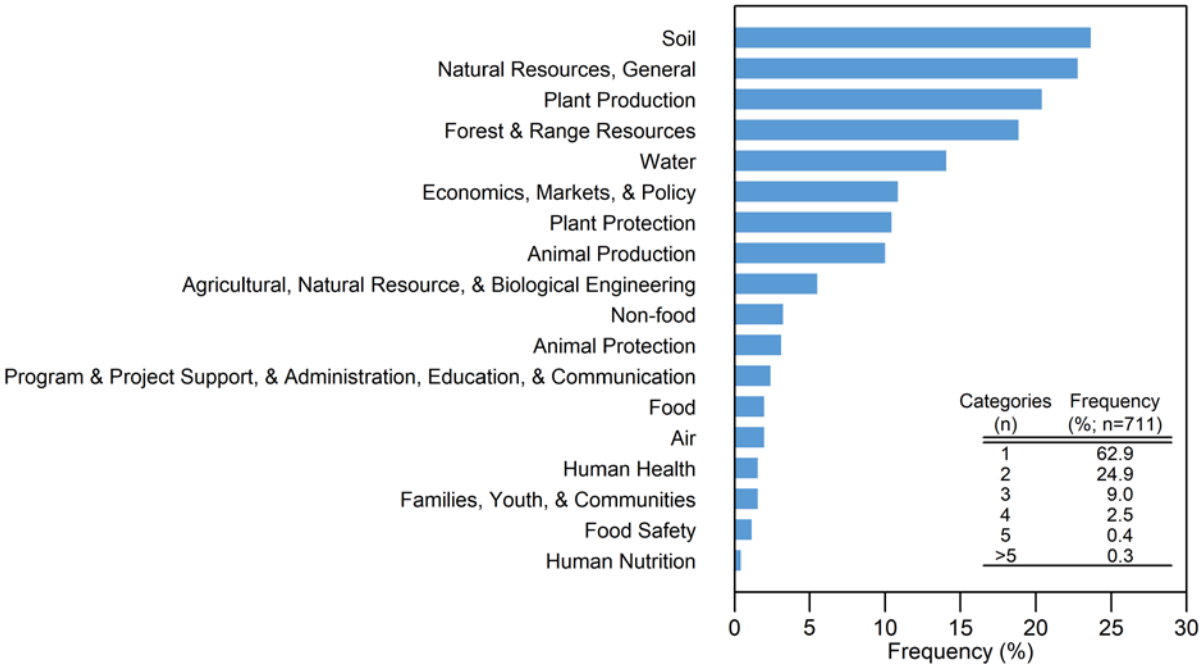

Figure 1. Capacity - Projects by NIFA Knowledge Area Topic
Inset table indicates the frequency of projects with ≥ 1 topic.

3.1.1.2 Respondent and Active Status

Nearly all (94.9%; total n=711) respondents identified as the PD or co-PD of the project (Q1) with the remainder indicating they had a significant role in the project.

Most (74.8%) of the projects were still active at the time the survey was completed (Q2).

3.1.1.3 Capacity Funding

To explore the funding avenues of capacity funded projects, a set of six questions were developed specifically for capacity projects (Q3-Q8). The majority (67.3%; total n=679) of PDs were required by their institution to apply for the capacity grant associated with their project (Q3). Almost 40% (37.4%) of the projects did not receive any direct funds. Projects that did receive direct funds, they were primarily used for "supplies/materials/equipment" (47.6%) and "travel" (43.9%; Figure 2A). Direct funds were spent on more than one category of funding (inset

table of Figure 2A). The other types of direct spending were identified as used for "personnel staffing" (n=13), "publication" (n=6) and "analysis costs" (n=4), "miscellaneous project expenses" (n=3), and not able to be coded due to PD response being vague or not relevant to question (n=12). Most PDs indicated that they were unaware of how indirect funds were allocated (44.0%) or did not receive indirect funds (31.3%) (Figure 2B). The other types of indirect spending were identified as "student support" (n=4), "supplies/materials/equipment" (n=3), "travel" (n=1), and not able to be coded due to response being vague or not relevant to question (n=10). Project goals were mostly completed due to "outside funding" (77.8%; total n= 679; Q6). Almost half (49.7%) of those projects required outside funding to complete 75-100% of the project goals (Table 1). Given the opportunity to provide additional feedback regarding capacity grants, PDs primarily discussed how the funds were allocated (Table 2).

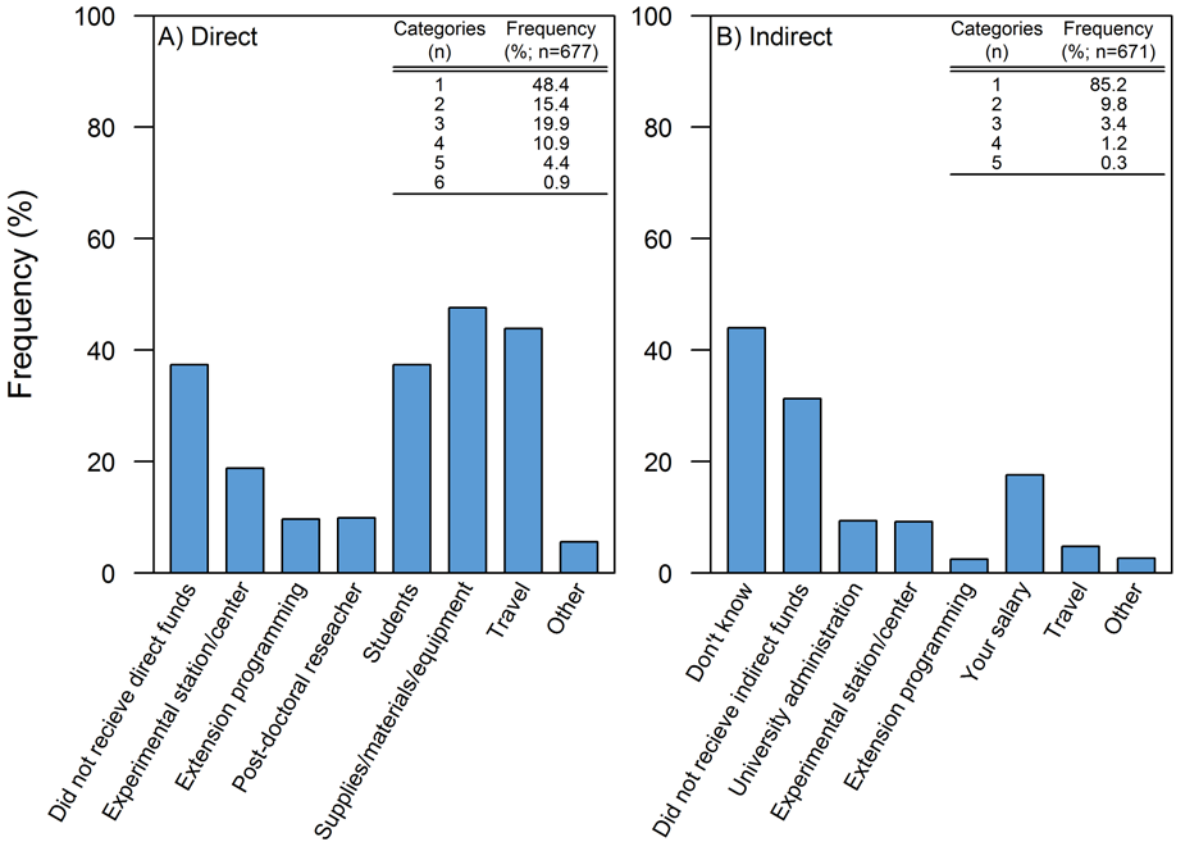

Figure 2. Capacity - A) Direct and B) indirect funds
Corresponds to A) closed Q4: Direct funds received (i.e., funds that you as the PD personally received to dispense) through this project were/will be used in the following categories (check all that apply):"and B) closed Q5 "Indirect funds received through this project were/will be used in the following categories (check all that apply):" Inset tables indicate the frequency of PDs to select ≥ 1 category.

Table 1. Capacity - Project goals completed with outside funds
Corresponds to closed Q7: "What approximate percentage of project goals were/will be completed with funding from other grants/sources?

Project Goals Completed	Frequency (%; n=521)
<25%	10.2
25-49%	15.0
50-74%	25.1
75-99%	32.8
100%	16.9

Table 2. Capacity - Grant application or funding process code frequencies and descriptions
Corresponds to open Q8: "Please provide any additional comments regarding the Capacity Grant application or funding process in the space below:" Codes ordered by frequency (n=161).

Code	Frequency (n)	Description	Examples
Fund allocation	60	Describes how formula funds are allocated (e.g., salary, travel, equipment, etc.)	*"Difficult to discount your own salary appropriately but really there is very little operational funding attached to this project."* *"At my institution all USDA regional project funds are dispersed through the agricultural experiment station."* *"Funds were used to travel to annual multistate project meeting."* *"Grant $ are being used to fund a PhD student (stipend), as well as an UG assistant and travel associated with the research."*
Required outside funds	33	Funding from outside sources required to do work	*"All of my projects require external grants."* *"Received funding from a commodity group to develop four videos and to help market the curriculum."* *"A very high percentage of project goals must be funded by other sources."*
No/not enough funding	24	Not enough funding to do the project/research	*"This is my Hatch project. I do not receive any direct funding in support of the research proposed in this project."* *"Some direct funds from NIFA is needed to ensure continuation of the research and to accomplish goals of the project."* *"A large grant was applied for once, but was not funded. No other funds were able to be obtained throughout the duration of the project, thus very little progress was made."*
Understanding	23	Lack of understanding of capacity funding, how it is allocated, and/or how it effects the PD	*"I don't have a clue where these funds go."* *"I really don't know how all the financial aspects work for these kinds of projects. I participate in this regional work group because of my commitment to agricultural research in irrigation management, but I am able to have a commitment to this research because I was hired in a college that valued the work. I assume the funding is all part of that."* *"This is the Evans Allen funds I receive, I do not consider them a capacity grant."*
Institutional requirement	19	Institution requires capacity funding grant/application	*"As I recall, it was required to develop a Hatch project proposal by all faculty with research appointment. The proposal was reviewed by external and internal peers before it was assigned a number. I was not required by the institution to submit this project proposal to apply for a grant or formula funding."* *"The operating dollars allocated through this mechanism provide the administrative mechanism to create a project with approved objectives . . ."* *"Although I was required to "write" and report on a hatch project, I was led to believe it covered only my salary."*

Code	Frequency (n)	Description	Examples
Research and career	19	Positive comments about how the funding was beneficial to PD's research program and/or career	*"The grant provides valuable funds that fill in gaps from other funding sources in achieving project goals."* *"Extremely valuable funding."* *"The capacity grant is the one that can keep my agronomy program going since the state funding for this is very limited."*
Leveraging ability	12	Able to leverage project for other funds or projects	*"The money is used as seed money and helps maintain low cost projects. The fund is very helpful in testing ideas and offering preliminary assessment as to the potential of the various projects."* *"Critical infrastructure support so that other funds can be acquired to complete programming."* *"These funds are also critical for attracting external funding from other sources."*
Instability	10	Funding lacks stability	*". . . it would be transformational to have a stable base research budget each year. Even if only in the $25,000 or less range, it would provide for a reliable source of funds every year."* *"The funding was hit or miss. Sometimes there was only money to travel to the project meeting, sometimes there were funds to support a graduate student during the summer. I do not feel this is an effective way to manage or fund a project."* *"Grant application has been unsuccessful, especially when our exp. station is far away or no long have livestock. I have decided not to take the money this year and going forward. Both the USDA and the university administration are a mess in administrating this. Why have an approved project when you do not approve $ even via formula funds? Why does USDA talk and encourage multi-discipline and multi-state and it ignores its own program."*
Miscellaneous	9	Miscellaneous	*"Our institution does not have an internal application process for capacity funds."* *"The funding allotted to each PI remains the same each project cycle regardless of changes in the objectives and project costs to actually carry out the work."*
Umbrella	8	Project described as overarching	*"At our institution, this project description serves as an umbrella under which all research activities are conducted."* *"Grants were written describing the type of research the PI wished to direct efforts towards."*
Competitive process	6	Institutional competitive grant process, includes panel reviews	*"This was a small McIntire-Stennis grant obtained through a competitive research grant process at my university."* *"Grant request were called for and evaluated and ranked (therefore competitive) by College level research committee, then awarded by rank until funding used up."*
Disproportionate effort	6	More effort in process and/or reporting compared to perceived gain	*"The process is very confusing because we do a lot of work for something that does not directly give us any money to actually complete the project."* *"The grants we get are very small, so only suitable for very limited exploratory research. However, there seem to be substantial expectations for deliverables."*

Code	Frequency (n)	Description	Examples
Lack of transparency	6	Lack of clarity on requirement or process (institutional or from NIFA)	*"The process of applying was confusing and I'm not sure I did things correctly (I was hired in the middle of departmental reorganization). I do not feel I understood what was going on or what was requested with this application and therefore probably did not do a very good job filling it out. This survey makes me feel better about it, at least it landed in a climate change section."* *"There is not a lot of clarity on how the application process works or the timeline for applications"*
Suggestions	6	Suggestions regarding funding or program	*"If other projects are funded from federal sources, they should be used to substitute the requirement for having a dedicated Hatch Project."* *"More funding opportunities are needed. I see many good scientists working hard to fund research and support graduate and undergraduate student researchers, but the funding sources have not been growing."*
None	5	No comments to leave	*"No comment."* *"None"*
Straightforward application process	4	Application process was clear	*"Application process has been streamlined recently. Big improvement."* *"The program provides a speedy and reliable process for securing research grants in a timely manner."*
Land grant mission	3	Contributes critical value to the land grant mission and addresses needs in the state	*"Federal formula funds are absolutely critical fulfilling the land grant mission. Without these funds, we would not be able to address the agriculture needs of this state."* *The research in the area is crucial for Alaska since a changing climate might allow Alaska grow cereals that not only secure the food supplies in the state but also supply food in the nation.*
Students	3	Project used to help train students	*"These funds have been invaluable to support graduate student research."* *"The funding is not used to support grad students but the activities that this funding provides is extremely important for maintaining a program that contributes to grad student education."*
Favoritism	1	Perceived favoritism or bias in the grant award process toward individuals or scientific areas	*"At the university level, deans and director for research do what they want. They channeled monies to their favorite faculties and for programs of their own interests."*
Institutional support	1	Institution provides assistance on grant/application process	*"There is excellent support for preparing the application.*
Time	1	Length of the grant too short	*"It is too short term, like many grants to do meaningful work on climate change or evolutionary processes when field work is part of the program."*
Not coded	14	Unclear, vague, or irrelevant	*"The project assists in educating small and limited wood land owners including high school the importance of Agroforestry practices such as forest farming, early cropping."* *"This was/is a regional research project involving many researchers at multiple institutions each of which received capacity funds."* *"Currently, we are looking data how much U.S. agricultural sales were made under export credits and historical data of default of importing countries. These types of data will enable us to estimate the additionally of U.S. export credits."*

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3.1.2 Project Summary

The majority of projects were categorized as "research" only (61.9%; Table 3). Of research oriented projects (i.e., those that indicated research in Q9), most (81.9%) projects were classified as "applied" (Figure 3). The dominant geographical focus was "farmland" (40%; Figure 4). The majority (51.2%) of respondents indicated their projects centered on a single geographical focus (inset table of Figure 4). The most frequent "other" geographical focus areas identified was coded as "broad" (i.e., cross-sectional or mixed) (Table 4). "Multi-state/multi-territory" geographical extent was the dominant extent for capacity projects (32.9%; Figure 5). A single extent was most (70.9%) frequently selected by PDs (inset table to Figure 5). Within the capacity project portfolio, work was being conducted in all states and territories, slightly favoring California (17.0%; Figures 6 and 7). Almost half (49.1%) of projects were conducted in a single state (inset table of Figure 6).

In terms of project teams, non-PD project scientists/professionals consisted primarily of "life scientists" (63.9%; Figure 8). The "other" scientists/professionals specified by PDs were coded and are included in Table 5. The average (median) number of PDs on a project was one and the number of PDs on a project ranged from 1-100 (n=663; Q15). The majority of co-PDs were located within the same university as the PD (63.6%; Figure 9). Co-PDs outside of universities and the government were in the minority; specified responses were coded and are included in Table 6. Most of the co-PDs were not from a minority serving institution (MSI) ("no"=75.0%, "yes"=13.2%, and "don't know"=11.8%; n=296; Q17). Additionally, most of the projects did not interact with MSIs ("no"=78.0%, "yes"=22.0%, and "don't know"=0%; n=501; Q18).

The project goals for most of the projects did not change over the course of the project ("no"=86.1% and "yes"=13.9%; n=655; Q19). For the projects that did modify project goals, it was predominantly (n=16) due to knowledge gained during the project that required the goals to evolve (Table 7).

The majority of projects generated datasets and made the datasets public (78.7% and 64.9%, respectively). Most projects did not access privileged datasets and those that did, did not make them available after use (91.6% and 56.5%, respectively). Half (50.2%) of projects did not use data created by other NIFA funded projects (Table 8).

Projects were unlikely (42.1%) to interact with multi-state Hatch projects but were likely (40.5%) to interact with other USDA funded initiatives (Table 9).

Table 3. Capacity - Project type
Corresponds to closed Q9: "Please specify the project type:"

Project Type	Frequency (%; n=666)
Education	0.2
Extension	2.0
Research	61.9
Education and Extension	1.1
Education and Research	9.3
Extension and Research	13.8
Education, Extension, and Research	11.9

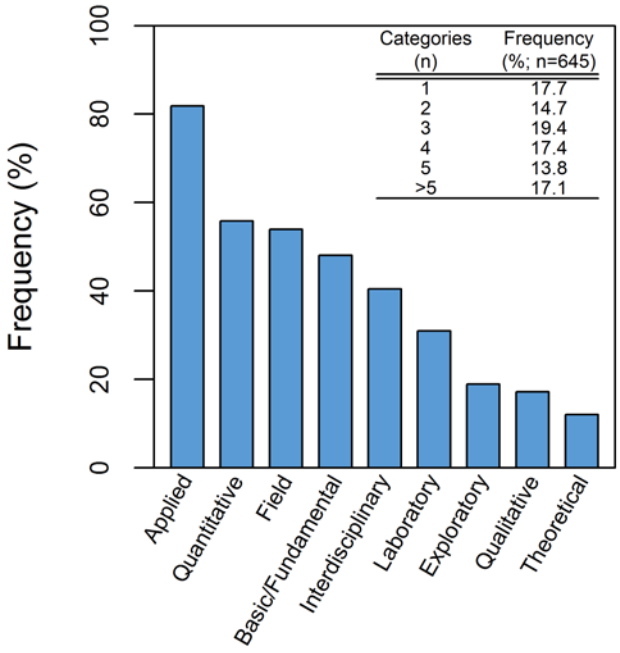

Figure 3. Capacity - Research classification
Corresponds to closed Q10: "How would you classify this project's research (check all that apply)?"

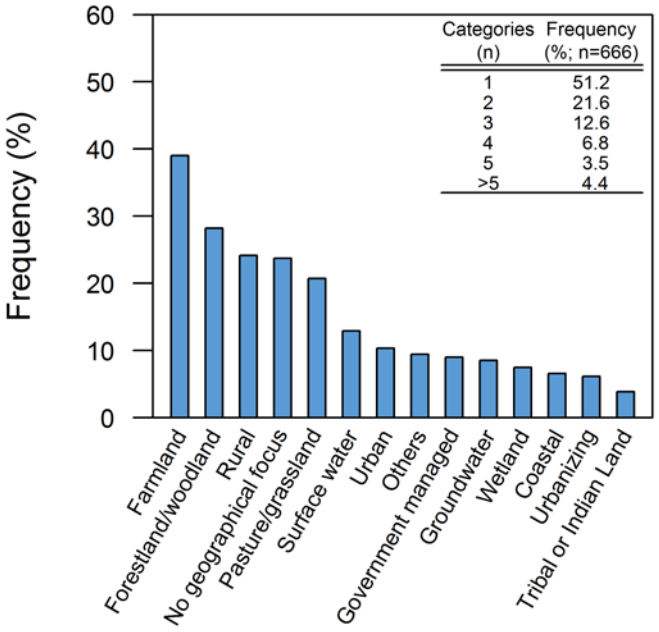

Figure 4. Capacity - Geographical focus areas
Corresponds to closed Q11: "Please indicate the geographical focus feature/area of the project (check all that apply):"

Table 4. Capacity - Geographical focus areas open response codes
Corresponds to open portion of Q11 (n=63[a]): "Please indicate the geographical focus feature/area of the project (check all that apply):"

Code	Frequency (n)
Broad (i.e., cross-sectional, mixed, not specific to any one feature)	19
Climate-specific (e.g., drylands, tropics)	6
Greenhouse/nursery	2
Mines	3
Rangeland	6
Riparian	1
Residential	2
Shrubland	8
Suburban	2
Miscellaneous[b]	3
Not specified	2
Not coded[c]	11

[a] Respondents indicated >1 "other" codes, which is included in the frequency table resulting in an n greater than the n of respondents.
[b] Miscellaneous focus areas include land not suitable for crops, lawns, sod farms, athletic fields.
[c] Response irrelevant or vague.

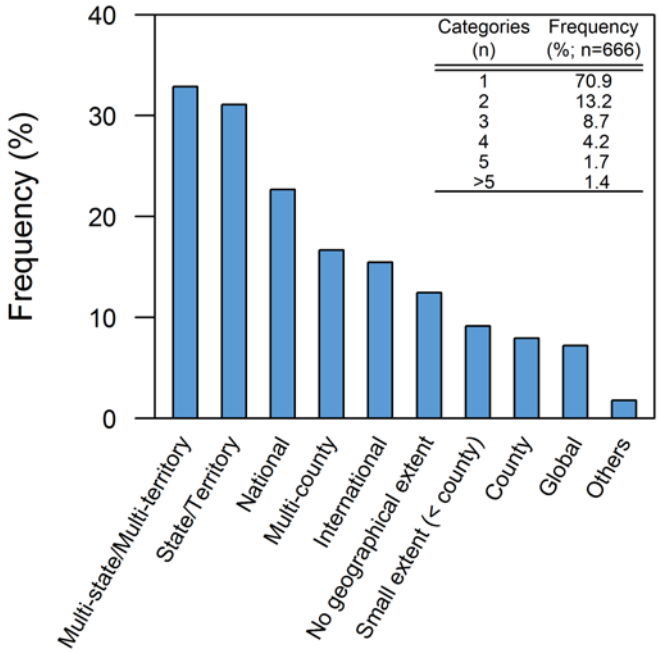

Figure 5. Capacity - Geographical extent
Corresponds to closed Q12: "Please indicate the geographical extent of your project (check all that apply):" Other responses include not coded (n=11) responses due to being either irrelevant or vague and a non-specified response.

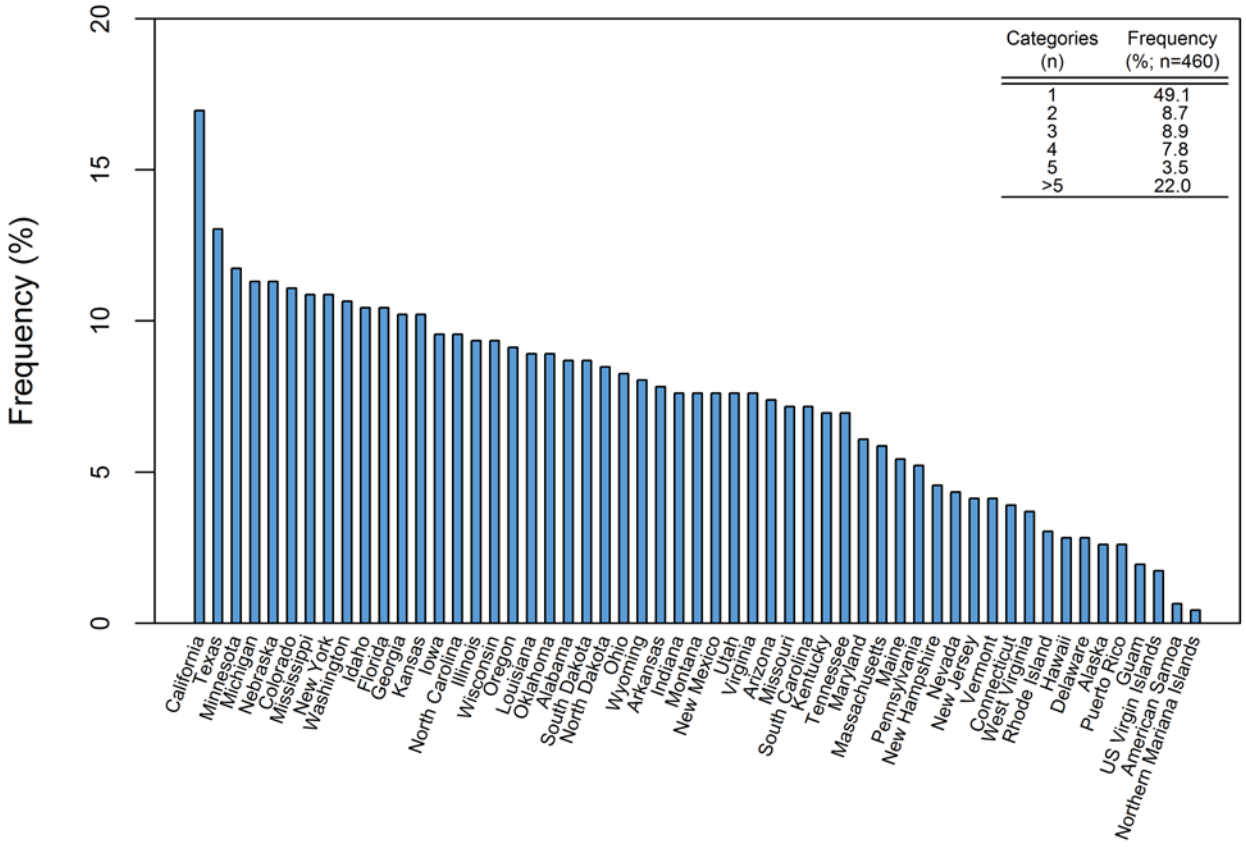

Figure 6. Capacity - States/Territories
Corresponds to closed Q13: "Please identify the state(s)/territory(-ies) included in the project's geographical extent (check all that apply):"

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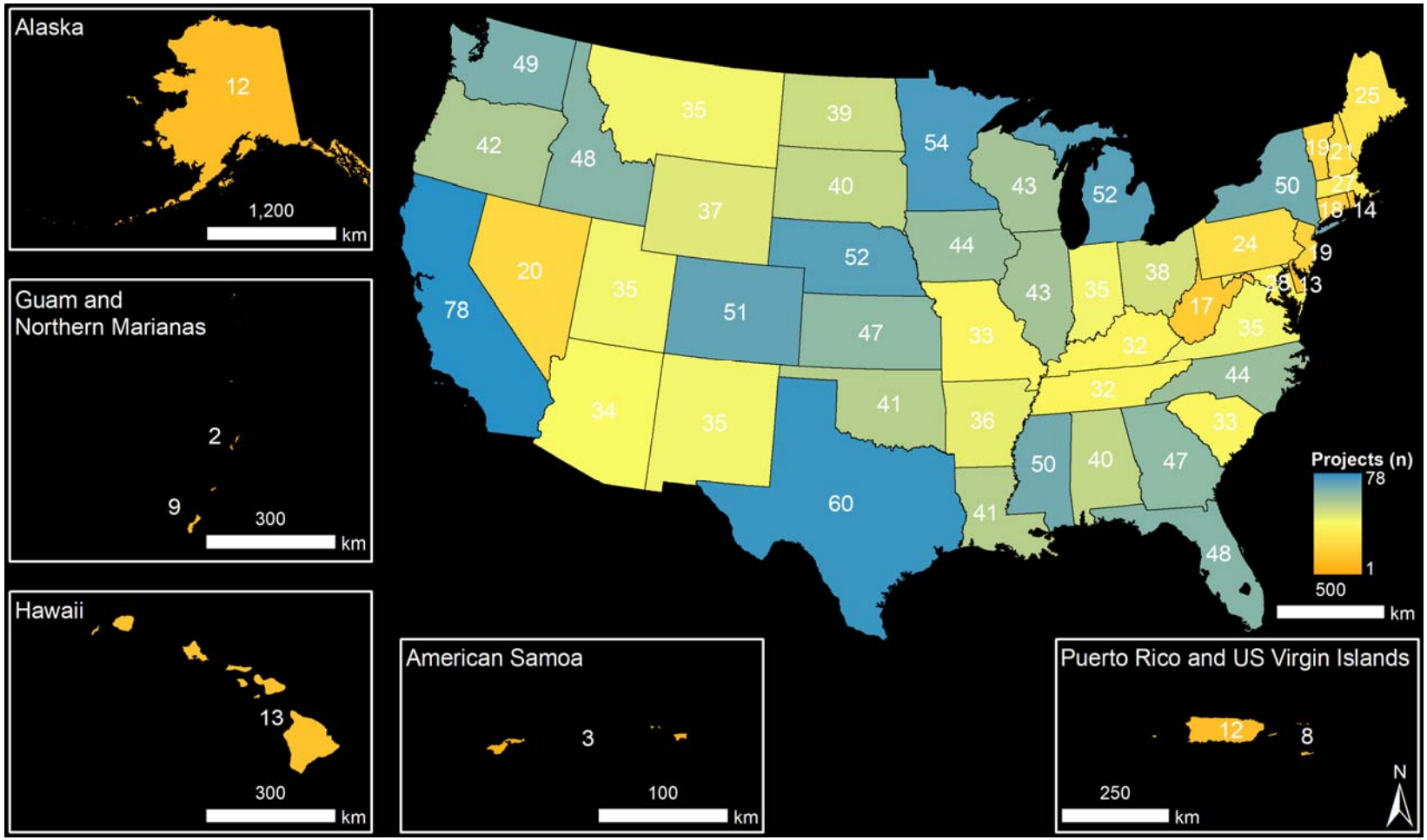

Figure 7. Capacity - States/Territories map
Corresponds to closed Q13: "Please identify the state(s)/territory(-ies) included in the project's geographical extent (check all that apply)."

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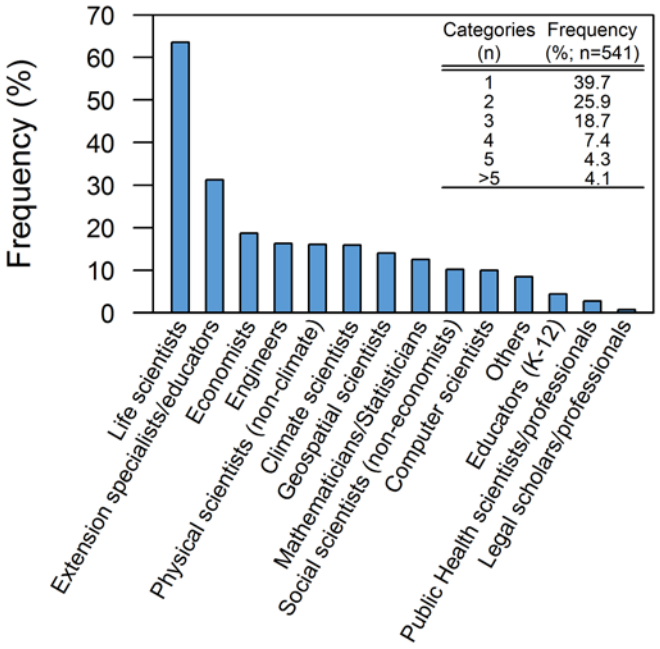

Figure 8. Capacity - Project personnel (non-PD)
Corresponds to closed Q14: "Excluding yourself as the PD, indicate the types of scientists/professionals included as part of the project team (i.e., funded by the project) (check all that apply):"

Table 5. Capacity - Project personnel (non-PD) open response codes
Corresponds to open portion of Q14 (n=46): "Excluding yourself as the PD, indicate the types of scientists/professionals included as part of the project team (i.e., funded by the project) (check all that apply):"

Code	Frequency (n)
Agriculturists	4
Business/industry professionals	2
None (i.e., no other personnel)	19
Soil scientists	5
Miscellaneous[a]	4
Not specified	2
Not coded[b]	10

[a] Miscellaneous scientists/professionals includes art/humanities, CERT trainer geographers, technology specialist.
[b] Response irrelevant or vague.

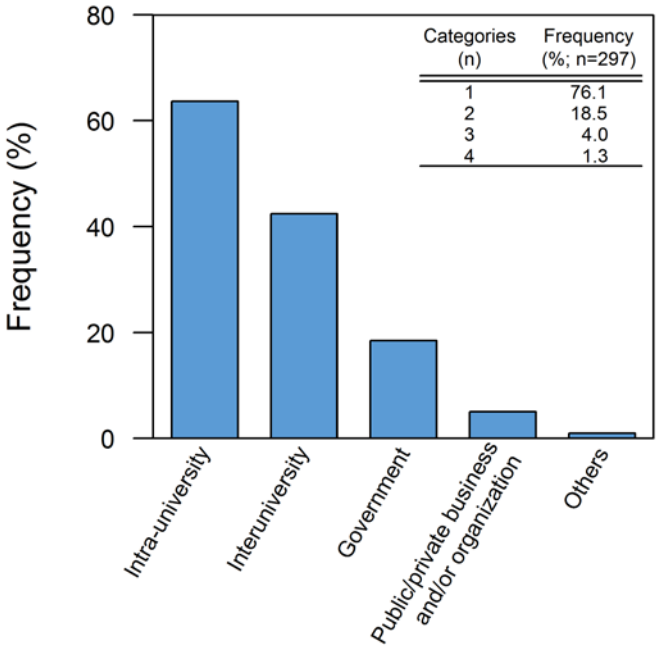

Figure 9. Capacity - Co-PD locations
Corresponds to closed Q16: "Please indicate where the co-PDs were located when this project was funded (check all that apply):"

Table 6. Capacity - Co-PD locations open response codes
Corresponds to open portion of Q16 (n=18[a]): "Please indicate where the co-PDs were located when this project was funded (check all that apply):"

Code	Frequency (n)
Public/private business and/or organization	
Agribusiness	1
Conservation	2
Business	1
Farmer/producers/ranchers	1
Research	3
Miscellaneous[b]	1
Not specified	5
Not coded[c]	1
Other	
International	2
Not coded[c]	2

[a] Respondents indicated >1 "other" codes, which is included in the frequency table resulting in an n greater than the n of respondents.
[b] Miscellaneous includes banks.
c Response irrelevant or vague.

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Table 7. Capacity - Rationale for project goal modification code frequencies and descriptions
Corresponds to open portion of Q19: "Have the project goal(s) changed over the course of the project? Yes (please explain how and why):" Codes ordered by frequency (n=91); respondents indicated >1 codes, which is included in the frequency table resulting in an n greater than the n of respondents.

Code	Frequency (n)	Description	Examples
Evolution	16	Knowledge gained during project required project to evolve	*"As we gained more knowledge we adjusted goals accordingly."* *"The goals were modified to adjust to what was learned during the project."* *"Original goals are in place but specific aims have changed to address findings."*
Emphasis changed	15	Altered emphasis	*"Moved from more basic ecophysiology to applied research. Also moved a portion of the work into bioenergy."* *"Oriented more toward grain yield responses in later years."* *"Initially more study of dairy and beef forage systems has evolved to focus much more on the environment"*
Expanded scope	9	Scope of work increased	*"Addition of genomic analysis."* *"They have broadened to look at climate change planning for various aspects of forest management, including fire, and beyond the original focus on planning alone."*
Funding limitations	9	Lack of funding	*"Some areas of the project were dropped because funding was too limited. Outside funds were required and those often dictated what original goals could be addressed."* *"Reduced goals due to limited funding."*
Unanticipated event/barrier	9	Reacted due to unexpected event or barrier	*"We eliminated one study under objective 4 because the research was vandalized and there were no funds to repeat the experiment."* *"Changed recently due to the "opportunities" presented when a wildfire burned several of our research pastures."*
Adapt	7	Project adapted due to outside influence(s)	*"To remain current with contemporary agroecology questions."* *"I respond to the demands of my industry."*
Personnel change	7	Project team member departed/replaced	*"Over the 5-year span, various PDs were no longer involved, others added, and this reduced our effectiveness in addressing some of the original goals."* *"One of the participants moved institutions, which eliminated the aboveground vegetation surveys that were originally proposed."*
Feasibility	6	Scope of work not feasible as planned	*"We found that our original plan was flawed and had to redesign our proposed construct. When we did, it was successful and became useful for additional plant species."* *"One objective was substituted with another one due to changes in the available resources."*
Requirement	3	Required to change by NIFA or institution	*"The project is revised and renewed every 5 years as required."* *"NIFA forced me to change the goals."*
Geographical scope	2	Location of work	*"The scope of work expanded into other regions."* *"Expanded beyond Colorado to investigate watershed investment programs in California and Idaho for comparison."*

Code	Frequency (n)	Description	Examples
Miscellaneous	3	Project specific detail	*"We are measuring aerosols differently than originally intended. . ."* *"Resveratrol was replaced with alpha lipoic acid and benfotiamine."*
Not specified	10	No response provided	*NA*
Not coded	4	Vague or irrelevant	*"My multi-state project has broad goals, and I adapt my plan of work within these goals."* *"I have left the institution, so if someone else picked up my Hatch then probably."*

Table 8. Capacity - Dataset generation and use

Question	Respondents	Frequency (%)		
	(n)	No	Yes	Don't know
Did/Will the project generate datasets? (Q20)	657	13.7	78.7	7.6
Were/Will the datasets made/be made publicly available? (Q21)	515	17.5	64.9	17.7
Did/Will the project access privileged datasets (i.e., restricted/proprietary data)? (Q22)	562	91.6	8.4	0
Were/Will the privileged datasets made/be made accessible to the public? (Q23)	46	56.5	15.2	28.3
Did/Will the project use data created by other NIFA funded projects? (Q24)	655	50.2	24.7	25.0

Table 9. Capacity - Project interaction with other USDA projects

Question	Respondents	Frequency (%)		
	(n)	No	Yes	Don't know
Did/Will the project interact (i.e., share resources, ideas, or data, meeting attendance, and/or collaborate) with multi-state Hatch projects? (Q25)	573	42.1	35.8	22.2
Did/Will the project interact (i.e., share resources, ideas, or data, meeting attendance, and/or collaborate) with other USDA-NIFA or USDA funded initiatives that were not multi-state Hatch projects (e.g., CAP projects, climate hubs, etc.)? (Q26)	657	31.2	40.5	28.3

3.1.3 Project Success

The survey requested PDs to reflect on project success in a series of open questions. The PD responses regarding how their project was successful resulted in the development of 31 codes (Table 10). The majority (n=186) of PDs identified their project success was due to "knowledge gained" followed by "publications" (n=142). For what could have made their projects more successful, their responses resulted in 26 codes; the most common code identified was additional funding (n=148; Table 11).

Most (72.3%) of the PDs indicated that they evaluated project success (n=632; Q29). Project evaluations were primarily conducted annually (71.1%; Figure 10). Specified other times projects were evaluated are presented in Table 12. Nearly all (96.9%) of PDs indicated that they assessed the completion of objectives (Figure 11). Other elements assessed by PDs are presented in Table 13. Most (78.3%) projects were evaluated by assessing the number of publications; however, few (7.8%) projects were only evaluated by one method (Figure 12). Other methods used to evaluate project success are presented in Table 14.

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Table 10. Capacity - How projects were successful code frequencies and descriptions
Corresponds to open Q27: " Please tell us, in your opinion, how this project was successful to date:" Codes ordered by frequency (n=545).

Code	Frequency (n)	Description	Examples
Knowledge gained	186	Scientific knowledge gained, expand knowledge	*"Able to develop effective livestock/climate models, which predict effect of climate on livestock production."* *"We generated new mechanisms as to how carbon is sequestered or emitted from soil. We developed new techniques and models for quantifying these changes."* *"The project was successful due to data collection across the landscape."* *"We have collected accessions from >25 sites along replicate elevation gradients, and have obtained evidence for climate-related genetic differentiation in important life history traits in common garden experiments."* *"Collection of large amount of data covering a wide variety of weather conditions."*
Publications	142	Project led to research publications includes presentations	*"We were able to generate nearly 100 refereed journal articles that improved our understanding of the basic ecology and management of rangeland and grassland systems that have become dominated with invasive shrubs."* *"My students, colleagues and I have published multiple peer-reviewed articles (average 3-4 per year), made scientific and public presentations (averaged 10+ per year)."* *"Several journal articles have materialized as a result of the research conducted under this project."* *"Eight manuscripts were published during the term of this project."* *"Published more than one paper per year."*
Students	98	Undergraduate/graduate students were involved and/or funded includes educational curriculum developed, and training of students and post-docs	*"This project has trained 2 graduate students, 2 postdoctoral researchers, and 2 undergraduate students."* *"Provide unique educational and research opportunities for a graduate student"* *"Students have been hired and involved and trained in research."* *"Help teachers meet education standards for 6-8th grade students in science, technology, engineering, math, geography, history, nutrition, health, and agriculture."*
Collaboration	82	Beneficial partnerships, relationships, or interactions established/ developed includes reciprocal data sharing	*"Collaborative work between multiple universities that involved people with different strengths."* *"The project was a success because it brought together many institutions and scientists from a diversity of disciplines who met together annually."* *"The three PIs overlap on the "biogeochemistry" of agricultural systems. We bring different skills to a common space, and we are willing to explore new ideas. The ideas are there, the energy is there, so it is self sustained. In short, a good team."* *"The members of this group are, and have been for a long time, working on many practical aspects of micro-irrigation management. The project has been successful because the group is formed of a diverse set of engineers, horticulturists, faculty, and extension personnel, who get together annually to discuss their work and their perspective in the issues in detail. The discussions broaden the perspective of all the participants, which is of value."*

Code	Frequency (n)	Description	Examples
Met objectives	65	Project goals accomplished	*"The project was successful to the extent that it successfully addressed the issues it was set to address in the original proposal."* *"Specific objectives have been accomplished."* *"The project, so far, is running successfully. All the experiments are current in progress as normal."* *"At the individual institutional level, the investigators are engaged in research as outlined in the proposal. It is successful in the sense that there are concerted efforts to answer the science questions."*
Stakeholder engagement	63	Project engagement with stakeholders and/or extension includes sharing results with stakeholders (can include researchers)	*"Lots of support by stakeholders. Research is based on needs of stakeholders."* *"We have done a good job in developing a stakeholder base interacting with farmers and extension specialists who will be critical in helping us find field sites to do our research at."* *"This project has been successful because it has allowed me to interact with producers throughout the state."* *"Research results have been communicated to audiences through field days, meeting presentations and scientific poster presentations."*
Foundational	59	Provides a "foundation" for further research, preliminary research, provides guidance, generated results that can/should be applied	*"The project established for the first time that groundwater quality in irrigated basins is not sustainable owing to agricultural land and water management practices. The project in turn identified land and water management strategies to minimize or reverse the degradation in water quality. These are being further investigated through modeling and field studies now."* *"Generating a valuable long-term dataset that can, and has been, used to answer a variety of questions."* *"We were the first to demonstrate differences in the GI tract concentration of enrofloxacin based on dosing schedule and associate those differences with changes in the microbiome and fecal bacteria."* *"The preliminary data currently collected as part of this Hatch project has provided important foundation for us…"*
Sustained outcomes	49	Project led to increased awareness, commercially available product, change in behavior, stakeholder adoption	*"Project resulted in some new products that improve welfare which are now being marketed to and adopted by farmers."* *"Has provided stakeholders with preliminary data to develop timely management recommendations."* *"Ideas generated and confirmed in this project have been adopted by other projects."*
Leveraging capability	43	Ability of project to be leveraged for either new funds or research	*"The ideas and preliminary results obtained from this project enabled us to develop competitive, successful proposals for additional research."* *"This project has provided baseline/preliminary data that has been critical for garnering research funding from other sources."* *"New funding have been obtained from public and private entities for further development and commercialization."*

Code	Frequency (n)	Description	Examples
Usefulness	36	Results are perceived by the PD as useful to scientific or stakeholder communities; includes publications being cited	*"It is purely driven by the critical needs in the region, and was useful from the moment it was started."* *"The project provides research questions relevant for stakeholders."* *"This project explicitly addresses three priority areas of international, national and regional significance to improving potato as a staple crop."*
Outside funding	27	Outside funds were necessary	*"Through additional funding, mostly from NSF, it is able to train students, develop publications, provide outreach as scientific and public talks, and inform policy-makers."* *"This project has been very successful due to success with extramural grants. This was made more difficult since many USDA grants exclude ornamental plant production and ornamental landscape pest management. If not for external grants nothing could have been done because apart from my salary I do not get funds to achieve extension or research goals from my university."* *"Very successful, mainly due to funding outside the Mac-Stennis framework."*
Develop or sustain research site, center, program, or project	26	Develop, establish, sustain, and/or maintain a center, program, project, site, or station	*"The funds provided by this project are being used to fund a long-term study on the effects of crop residue removal for purposes such as biofuel on subsequent crop yields and how this might affect soil resources. Having the funds to do such long-term research is critical, as some of the soil properties will respond slowly over time. A three-year project, for example, would not be an adequate amount of time to do such a project. My project has completed its 8th year now, and is going to produce an excellent data set that I can put together with the other collaborators on this multi-state project, and this will be useful in decision-making by both farmers and policy makers when considering using crop residues as a feedstock for biofuels. It is imperative that we understand if using crop residues is truly a renewable fuel feedstock or not, if it leads to soil degradation in the long term."* *"I have set up and established a working population of bees and have done what I can as an individual."* *"The project has established a long-term baseline air quality monitoring site on a coast range mountain top site that can monitor the changing atmospheric composition in the background air that constitutes California's (and North America's) air quality. This is a critical measurement that was impossible to get funded by the federal agencies that often oversee such efforts (e.g., NOAA), but that has been lauded by many scientists as an important component to understanding global atmospheric chemistry changes."*
Policy	19	Project led to a policy change includes guideline and inventory equation(s), BMPs, developing policy changes, talking with policymakers	*"Most recent success and perhaps most important success: work accomplished under this project enabled us to provide the USDA with a White Paper on [topic], a major regulatory issue facing U.S. [name] agricultural shippers. This White Paper was subsequently submitted by the USDA as its formal regulatory filing with the [board name]. Research conducted under this project facilitated the economic analysis used in the filing."* *"The project supported efforts to conduct research and inform policy makers and the public on issues related to agricultural and biofuel policies. The work was widely used in policy debates in Congress, at USDA, EPA and at international institutions."* *"The insights gained from my data analysis have been directly shared with policymakers at the U.S. Department of Energy and the California Energy Commission."*

Code	Frequency (n)	Description	Examples
Positive reception	18	Community (either scientific or stakeholders) view the results/publications positively; community acceptance includes news coverage	*"Our work in local agriculture has also drawn attention from the agricultural and policy communities."* *"The citations of these articles have been increasing steadily and the popular articles published based on this research received wide attention by the researchers, stakeholders and policy makers"* *"The work to experimentally quantify the contribution of long range air pollution (most directly ozone) to the air quality problems of California has received a lot of national and international attention (through traditional news media - radio and newspaper outlets)…"*
Ongoing	13	Project ongoing and respondents indicated too early to judge project success	*"Not finished yet so too soon to tell."* *"The project in in process. I can't gauge the success at this time."* *"It is in the early stages, of exploratory data analysis, and the PhD student is refining a proposal."*
Broad application	11	Large application or potential application of results	*"Project efforts have contributed to many successful outcomes across the multi-states."* *"The knowledge generated from this project has helped seed industry and producers in developing new crop genetics and crop management strategies."* *"Generated applied field information which could be quickly implemented into management changes."*
Integration of pre-existing projects/interests	11	Developed broadly to incorporate multiple PD interests, integration of pre-existing projects or data	*"The project was successful because the project was designed around research that the PIs were currently doing and had other funding to support the work."* *"This is a hatch project written to encompass my entire research program."* *"The project was formula-funded, so much of the success was dependent on careful writing of the proposal to serve as an umbrella for the somewhat diverse activities of the project."*
None	9	No success to report	*"This project is nothing more than a reporting vehicle."* *"In my opinion, this project is a total failure in [state], because we do not receive any funds to support doing the work. [university name] gets funds, but it uses them for its own purposes and does not give any to me except for one travel reimbursement each year for the annual [name] meeting. This means we have to rely on getting other grants to conduct the work. This has, to date, not been successful because we don't even have a financial means for collecting relevant preliminary data for a grant proposal. For what it is worth, my colleagues on many other [name] projects tell me the same thing happens at their institutions. Their universities assign them to projects but do not give them the money."*
Project management	9	Management of tasks, within budget, on time	*"Make good plan and project management."* *"Relentless focus on quality and core goals."*
Mission	6	Established a mission for PD	*"It compelled me to develop and execute a long-range research program that met the mission of the agricultural experiment station at my institution, and required me at five year intervals to review progress and impacts and revise and resubmit a new program plan. This is valuable for all research scientists, especially new ones."* *"This project was successful by: 1. Moving the PD into more applied areas and less well studied crops (particularly forage grasses)… "*

Code	Frequency (n)	Description	Examples
Minorities	5	Employing and/or training minorities	*"Additionally, we've involved and trained multiple undergraduate students including URM students (under-represented and/or minority students)."* *"Numerous students have been trained, including several minority students."*
Recognition	4	Awards or new program recognition	*"The project historically has been quite successful as evidenced by it receiving National Award of Excellence in Multistate Research in [year] under its previous name [name]."* *"Awarded highest state honor for environmental work. State declared a Senate proclamation thanking us for this work."*
Job placement	3	Student or project personnel acquired relevant jobs	*"We have also supported through internships up to 5-10 undergraduates, nearly all who have gone on to find employment in the field of their choice."* *"We have also placed some of our graduate students and field technicians in academic, non-profit, and government-based agencies focused on management of Midwestern grasslands and Species of Greatest Conservation need.*
Lessons learned	3	Knowledge or understanding gained by experience that has a significant impact; experience may be either positive or negative.	*"We have identified some of the issues related to end users of this technology and related software and are working to come up with guidance."* *"The project itself revealed a fundamental problem in the experimental design that once it was appreciated, was addressed and became useful for follow-up projects."*
PD professional development	3	Learned/developed new skills	*"The project was very successful as I achieved a lot of professional development and readiness to carry out whole genome projects and perform upstream and downstream bioinformatics analysis."* *"Also, as older scientists reach retiring age, they are able to pass on the wisdom and momentum of this project to new scientists."*
Adapting	2	Flexibility to adapt to changing needs	*"We also respond to new challenges such as new diseases or new markets."* *"Harsh winters have helped make this ID more rigorous and emphasize need for understanding climate extremes."*
Overcame obstacles	2	Troubleshooting capability	*'Because both technologies were new, there was a considerable amount of trouble shooting."* *"We are now defining ways/objectives to overcome some of those limitations."*
Extended scope	1	Ability to expand project to a larger area (either geographically or disciplinarily)	*"We also expanded the focus to range from fundamental fluid dynamics to assessment of variables of direct interest to Agricultural production."*
Personnel staffing	1	Hiring of post docs and/or research staff	*"…supported staff…"*

Code	Frequency (n)	Description	Examples
Miscellaneous	11	Miscellaneous project specific activities and/or interactions	*"Restored over 700 acres of tidal marsh, reconnected over 5 miles of tidal network."* *"It was great that I could work on a topic I really love without the hassle of obtaining a highly coveted grant such as from NSF."* *"Preliminary data collected prior to creating and submitting the project was positive/encouraging."*
Not coded	27	Irrelevant or vague	*"It is successful with limited funds."* *"So far so good."* *"The project has been very successful."*

Table 11. Capacity - How projects could be more successful code frequencies and descriptions
Corresponds to open Q28: " Please tell us, in your opinion, how this project could have been more successful to date:" Codes ordered by frequency (n=481).

Code	Frequency (n)	Description	Examples
Funding - higher	148	Additional funding	*"The project, like most Hatch projects, was grossly underfunded. Underfunded from both the federal, state and local industry sponsorship support. Researchers and Extension Educators always need more money and access to qualified technical support at affordable wage/salary level or having access to enough funds to pay the going rate of qualified technical support. In short, more funding was needed from federal, state and local sources. It is a reoccurring theme over the decades."* *"Higher level of funding."* *"Funds were bare minimal in allocation that is not sufficient for even a quarter-time student."* *"It was pretty successful, other than the usual 'more funding' I don't think things could have gone better."* *"We are limited to a cap of $8000 per year in our unit, and there isn't much one can do with that... it is just enough to cover a summer hourly grad student and travel for that grad student to a conference to present their work."*
Expansion	63	Increased/broadened project to include or expand project element (e.g., outreach, scale, tools used, scope, participants, project team personnel, and/or evaluation)	*"Many of the issues studied are applicable to the entire Appalachian region but much of the science was conducted within West Virginia. More collaborations throughout the region would have been beneficial for broader impact."* *"Access to statistical expertise would facilitate analysis and publication of results. Relying on statistical expertise at other institutions slows this process."* *"Include more field experiments.* *"This project would have been more successful if 1) We had planned for more than one workshop, instead of trying to meet our goal of participants having 1 training session with a large group of participants…."*
Funding - PD allocation	63	Funds to be spent at the PD discretion without restrictions	*"The absence of direct funding inhibits closer collaborations with other research scientists both within and outside of the project. The lack of direct funding also limits the capacity to collect data, provide student training and support, methodology development, and disseminate findings and outcomes."* *"The experiment stations directors should allocate something for the coPD of this project. We get nothing but travel. Many members don't even get travel to the annual meeting. It is a sad state of affairs. I have heard NIFA allocates large amounts of $$ to these projects --well -the rain doesn't reach us in the USDA jungle. We can do much more with a little $$ --just a little."* *"Many individuals on this project at different institutions never received any funding from their institution to conduct research. As a result, collaborative work across institutions to explore new ideas received little financial support."* *"I wish it would provide funding. It is hard as a starting assistant professor to come up with a 5-year hatch project and to ensure achievement of goals and objectives, particularly if no funding can be obtained for those goals."*

Code	Frequency (n)	Description	Examples
Staff	58	Additional staff (not Extension) to complete project work which includes students	*"This could have been more successful by hiring a graduate student to help with the work."* *"If more students can be hired, the progress can be bigger."* *"Have limited personnel at our university to help us design video clips, and edit the instructor manual. This has delayed marketing the curriculum and limited its access."* *"The hiring of the postdoctoral associate has been slowed down by a lack of qualified candidates due to stiff competition for talent. This component of the implementation schedule is lagging."*
None	50	No change would have helped the project be more successful	*"It has achieved the success I had hoped for."* *"Considering fiscal constraints, I don't know that it could have been more successful."* *"The project is doing well and is well supported."*
Barriers	39	Barriers related to conducting tasks such as politics, natural phenomenon, mandated work, etc.	*"Weather has been a significant factor in field work. Research conducted in 2015 & 2016 was subject to severe drought and excessive rainfall."* *"The drop out recovery high school population is a challenging group to work with. We discovered that literacy is a huge problem among the 332 students enrolled at this implementation site. The average student reads at a 2nd grade level --only 6% of students tested reading at the eighth grade level or above. We had to make major adjustment to our curriculum development and delivery based on this fact."* *"The project could have a greater impact if development of the biofuel industry had not stalled during the life of the project. In the initial years of the project we were sharing our findings with emerging biofuel companies interested in investing within the study region, but as the energy market underwent great changes from the collapse of fossil fuel prices and reduced public investment in biofuels we had fewer opportunities to interact with private industry."*
Project management	32	Increased and/or improved project management, study design, and/or preparation	*"The group has struggled with on-going coordination of research activities and outputs."* *"Could have addressed the broader questions originally laid out in proposal."* *"This project could have been more successful if the scope of the project was somewhat narrower to allow the PD more time and focus on specific research topics that would have the greatest impacts."*
Collaboration	29	Improved partnerships, relationships or interactions with others in the project team, including continued collaboration	*"We had some attrition of interest among initial participants. Not sure why that was, but efforts to maintain interest in such projects is important."* *"More communication between PIs, have the annual meeting on different dates."* *"The project would be more successful if there were more products from the project that were collaborations among a majority of the project team members."*
Support	21	Increased support from scientists, extension, stakeholders, industry, institution, and/or USDA	*"Greater interest in the scientific community regarding the effects of climate change on livestock."* *"It is a good project but it lacks support from USDA and local university administration."* *"If tick-borne diseases in the central Midwest were a priority."*

Code	Frequency (n)	Description	Examples
Additional resources	19	More resources required, does not include what specific resources are needed	*"Greater resources could have accelerated progress and be used to drawn conclusion that could be used in other regions of the country or on other crops."* *"Additional resources for more extensive model development and for outreach and extension would have helped to extend research impacts."* *"With additional resources we would be able to promote this project more widely, provide more instruction, ensure even better data quality than we already strive to maintain and use the data, often in conjunction with user communities, more frequently in a wide variety of studies."*
Funding - stable	17	Funding consistency	*"This project has been hampered by lack of consistent funding. Most of the work was funded indirectly by obtaining funds for doing more directly applied projects for industry and then using some of the funding to advance the goals of this project. I was fortunate however because when I started my career I had Hatch formula-funded technicians who had vast experience in working with perennial cropping systems. This consistent funding allowed for the planning and execution of long-term projects on perennial crops. This consistent funding stream dried up in the 80's and all work after that was done on short term 1-3 year grants."* *"Uncertainty within federal and state budgets have dampened scope that faculty wish to extend themselves."* *"Project was dependent on grant funding from public and private sources outside of University setting. Periodic interruptions in funding made recruitment and retention of graduate students and technical support personnel difficult."*
Publications	17	Increase in publications	*"This project is only now starting to produce manuscripts for publication in peer-reviewed manuscripts."* *"More quickly publishing data."* *"There are a few components of the research that have not yet been published in peer-reviewed literature. Although these data can be made available on request, publication makes a broader audience aware of the availability of this research."*
Time management	15	Not enough time in day to complete work, administrative duties take too much time away from project goals	*"Much of the PIs time is devoted to writing proposals and the administration of proposals and field sites. More of that time spent on science and with students would yield greater ROI."* *"If I had 48 hours in a day."* *"Time consuming because of data needs and multiple facets."*
Increased leveraging capability	14	Project needs to result in additional projects and acquiring additional grants, follow-up proposal funded	*"Had we secured other funds we could have made more success."* *"Proposals based on the project results need to be developed."* *"Since last four years, I have applied to the NIFA program (Agriculture and Food Research Initiative) based on this project outcome, but never got funded, meaning that no further breakthrough progress has been made."*

Code	Frequency (n)	Description	Examples
Funding	11	Funding issue, broadly or no specific detail included	*"Funding is always key to success of any project, and is always the glue that holds together collaborations."* *"It is difficult to attribute the successes towards the project goals to this particular project, given that there was no money associated with it. The project goals, from my perspective as PI, were met using grant funds. I gather that the existence of the project made various Experiment Station administrative operations more effective."* *"1. Funds are difficult to carry over. 2. Funds, as they are currently dispensed for an RA position, are worse than a TA position at [university] for the students financially. 3. Matching funds are difficult to allocate appropriately. 4. Overall university costs are increasing (student tuition and RA ships) so that the available funds through the NIFA program do not go as far as they used to."*
NIFA constraints	10	Programmatic/funding agency barriers/ imitations/restrictions includes the type of project not being funded by NIFA	*"This current climate and practice of short-term grants is a disaster for engaging young scientists in long term tree crop research (you can't plant trees at the beginning of a three year grant and conduct any meaningful research about mature tree functioning in the term of a three-year grant."* *"Needs a funding program directed specifically and native plant development and urban water conservation."* *"Need direct contact with the USDA personnel to assist with what types of data existed or restricted/confidential."*
Personnel change	10	Project team member died, fell sick, retired, or transferred jobs causing setbacks to project goals and outcomes	*"Staffing changes created some minor changes of timeline from anticipated project goals."* *"Unfortunately, some of the PDs were not gaining meaningful acknowledgement or funds to support their involvement (USDA-ARS employees) and as the main lead on directing the ideas in the project, they pulled away, leaving the other contributing PDs at a loss."* *"We lost a key collaborator and source of data just before the project started and have been slowed down because of that, but have been able to find other collaborators to fill that gap."*
Stakeholder engagement	9	Additional participation by stakeholders	*"Getting new information to the users is always a challenge as well as getting feedback from potential stake-holders."* *"I wish more folks would have responded to our survey requests."*
Impact	7	Broader impact and adoption of project results/outcomes	*"Greater networking nationally to share results and disseminate information would be helpful. However, I think we have done an excellent job working on this independently. In general, however, we lack easy means to coordinate nationally on such efforts."* *"The challenge with environmental social science is that we often find out what people are doing and why, but we're less successful in getting traction for ideas about how to change what people are doing."*
Funding - long-term	6	Longer-term funding	*"The project needed to be funded for multiple years."* *"The dedicated funding for further years would be very useful."*
Ongoing	6	Project ongoing and success cannot yet be judged	*"Not finished yet so too soon to tell."* *"It is too early for me to answer this question. Our project started July 2016."*

Code	Frequency (n)	Description	Examples
Extended project length	5	More time is required to achieve project objects; current grants too short to complete work	*"Longer time period to allow repeat seed collection."* *"Not sure, other than more time."*
Extension	1	More Extension	*"More research and extension activities by CE Specialists focusing on groundwater hydrology and quality. Need more CE Specialists in that area."*
Funding - delay	1	Funding received later than expected	*"It took FOREVER to get the money because everything was held up with paperwork between NIFA and the universities. By the time the money came through, the FY was almost over and the entire amount of money had to be spent. If there is any way to streamline this process that would be incredibly helpful and efficient."*
Miscellaneous	7	Miscellaneous project specific constraints	*"Lack of transgenic traits has slowed down the commercialization of our inbred lines."* *"The project could have been more successful if we had been able to attract more and better graduate students."*
Not coded	17	Irrelevant or vague	*"Not sure..."* *"I don't know."* *"The project is developing protocols for evaluating models used for BMPs."*

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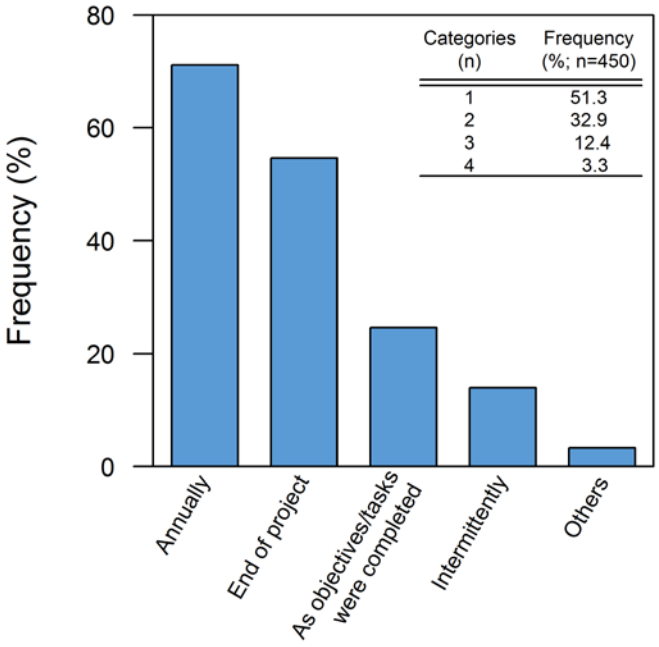

Figure 10. Capacity - Project evaluation timing
Corresponds to closed Q30: "When was/will the project's success evaluated/be evaluated (check all that apply)?"

Table 12. Capacity - Project evaluation timing open response codes
Corresponds to open portion of Q30 (n=15): "When was/will the project's success evaluated/be evaluated (check all that apply)?"

Code	Frequency (n)
Between 2-6 times	3
Every 5 years	1
Monthly	1
Weekly	1
Not specified	3
Not coded[a]	6

[a] Response irrelevant or vague.

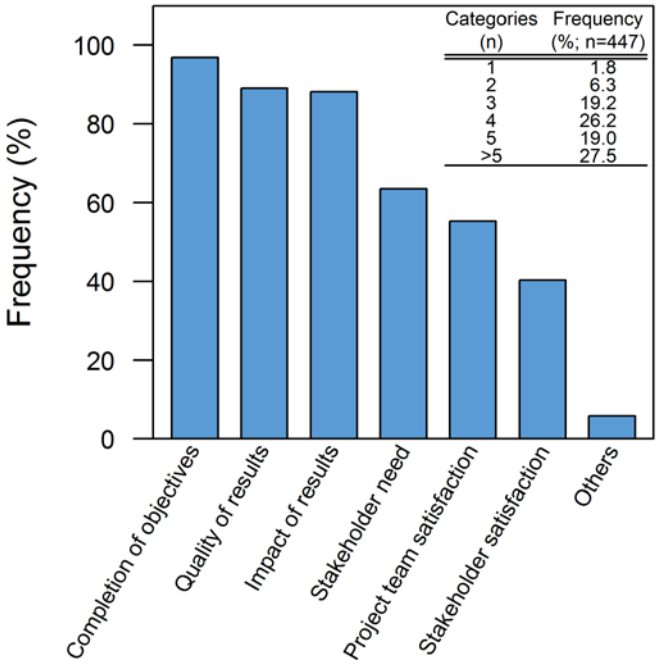

Figure 11. Capacity - Project evaluation elements
Corresponds to closed Q31: "When you evaluated/evaluate project success were/will any of the following project elements assessed?"

Table 13. Capacity - Project evaluation elements open response codes
Corresponds to open portion of Q31 (n=26[a]): "When you evaluated/evaluate project success were/will any of the following project elements assessed?"

Code	Frequency (n)
Leveraging	3
Ongoing	1
Publications	8
Scientific contribution	4
Students (learning and/or training)	6
Miscellaneous[b]	2
Not specified	2
Not coded[c]	4

[a] Respondents indicated >1 "Other" codes, which is included in the frequency table resulting in an n greater than the n of respondents.
[b] Miscellaneous includes collaboration with other projects and difficulty of project process compared to results.
[c] Response irrelevant or vague.

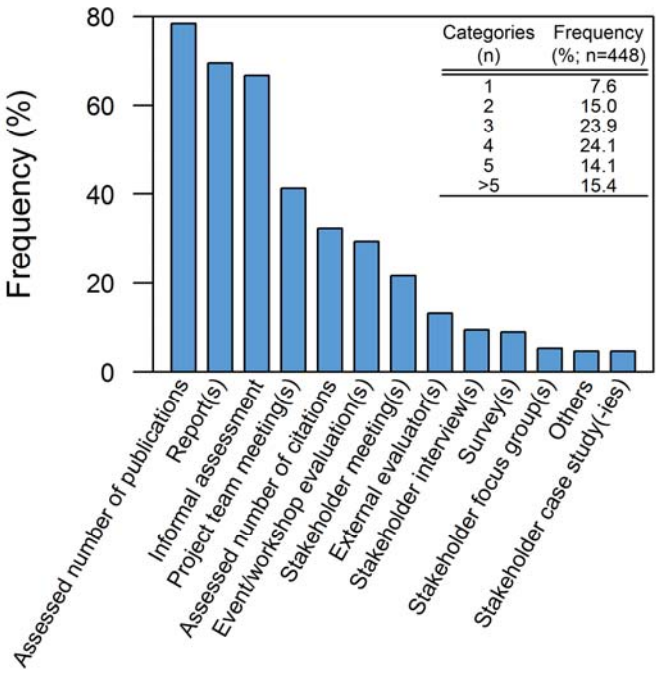

Figure 12. Capacity - Project evaluation methods
Corresponds to closed Q32: "The following methods were/will be used to evaluate project success (check all that apply):"

Table 14. Capacity - Project evaluation methods open response codes
Corresponds to open portion of Q32 (n=21): "The following methods were/will be used to evaluate project success (check all that apply):"

Code	Frequency (n)
Institutional review	3
Students (training and/or graduation)	1
Miscellaneous[a]	5
Not coded[b]	12

[a] Miscellaneous includes industry presentations, development, patents, accepted revised proposal, and coalesced all work on the project and evaluate.
[b] Response irrelevant or vague.

3.1.4 Project Stakeholders

The primary project stakeholder groups were "researchers" and "colleges/universities" (91.9% and 86.4%, respectively; Figure 13). The majority (67.5%) of projects had more than five stakeholders (inset table of Figure 13). The other stakeholder groups specified by PDs are presented in Table 15. The most common type of project knowledge disseminated to stakeholders were "results" (85.5%) followed by "management practices" (46.5%) and "methods/models/technologies" (45.6%) (Figure 14). The other knowledge types identified are presented in Table 16. The most frequent dissemination methods were "publications" and "conferences" (85.2% and 81.0%, respectively; Figure 15). The majority (67.5%) of PDs used more than 5 dissemination methods; specified other methods are included in Table 17). Websites used to disseminate project knowledge were primarily (52.7%) "available/accessible to the public and updated regularly" ("not regularly updated"=34.0%, "under construction"=10.6%, and "not available"= 2.7%; n=188; Q36).

The survey requested PDs to reflect on the successful methods for communicating with stakeholders. The PD responses regarding their stakeholder communication strategy resulted in the development of 19 codes (Table 18). The majority (n=138) of PDs use multiple methods and these methods are similar for all of their stakeholder groups.

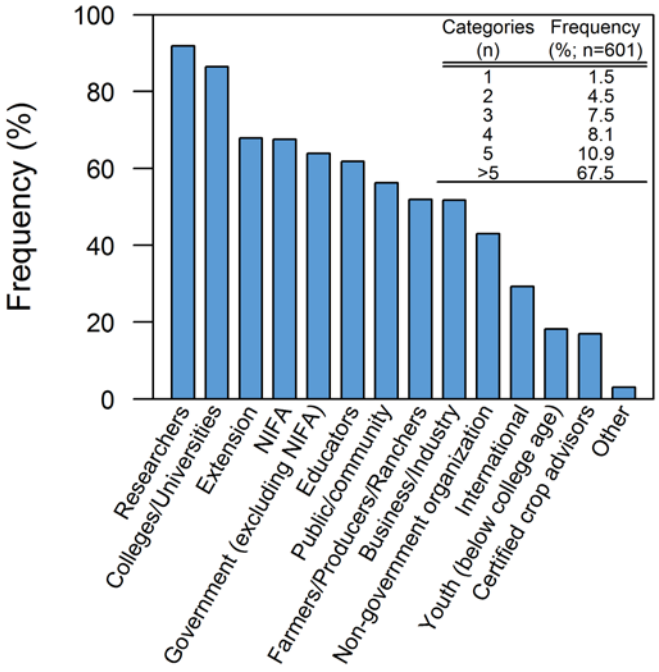

Figure 13. Capacity - Stakeholder groups
Corresponds to closed Q33: "Were/Will the following stakeholder groups informed/be informed of project knowledge or not:"

Table 15. Capacity - Stakeholder groups open response codes
Corresponds to open portion of Q33 (n=19): "The following methods were/will be used to evaluate project success (check all that apply):"

Code	Frequency (n)
College students	4
Miscellaneous[a]	3
Not specified	1
Not coded[b]	11

[a] Miscellaneous includes veterinarians, software users, and parents/grandparents.
[b] Response irrelevant or vague.

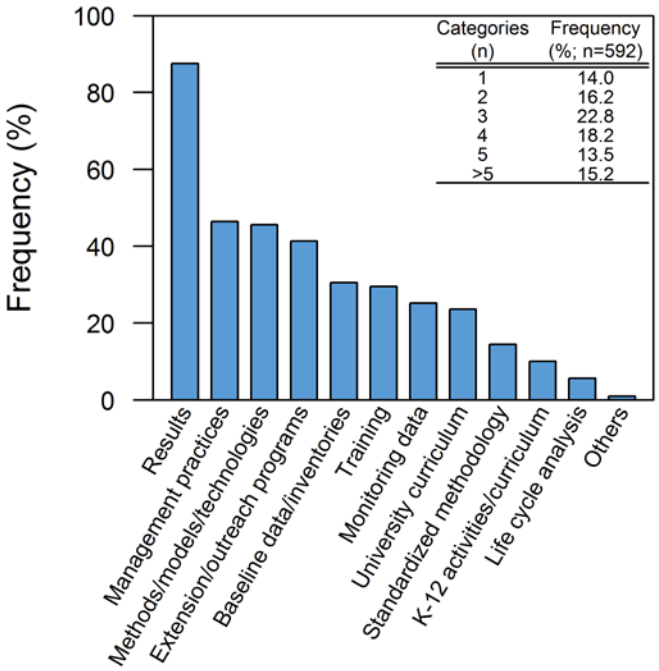

Figure 14. Capacity - Disseminated project knowledge types
Corresponds to closed Q34: "What type(s) of project knowledge was/will be disseminated to stakeholders (check all that apply)?"

Table 16. Capacity - Disseminated project knowledge types open response codes
Corresponds to open portion of Q34 (n=6): "What type(s) of project knowledge was/will be disseminated to stakeholders (check all that apply)?"

Code	Frequency (n)
None	1
Not coded[a]	5

[a] Response irrelevant or vague.

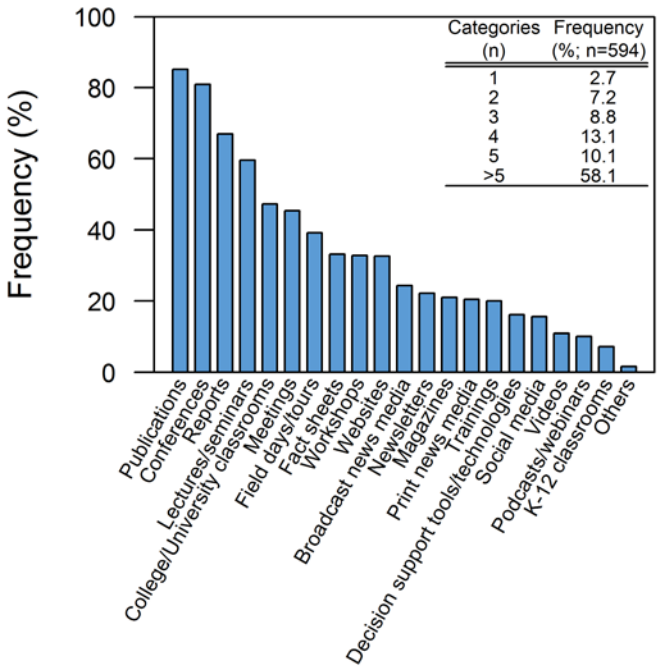

Figure 15. Capacity - Dissemination methods
Corresponds to closed Q35: "The project team disseminated/will disseminate project knowledge to stakeholder groups through the following means (check all that apply):"

Table 17. Capacity - Dissemination methods open response codes
Corresponds to open portion of Q35 (n=10): "The project team disseminated/will disseminate project knowledge to stakeholder groups through the following means (check all that apply):"

Code	Frequency (n)
None	1
Miscellaneous[a]	6
Not coded[b]	3

[a] Miscellaneous includes a regulatory filing, planning worksheets, grant proposals, databases, displays, and a policy brief.
[b] Response irrelevant or vague.

Table 18. Capacity - Stakeholder communication strategy code frequencies and descriptions
Corresponds to open Q37: "In your opinion, what is the most successful way to communicate with stakeholders? How, if at all, does this method change for different stakeholder groups?" Codes ordered by frequency (n=434).

Code	Frequency (n)	Description	Examples
Similar for all stakeholders - multiple methods	138	Same multiple method used for all stakeholders	*"Meetings, videos and demonstration plots for growers, educators, and funding agencies."* *"I think the most successful way could be through giving presentations in field days, which is followed by further meetings to gather feedback from stakeholders."* *"For this project, the most successful way are reports and publications in scientific journals."* *"For this research, stakeholder groups are best informed through written summaries, presentations, websites, and workshops."* *"Conduct field demonstration on commercial farms with inputs from stakeholders and hold workshops and social media."*
Similar for all stakeholders - single method	117	Same single methods used for all stakeholders	*"Conference was the most useful method to communicate with stakeholders for my project. The industry people and researchers in our field attend the same conference(s) every year."* *"In person meetings - always."* *"Face-to-face meeting and hand-shake. This strategy allows for live exchanges to provide more insurance to the stakeholders' doubtful questions. Some of the demanded changes may require substantial investment in time, materials, or labor. Stakeholders first look at the associated costs before decision-making."* *"We believe that the field days are the most successful way to communicate with stakeholders because the participants of the field days are probably the early adaptors and enthusiastic group."* *"Field days are a great way to talk and listen to producers. I've done loads of radio interviews, a few TV shows, and I guess my inconsiderable charm fails to inspire listeners. Climate change is obvious, and stakeholders' beliefs are unimportant. Stakeholders need to learn that knowledge trumps belief."*
Stakeholder dependent - multiple methods	83	Unique multiple methods used per stakeholder group	*"Multiple ways of communicating are a must due to different inclinations of stakeholder groups."* *"Workshop and training are two most successful way to communicate effectively with local stakeholders. Publications and conferences are most successful way to communicate with researchers."* *"I think that a range of communication methods are necessary to reach different audiences. What is appropriate for one audience may not be appropriate for another."* *"Communication must be tailored to specific stakeholders. In the case of our project, we communicated the results of our research with the research community (university, industry and government) through publication in peer reviewed journals and presentation at conferences. To reach a broad research community, we specifically chose to publish in an open access journal. In communicating with growers, we were most interested in them viewing our research in the context of the college programs aimed at the needs of the growers. To this end, we set up our field equipment in a farmer's field and also included a description and purpose of the instrumentation in field days."*

Code	Frequency (n)	Description	Examples
Stakeholder dependent - single method	51	Unique single method used per stakeholder group	*"Research briefing to policy makers and practitioners, face-to-face meeting with local people, and symposium to students/researchers."* *"Social media: graduate students and post-docs; Peer reviewed publications: Scientists and faculty; videos: graduate students and technical staff; conferences: scientists, faculty and graduate students."* *"News media is good for the general public and the general producer community. Direct contact works best for state government personnel."* *"Field days are most successful for farmers and extension personnel. Professional meetings are most successful for researchers and university educators."*
Stakeholder dependent	27	Method varies by stakeholder but types of method(s) not identified	*"It depends on the stakeholder and their particular area of interest. There is not a one-size-fits-all approach to communicating with diverse stakeholder types."* *"Depends on the stakeholder circumstances and the type of information."* *"Depends who they are...different groups respond to different methods."*
Extension	24	Utilizes Extension	*"It is critical to have extension experts who work closely with stakeholders and to partner with those individuals to generate any programs for those stakeholders. Often, the extension specialist is better at "translating" the work to their stakeholders."* *"Traditional Extension communications ranging from extension publications to broadcast news media."* *"Working with the university's extension team is the best way to reach stakeholders in the form of private landowners."*
Targeted communication	15	Specific communication style/objective required for stakeholder communication based on PD perception	*"Depending on the stakeholder group, the communication style has to be modified. For example, the content of a technical presentation in a conference should be different from a talk given at an extension meeting. If the materials presented is geared more towards the potential audience, the communication becomes more effective."* *"Successful communication with stakeholders includes defining the problem or questions to be investigated, describe the approaches used, what was learned, and how this information relates to the initial problem or question of study. With different stakeholder groups, one important change is to communicate within the perspective of the audience. Other scientists are most likely interested in the knowledge gained and innovations in approach, whereas crop producers will be most interested in what the outcomes are and how they could be applied."* *"These meetings are tailored depending on the stakeholder groups and their primary functions as well as educational backgrounds. For example, the content and format of these meetings for crop consultants will be different from growers or field workers."*

Code	Frequency (n)	Description	Examples
Need based	12	Stakeholder needs drive communication strategy, includes context and situation, stakeholder indicates need/interest of information	*"Communicate with them to learn of their concerns/objectives. Communicate research results in clear terms that illustrate consequences related to their concerns/objectives, as well as consequences that they may not have anticipated."* *"The big lesson for me is that each stakeholder group has different words, examples and outlets that can either enable a program or project to be well-received -- or which can turn off the stakeholders. These nuances are extremely important."* *"Tribal audiences respond differently. They are much more influenced by personal relationships, socializing, and incentives."*
Multiple methods	7	Uses multiple methods on one stakeholder	*"The mechanisms to inform the public are very varied and multiple approaches are required to inform."* *"Conference and publication for other researchers."*
Single method	7	One method is listed, indicates a single method for only one stakeholder	*"The primary users of the science coming out of this project are members of natural resource management agencies. The best way to communicate with them on results of this project has been through workshops that show them project results and how to use information in a decision support capacity."* *"To researchers via publications."*
Trust dependent	7	Communication must be from trusted individual	*"Build long-term relationships so that stakeholders will turn to you for advice and answers about your area of expertise."* *"For producer and extension audiences, showing up at meetings and events seems critical to build relationships of trust so that information will be valued."*
Project needs	6	Project objectives drive communication strategy	*"It depends on the research project and the outcomes. Basic/fundamental research may only pertain to other scientists whereas some of the applied research will apply to producers or the public."* *"This differs by the various outputs of the project. Web-based communications and social media tend to be our baseline for information. Most of our deeper training is via in-person workshops and cohort-based training."*
Early consultation	3	Communicates with stakeholders early or throughout process	*"Involve stakeholder groups in the research process."* *"Suggestions for improvement of the website were solicited throughout the project from apple growers actively participating in the field validations, private pest consultants with whom they work, regional cooperative extension fruit educators, and specialists responsible for the different NY apple production regions. Because website access is available to the entire fruit industry, online and in-person feedback response mechanisms can be established to request recommendations for optimizing the system's effectiveness."*
Technology dependent	3	Technology access or savvy includes internet access	*"While it is convenient to rely on electronic newsletters and college/departmental websites to communicate results, a substantial number of our ranchers/farmers (probably 30 - 40%) live and operate outside the internet broadcast zone. They have no access to facebook, twitter, etc. Additionally, another 20 - 30% within the internet broadcast zone are uncomfortable with social media or don't understand how to use it."* *"Individual email correspondence is very effective as long as the stakeholder has capability."*

Code	Frequency (n)	Description	Examples
None	2	No one successful method	*"There is NO good way to communicate with all stakeholders because folks are inundated by information. As a result it is imperative to provide new knowledge in many ways and in an upbeat repetitive manner."* *"I don't think there is any one successful way to communicate with stakeholders."*
No effective method	1	Has yet to identify an effective tool for stakeholder	*"None."*
Time dependent	1	Constrained by time frame, depends on how soon stakeholders need to be contacted	*"On a daily basis, website access to the data is the most effective means of communicating. Otherwise we find that one on one conversations (verbal or written), mention of the data being gathered via the media and reference to the program in various presentations are useful."*
Miscellaneous	3	Miscellaneous project specific constraints	*"Personally, I believe that the development of the research objectives must align with the needed research problems of stakeholders."* *"When stakeholders are young people I approach relationships slightly differently. I tried to identify as an ally and mentor type person who is genuinely interested in working for the greater good. I value their contributions and encourage them taking full ownership of their powerful voices to make our work better."*
Not coded	22	Irrelevant or vague	*"Working with state and federal government agencies."* *"It is hard to tell whether communications could have been better..."* *"My research is generally theoretical, so in many cases is not of general interest to stakeholders. In my experience, the main stakeholders are more interested in application rather than research."*

3.1.5 Project Outcomes

Funds used to seed the projects were more likely non-NIFA funds (30.1% relative to 16.7% of NIFA funds; Figure 16). Projects did also lead to additional funding from non-NIFA (47.5%) and NIFA sources (23.9%) (Figure 17). The most frequent publication type was journal articles; on average (median) projects published four journal articles (Table 19). Nearly all PDs (92.3%) indicated that "scientific knowledge expanded" and most (87.3%) indicated "training university students" were outcomes that were achieved (Figure 18). On average (median), four students were trained within each project (Table 20). Moreover, it was likely (46.4%) that the students were from the same discipline as the PD (Table 21).

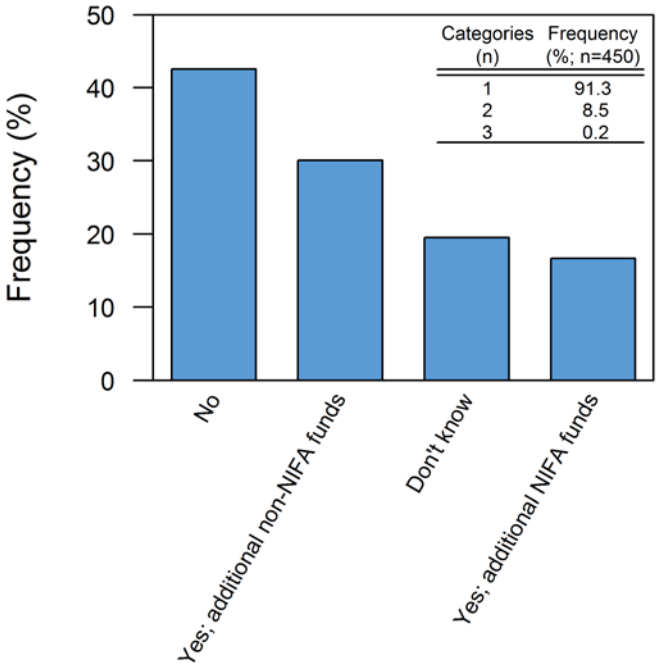

Figure 16. Capacity - Seed funding
Corresponds to closed Q38: "Were funds used to seed this project (if yes, check all that apply)?"

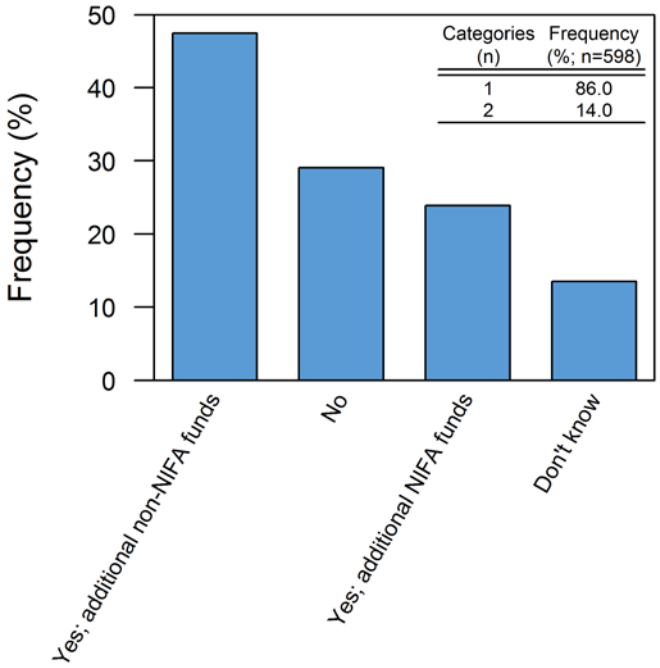

Figure 17. Capacity - Funding leveraged
Corresponds to closed Q39: "Has this project led to funding for (an) additional project(s) (if yes, check all that apply)?"

Table 19. Capacity - Publication types
Corresponds to closed Q40 (n=527): "Please indicate the following publication types and the number of each published from this NIFA project to date (if you do not specifically remember, please enter your best guess):"

Type	Respondents (%)	Median (n)	Range (n)
Journal articles	75.9	4	1-1000
Theses/dissertations	59.0	2	1-200
Extension	34.3	3	1-500
Other[a]	26.2	NA	NA

[a] The specified types are similar to the dissemination methods listed in Q35 and are not detailed in this report.

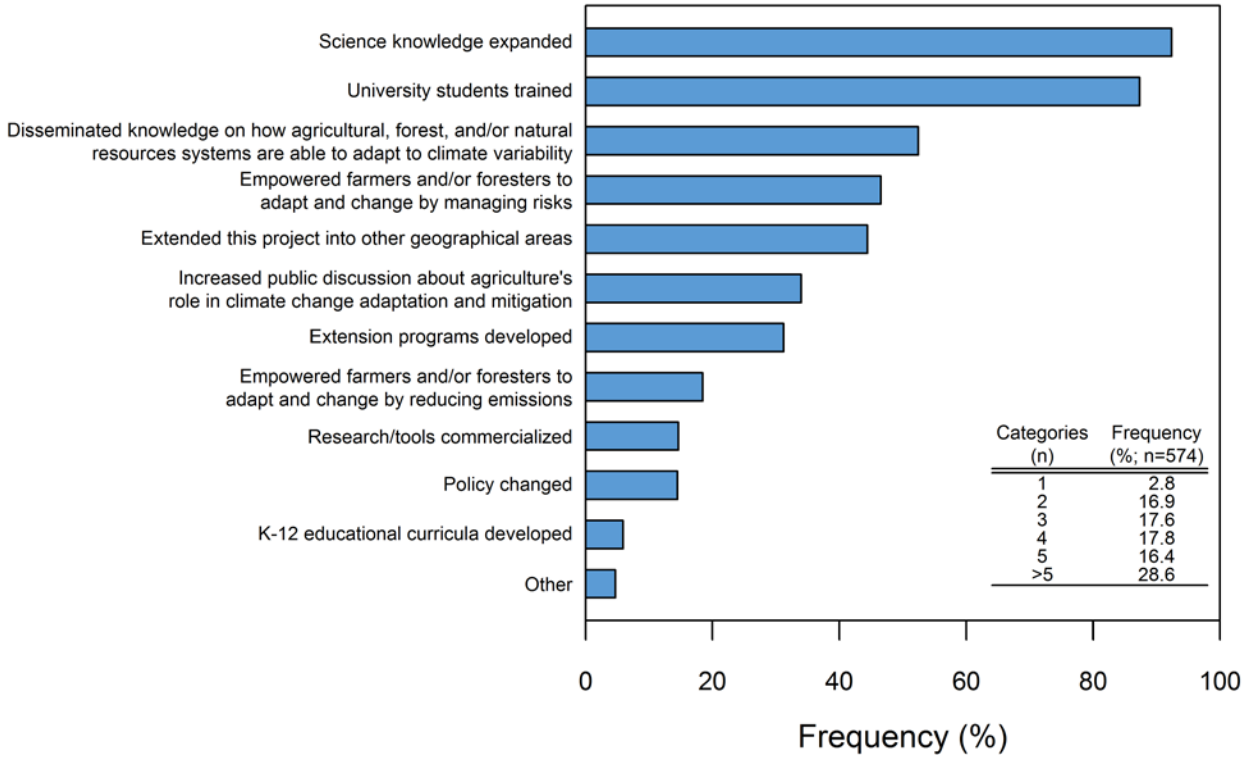

Figure 18. Capacity - Outcomes
Corresponds to closed Q41: "Have/Will the following outcomes been/be achieved or not?" The specified other types (n=27) are not detailed in this report.

Table 20. Capacity - Students trained
Corresponds to closed Q42: "You indicated university students were/will be trained through this project. How many students were/will be trained?"

	Respondents (n)	Median (n)	Range (n)
Students trained	482	4	1-2000

Table 21. Capacity - Student discipline
Corresponds to closed Q43: "Were/Will the student(s) from/will be the same discipline as the primary PD?"

	Respondents	Frequency (%)			
	(n)	No	Yes	Some but not all	Don't know
Student discipline	500	7.8	46.4	43.0	2.8

3.1.6 Project Synthesis

In addition to open questions about project success, PDs were asked to rate their project's success in 31 specific areas on a 5-point Likert scale (1="very unsuccessful," 5="very successful"). Overall, the projects rated as just above "neither successful nor unsuccessful" to "very successful" with a mean Likert score range of 3.3-4.4 (Table 22). The highest (Likert mean=4.4 and highlighted in dark blue) ranked areas were "generating research results" and "training university students." The lowest score (Likert mean=3.3) was "improving policy making."

If respondents selected neither through very successful for "developing new relationships/synergies with other organizations" a follow-up question was asked (Table 23). Synergies/relationships resulted in an overall increase and/or improvement with a Likert mean range of 3.5-3.9 out of a 1-5 (1="strongly disagree," 5="strongly agree") point scale. The highest score (Likert mean=3.9) was for "leveraging additional funds." The lowest score (excluding "other"; Likert mean 3.5) was the ability to "increase public discussion about agriculture's role in climate change adaptation and mitigation."

Q46, which requested PDs to identify knowledge gaps based on project findings, was not coded into themes since the detail provided by the respondents is essential for understanding knowledge gaps. Rather than qualitative coding, the responses were organized by their NIFA Knowledge Area Topics (as provided in the portfolio database) in Table 24.

When asked to identify the largest contribution of the project (Q47), upon analysis of the responses, 22 codes emerged (Table 25). The majority (n=103) of respondents indicated that the largest contribution of their project was to quantify, identify, and/or document an element of their project. "Development," "application," and "better understanding" were the next most common codes (n=56, 50, and 45, respectively).

The survey requested PDs to reflect on their grant proposal and if it was possible to go back and revise it (Q48), indicate what they would modify. The PD responses resulted in the development of 22 codes (Table 26). The majority (n=111) of PDs indicated that they would not change anything about their proposal. Those PDs that would modify it would increase the scope of their projects (n=53).

Table 22. Capacity - Project area success

Corresponds to closed Q44: "In your opinion, how successful was this project in the following areas to date?" The option to select "Don't know" and "Not applicable" was available to participants, which is included in Appendix Table 1.

Project areas	Respondents (n)	Frequency (%)					Likert mean[a]
		Very unsuccessful	Unsuccessful	Neither	Successful	Very successful	
Ability/flexibility to troubleshoot	463	1.7	0.6	14.7	47.5	35.4	4.1
Communicating with collaborators	518	1.4	1.2	5.6	49.4	42.5	4.3
Completing all project goals/objectives	541	1.1	3.0	13.7	53.2	29.0	4.1
Creating standardized protocols	415	1.7	1.4	23.9	52.8	20.2	3.9
Defining data needs/objectives prior to implementation	497	1.2	1.0	10.7	57.3	29.8	4.1
Defining project mission	527	1.3	0.4	6.5	56.0	35.9	4.2
Developing new relationships/ synergies with other organizations	495	1.4	3.2	19.8	42.8	32.7	4.0
Empowering stakeholders with science-based knowledge	504	1.6	3.2	19.4	49.0	26.8	4.0
Engaging in social activities with collaborators/project team	391	2.8	4.6	36.3	42.7	13.6	3.6
Enhancing extension capacity	394	2.0	6.1	29.2	49.0	13.7	3.7
Enhancing project team relationship	464	1.3	1.5	12.3	56.2	28.7	4.1
Enhancing/developing relationship with partner institutions	464	1.3	1.5	12.3	56.2	28.7	4.1
Enhancing/developing relationship with stakeholders	480	1.5	2.1	22.9	48.5	25.0	3.9
Funding agency satisfaction with outcomes/progress	420	1.2	1.9	16.9	50.2	29.8	4.1
Generating research results	535	1.3	1.1	5.8	42.2	49.5	4.4
Having an interdisciplinary project team	472	1.7	1.7	18.6	40.3	37.7	4.1
Having institutional support for and authority to acquire resources	492	4.7	9.1	26.2	43.7	16.3	3.6
Impacting stakeholder behavior	378	1.9	4.5	36.0	48.1	9.5	3.6
Improving policy making	325	2.5	10.5	50.5	29.8	6.8	3.3
Increasing public discussion about agriculture's role in climate change adaptation and mitigation	345	2.6	8.1	42.3	39.4	7.5	3.4
Increasing your reputation/value to funding agency	424	1.4	3.1	20.3	58.3	17.0	3.9
Involving project stakeholders early on in project design	439	2.1	7.3	31.0	43.5	16.2	3.6
Leveraging other funds	487	2.5	7.6	17.0	43.3	29.6	3.9
Monitoring and receiving feedback from stakeholders	429	1.6	6.3	34.3	44.5	13.3	3.6
Opening/having a line of communication with funding agency	444	2.3	9.0	39.2	41.0	8.6	3.4
Overcoming technological limitations	444	1.1	2.5	26.8	53.8	15.8	3.8
Project team satisfaction with project outcomes/progress	493	0.8	2.0	10.5	62.1	24.5	4.1
Publishing research results	520	1.5	2.3	14.2	45.8	36.2	4.1
Recruiting personnel	450	2.2	2.7	21.6	54.9	18.7	3.9
Training university students	514	1.6	0.8	3.9	47.5	46.3	4.4
Other[b]	21	4.8	0	57.1	14.3	23.8	3.5

[a] Calculated from Likert scale 1-5 (1="Very unsuccessful" to 5="Very successful"); shading corresponds to lowest mean=light blue and highest mean=dark blue. [b] The specified other areas are not detailed in this report.

Table 23. Capacity - Developed synergies/relationships
Corresponds to closed Q45: "New synergies/relationships developed through this project influenced your ability to:" The option to select "Don't know" was available to participants, which is included in Appendix Table 3.

Synergy	Respondents (n)	Frequency (%)					Likert mean[a]
		Strongly disagree	Disagree	Neither	Agree	Strongly agree	
Improve decision maker adoption of project results	368	0.5	3.5	33.4	51.4	11.1	3.7
Improve partner agency adoption of project results	354	0.6	4.0	39.0	44.9	11.6	3.6
Improve stakeholder adoption of project results	378	0.5	2.6	32.8	50.5	13.5	3.7
Increase public discussion about agriculture's role in climate change adaptation and mitigation	334	2.4	8.4	39.8	38.9	10.5	3.5
Leverage additional funds	420	0.7	4.5	18.8	51.9	24.0	3.9
Other	17	0	0	70.6	11.8	17.6	3.5

[a] Calculated from Likert scale 1-5 (1="Strongly disagree" to 5="Strongly agree"); shading corresponds to lowest mean=light blue and highest mean=dark blue. [b] The specified other synergies are not detailed in this report.

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Table 24. Capacity - Remaining knowledge gaps
Corresponds to open Q46 (n=358): "Based on project findings what knowledge gaps remain?"

Knowledge gaps by NIFA Knowledge Area Topics
Agricultural, Natural Resource, & Biological Engineering
"Catalyst development and improvement"
"Efficiency of electron production using a bioelectrochemical system (BES)."
"Further improving performances of feedstock logistics for biorefineries."
"I was not involved with all aspects of the project and have little knowledge about this issue."
"Identifying key factors to lowering the cost of producing biofuels."
"limited resources for in-depth research"
"Not quite sure with this question. But if what is being referred to was between the technology develop and the user - technically, huge, but users of this project does not need to know and understand the science behind, but only need to know on how to use it."
"Physiological mechanisms. Dose/response relationships. Identification of optimum dose."
"Quantifying bioresource cycling in relation to life cycle analyses for bioenergy and livestock production and urban waste management."
"Speed and quickness of remediation"
"The lab and field scale works would be different."
"The primary knowledge gap with regard to the animal bedding production portion of the project is whether tree species other than pine can be used for bedding. Pine has always been the industry standard for dairy, equine and poultry operations in the Northeastern US. However, little information exists on whether other softwood species, like hemlock, are suitable. It would be useful to test other tree species to determine whether they have comparable moisture absorption, bacterial counts, etc. to pine. This would increase the value of an on-farm animal bedding operation, as it would not be so limited on the tree species. The primary knowledge gap for the energy from compost portion of the project pertains to government grants and policy. In the field of waste management, the US government does not recognize energy recovery from composting. Instead, most funding (academic and industry) goes to anaerobic digestion. While anaerobic digestion has been around longer, we have proven that energy recovery from composting is less expensive and is capable of handling semi-solid to solid wastes, which anaerobic digestion does not handle."
Air
"Our knowledge of agricultural air pollutant emissions is very poor, inventory numbers are often based on what little research was available in the literature whether appropriate regionally, geographically, or to the current production system. Work on mitigation in general has not moved from the laboratory bench scale. There is a lack of demonstrated mitigation techniques that are economically feasible, practical, and implementable on a real industry scale. Without clear signals from government at all levels and appropriate encouragement to move forward (carrot or stick) industry is not prepared to act."
"There is still an enormous amount that is not known about reactions in fog and cloud drops and how these affect the composition of the atmosphere. Similarly, while we have significantly advanced our understanding of the particle components that damage human health, there is much to be learned, especially about the impacts of component mixtures on oxidant generation."
"this project is fairly young and a number of gaps remain, especially connecting the dots regarding 'translatability' of findings to human/animal disease outcomes"
Animal Production
"Ability of cows to maintain reproductive performance in an integrated system using high quality annual forages that tend to be high in protein."
"Alternative forage for production because of failure of stand establishment during project period. We need to evaluate the impact of some alternative forages that are being recommended from different sources to allow producers to improve their production efficiency. This project was not intended to be an environmental issue project."

Knowledge gaps by NIFA Knowledge Area Topics
"Basic understanding of host parasite relationship for small ruminant is still missing. Inexpensive fencing system to control goats has limited the growth of goat production."
"Candidate rumen bacteria identified need to be isolated as pure cultures and their genome needs to be sequenced."
"Develop strategies for immediate use by stakeholders and for long-term basic research."
"Do not know"
"funding consistency and support"
"Gaining the required physiological data for large mature trees in the field (crown photosynthetic rates etc.), gaining enough sample size to estimate variability between forest stands, data on southeastern bottomland forests including storage of carbon and responses to climate."
"How far can we go....can we get 50 % of our national herd to produce more than 30000 lbs. of 4 % fat and 3.4 % protein milk in 305 days or 365 d? Can we increase digestibility 5 % without using more nonfibrous materials. Can we kill the idea that organic dairy production is better for the cows, people, farmers, consumers, ground, air, climate? Let me repeat that: can we kill the idea that organic dairy production is better for the cows, people, farmers, consumers, ground, air, climate? the data are there! is the intellectual honesty there? or just greed for more research dollars? Can we support a national herd of 8 million cows that produces 800 million lbs. of high quality milk per day and maintain environmental sustainability."
"Identifying critical environmental stress thresholds for all domestic livestock species, based on comprehensive environmental condition, including temperature, humidity. wind speed, and/or radiation"
"impact of weather on nutrient recycling"
"In ability to quantitate hydrogen ion leak into the mitochondria"
"Land-based culture of corals and commensal sea urchins."
"Many gaps but three listed below: 1. Microbial interactions with their environment 2. Microbe - microbe communication\3. Stimuli that alter microbial response"
"Modeling of efficient poultry systems with more inputs."
"More work is required to determine if beef cows respond to monensin long-term. Monensin improves nitrogen utilization and reduces methane production. However, in our initial work, and the work of a few other laboratories/groups, monensin has not been proven to consistently enhance beef cow production. If production is not improved, producers will not and should not pay for incorporating this "green technology" into their management system."
"Need for integration of findings across production systems. The shift to alternative production systems in poultry production and increasing restrictions via government, consumers, etc. on production practices is still a large gap since there so many areas to be covered."
"Other environmental impacts to be assessed"
"Physiological changes that occur in livestock under climatic changes"
"the economics of making changes to improve climatic outcomes"
"The need to extrapolate the findings of our study to horses in other geographical regions, and the need to identify functional characteristics of the microbial communities characterized in the current study."
"Understanding and modeling long-term adaptation of domestic animals to environmental stress."
"Variability in N cycling across regions and soil types. Long-term impacts of varied forage management strategies on animal performance and soil and plant community changes."
"We are still actively trying to determine the exact underlying molecular mechanism that causes GST gene silencing in domesticated turkeys. These and other questions of genome function provide the basis for future studies."
"We still do not understand what impact blood storage with or without leukoreduction will have on healthy or sick whole blood transfusion recipients."
"We still have one more year, but we know that in general, the mobility of deep soil carbon in managed forest stands is difficult to determine and will require more research."

Knowledge gaps by NIFA Knowledge Area Topics
"We still need to establish a baseline for GHG emissions of cattle in a grazing environment. It will take multiple studies overtime. We also need to validate new measurement techniques."
"With regard to feed efficiency, current traits used in the beef industry are likely not improving energy efficiency in growing cattle or mature cows. Additional traits need to be developed that focus on improvements in efficiency of metabolizable energy use or reductions in maintenance energy requirements. With regard to animal health, this project was the first to demonstrate that prenatal immune challenge impacts the postnatal response to immune challenge in cattle. This initiates a new area of research where effect of different pathogens, timing during gestation, and dosage will need to be determined before commercial use of this practice will be feasible."
Animal Protection
"20 years of continuing data to ascertain if the trends are truly following a pattern"
"Better understanding of uveitis and glaucoma"
"Dose effect of zinc"
"Many did not know the impact of best management practices on their production and what all was included in a herd health plans. Many did not know the impact of diseases and how they can impact human health as well."
"There are enormous problems, particularly with protozoal pathogens as no effective drugs are currently legal for use in food producing animals."
"We are still trying to understand how this pathogen has moved around the Caribbean, whether there are any vectors for transmission, and whether the pathogen is emergent or has existed for a long period prior to its discovery. We also need to understand how some lobsters are capable of resisting infection and remain 'carriers' in perpetuity."
"We need to take this group level association to the individual level (i.e., cow level) and test the newly generated hypothesis that incidence of mastitis due to Mycoplasma bovis is indeed elevated in moist humid conditions and furthermore that these moist conditions can be either due to rain but also due to use of sprinklers for heat abatement which would explain the effect regional differences across seasons that we observed."
Economics, Markets, & Policy
"1. How to scale up from individual research findings and technology developments into large scale systems and policy changes"
"Ability for local and state government to adapt and address at an adequate speed related to community needs and climate impacts."
"Although evaluation of BMPs accounts for the improved ecosystem services, there are other ecosystem services that could not be fully accounted for in the valuation. A guideline to provide some valuation to these unaccounted services would provide a full accountability of benefits of management practices."
"analysis of data on local agriculture demands"
"Because the project is at the very early stages several knowledge gaps remain. From the scientists (PI and students) there is much work needed to understand the focal pest, timing of management, and management options. This information would then be provided to end-users for management decisions."
"Better understanding of drivers behind human behavior that leads to degradation of the natural environment and are not in their long-term interest."
"Do not know what types of data that USDA are available. This will be helpful if the USDA personnel can provide a tour guide of the USDA's data sources."
"Dynamic analysis of GHG emission with biofuels, including the problems of measuring land use change and other indirect effects"
"How the pieces fit together to project tradeoffs in future food/resource outcomes"
"I don't think my project has a ton to do with climate change although we emphasize that changing climate will impact food systems quite a bit. Moreover, we generally discuss climate change and sustainable agriculture's role in adapting to and mitigating it in undergraduate classes in sustainable agriculture. However, the project itself is more concerned with the economic and social organization of agriculture and food systems and how that impacts ecologies. ."

Knowledge gaps by NIFA Knowledge Area Topics
"I have worked to examine the impact of solar and renewable electricity generation on environmental and market outcomes in the near term. What remains unknown is how the large additions of renewable capacity will affect environmental and market outcomes in the longer run."
"I really have no idea."
"Identify heterogeneous responses"
"landowners willingness to adopt for new short rotation woody biomass"
"Linkages between climate variability and non-agricultural sectors of local economies"
"More experimental data regarding plant diseases and new strains of viruses is needed."
"most effective ways to engage environmental education program participants in collective action around climate change mitigation and ecosystem-based, community-based, and institutional adaptation"
"N/A"
"Need to understand the uncertainty with global wood products trade"
"No one knows why a very large segment of the coastal population chooses to ignore the prospect of future damages from hurricanes. See there, I referred to hurricanes rather than man-caused climate change. That's how sensitive the issue is."
"One of the biggest knowledge gaps regard behavioral responses from affected individuals and communities, their ability to assimilate knowledge and information, and response accordingly and consistently."
"Parental knowledge\Teen age behavior: how younger adolescents are using digital technologies to explore their sexuality"
"Still need better understanding of alternative regulatory and funding mechanisms that will enable the ag transportation system to function most effectively consistent with environmental goals."
"There are many areas in this broad area needing additional research."
"There is still a lot to be done regarding the GHG mitigation potential of agriculture, and adaptation to climate change by farmers."
"This project has had a couple sub-projects that were quite different. One sub-project dealt with Utah ranching and drought impacts at a state-wide scale, while the other dealt with Utah ranching and noxious weed control at a local scale. With regards to ranching and drought, the main knowledge gap that remains is to what extent the accuracy of weather forecasting tools can be improved so that ranchers can more effectively use them. Improved weather forecasting is the main problem identified by ranchers with respect to drought planning, but the low utility of forecasting tools that are currently available for the public is an obstacle for improving drought management. Ranchers also seem to think that the current spectrum of Extension information on drought management is not very helpful. Exactly why is unclear. With regards to ranching and noxious weed control concerning the invasive species called medusahead, the main knowledge gap is a continued lack of an effective, science-based control package that could be readily adopted by landowners. Such a control package will invariably include a herbicide in tandem with recommendations for vegetation and soil management, and this package needs to be cost effective and relevant for local conditions found in northern Utah. Research, however, has yet to come up with such a package, and our studies have identified that funding support for the necessary research has been inadequate. In addition, there is concern among researchers that landowners may be unable or unwilling to undertake changes in grazing management that are required for effective medusahead control. In other words, land owners are often looking for a silver bullet with respect to a herbicide, but sustainable control also requires reducing grazing pressure at certain times of the year and restoration of improved forage conditions. The latter is less appealing to ranchers who tend to resist changes in traditional practices that might reduce their income or take more time or resources to implement."
"This project is not related to climate science per se. Gaps include processes by which exposure to nature promotes positive family relationships."
"Understanding risk management in agriculture remains a significant challenge."
"We found consumer willingness to pay a premium for horticultural products grown with environmentally friendly water recycling practices based on hypothetical surveys. We still don't know if such premiums will hold up under when consumers are asked to pay an actual premium. This could be done with an in-store experiment."

Knowledge gaps by NIFA Knowledge Area Topics
"We need to collect more genetics baseline information for oysters in Delaware Bay and Delaware Inland Bays. We also need to test more oysters and have more people involved in oyster research in Delaware."
Families, Youth, & Communities
"How microenviromental variation influences well-being and what land cover decisions influence microenvironments"
Food
"Evaluation of additional soil types to determine the differences that may influence responses to nematicides in soybean."
"More work to evaluate safety of food products is essential."
"We are still focused on increasing our understanding of Gram negative bacterial pathogen/host interactions---much left to learn"
Food Safety
"Disease potential/virulence of toxigenic strains in different crops."
Forest & Range Resources
"1. How to use natural solutions to protect the coast and minimize costs from climate-change induced coastal erosion? This is a major issue, as engineers are beginning to move towards the engineering-ecology linkage, and start programs like 'Engineering with Nature' (US Army Corps of Engineers' major push). Policymakers want to protect the coast from hurricanes and sea level rise, but do it cheaply and smartly. 2. How and where is the carbon in US tidal wetlands? This is important for our country as we negotiate internationally regarding CO2 emissions. We need to know how and where to manage the carbon as offsets, as a resource that can be budgeted, traded, and negotiated. Tidal wetlands have much more carbon in them than rainforests, and the USA has a lot of tidal wetlands that we can manage. 3. How is the coast changing in Mexico, Cuba, and the Caribbean, all in adjacent water bodies to the US? There is very little known, and these countries need our help through collaboration to leverage their abilities to best manage our common resources."
"Application of innovations in production settings, integration into existing systems."
"Application of knowledge gained by USFS. They don't seem to be paying attention."
"Behavior of private landowners. Growth and yield modeling for aspen forest cover type in Minnesota."
"By what mechanism does prescribed fire promote grass invasion of forests? How do fluctuating environmental conditions influence grass invasion?"
"Development of comparable information for a broad array of other forest types and conditions."
"Do our methods of leaving woody biomass on the forest floor lead to better health of existing mature trees. Do the financial benefits of improved long-term forest health outweigh the short-term income generated from removing all downed wood after harvest."
"Freshwater forested wetlands are dramatically affected by both man-made changes and climate variability. Forestry producers, land managers, and other decision makers need information, technologies, and decision-support tools about mitigation, adaptation strategies, and policy outcomes. Forest management strategies must take climate variability into account to improve sustainability over the long term. The potential for forests to serve as carbon sinks and to reduce greenhouse gas emissions must be quantified to support sound policies and environmental markets. Outreach and extension networks must be implemented to advance the incorporation of these climate-change mitigation and adaptation strategies into management practices and utilize scientific findings for restoration projects, planning, and prescriptions."
"Gaps were filled or are being filled by the subsequent grants that followed this older project"
"Geographic range of study sites is still limited. Total project duration still needs another 100 years to deal with changes in forest growth and distribution across Alaska"
"Getting access to black ash for harvesting."
"How changes in vegetation translate into changes on soil organic carbon pools - The role of microbial communities in mediating soil carbon transformation - How changes in climate and climate variability will affect ecosystem structure and function - Developing remote sensing tools to reliably quantify changes in woody-herbaceous abundance in drylands"
"How to extend work to larger spatial scales"
"How to sequence the genetic sequence of choice for our study organism."

Knowledge gaps by NIFA Knowledge Area Topics
"I focused on barriers to adoption of new science by public land managers. We identified barriers and potential ways to circumvent them, but don't know whether those potential methods will work (nor even whether anyone is trying to use them)."
"Influences of ploidy on tolerance of extreme environmental conditions"
"It is unclear how the imminent complex of environmental stressors such as exotic insects and diseases will affect the ability of these forests to continue to store carbon. There are various scenarios depending on how severe the stressors become. But the most likely scenarios involving emerald ash borer, Asian long horned beetle, hemlock woolly adelgid, European earthworms, and invasive shrubs are likely to be catastrophic in combination."
"Long term (5-10 year) impacts should be examined."
"Long-term climate effects on forests."
"Major gaps include accounting for manager perceptions of insect risk, institutional constraints that limits management responses to insect outbreaks and integration with other types of forest disturbance such as fire."
"Microbial community structure-function relationships, disturbance effects on soil CH4 uptake"
"More farmers understanding, seeing the importance and adopting the more agroforestry practices"
"More sophisticated methods to retrieve small trees and methods to estimate value, not just tree attributes"
"Need to apply field results to growth, carbon and climate change models. Need longer term data sets, especially following prescribed fire or woody growth response following biomass harvesting"
"Not all parts of this ranch land destroyed by homesteading and the drought of the 1930's have been restored. While most have returned to their natural state, streams and other aquatic resources are yet to recover completely. The largest knowledge gap is when and if these valuable components of this ranch will recover."
"Other species!"
"Species adaptability in the often-harsh local climate."
"Still need to better understand the mechanisms involved in crop tolerant phenotypes under abiotic stresses"
"Targeted/focused research is needed to address the needs of the potato industry in both areas of genomics and phenotypic evaluation."
"The following are some gaps that still remain: 1) How much interannual variability in species level responses is caused by climatic conditions versus management. 2) How long will a reduction in invasive plant species be maintained and how often does one have to apply a treatment to maintain an improvement with respect to native plant species composition."
"The influence of topographic variability on mediating climate change and how these potential climate refugia could influence the distribution of tree species and forest productivity."
"The potential amount of C sequestrated below the ground in the inter-cropping stand of Switchgrass and loblolly pine compared to adjacent monoculture plots yet to be determined.\Information on the quality and process SCS by the respective system and species components in the systems is still scarce."
"The research was focused on long-term experiments, and so, more time is required to see if the early trends will persist."
"The role of climate in pinon-juniper woodland dynamics"
"This is a growing area of concern in terms of ecosystem service provision in urban and urbanizing areas. Thus the gaps are too vast to catalog here. There is not a large body of work in this area."
"We are not involved in climate change projects"
"We are only scratching at the surface of valuing ecosystem services, and the interconnections between various ecosystem service production functions. The public and policy makes do not understand how forests provide services to society nor do they understand their value. Standard techniques for quantifying non-market valuation and appraisal need to be developed."
"We continue to need better long-term forecasting tools we can provide to ranchers."
"We don't know how small trees in a field setting will respond to climate change."

Knowledge gaps by NIFA Knowledge Area Topics
"We dramatically advanced models of aboveground tree biomass but given the stands utilized we could not do this under the expected thinning regimes that would have likely occurred in operationally managed stands as opposed to these research stands. Belowground we were able to make great advances in quantifying the mass of carbon belowground and its potential residence time. Given the short-term nature of the project (5-yrs), however, we need to extrapolate beyond the time line of our data. Being able to extend the time of decomposition studies belowground would fill in this knowledge gap."
"We need to complete a 'methods paper' reflecting our results so that other agencies can 'use' our methods to enhance whitebark pine regeneration."
"We need to understand how climate change will affect tree species migration."
"We studied the experimental destabilization, and to a lesser degree, recovery of grass-stabilized semi-arid sand dunes. Paleo-dating of dune activity over the last 10,000 years indicate that these dunes have lost and recovered their grass cover half a dozen times. We still do not have a clear understanding of the spatial and temporal pattern of recovery when this landscape shifted in the past from an active to a stabilized state. Another question involves the ecohydrology and resilience of the wet interdunal valleys in our landscape, where groundwater subsidizes ET and NPP. Although we can estimate groundwater recharge reasonably well for uplands, the wet valleys complicate this considerably."
"We've only scratched the surface. We haven't quantified basic plant water use amounts for most species in most stand conditions, so can't estimate how changes in species will interact with climate to alter water cycles"
"What are limits of adaptability beyond minimum winter temperature?"
"Whether epigenetic effects we see in jack pine growth are transient in this generation only or heritable and passed on to the next generation."
"Wildlife Appropriation of NPP\Fire impacts on National Parks and Drylands\Below Ground Biomass Dynamics"
Human Health
"A significant disease sequencing problem remains. As climate shifts across temporal scales will we see disease introduced early or late into any new environment."
"Environmental determinants of lone star tick establishment into new regions."
"Latitudinal patterns of vector-borne disease ecology"
Natural Resources, General
"A major knowledge gaps exist in the evaluation of soil quality changes related to different management practices with plastic mulches and biodegradable plastic mulches. The major problem with assessing soil quality changes is that these changes are occurring over long time-scales and are very gradual. Important knowledge gaps remain about how well biodegradable plastic mulches degrade in soil. How will climate change affect use and degradation of biodegradable plastic mulches. How do nanoparticles released from biodegradable mulches move through soils?"
"Ability to move regional and federal policies to align with research results."
"Additional implementation"
"Additional information on specific impacts related to climate and agriculture in the Midwest. Additional tools to address those impacts."
"Changing relationships between wildlife and habitat quality in a changing climate. Influence of climate change on fire's role in shaping plant communities."
"climate change impact assessment on water availability and water quality"
"Climate is a very complex and non-linear system - there will always be knowledge gaps"
"Designing restoration programs in terms of efficiency, effectiveness, and equity."
"Greater understanding of underlying hydrological processes."
"How interannual and interdecadal variability may change with changes in climate"
"How to implement adaptation either in municipal or agricultural settings\Monitoring of effectiveness of interventions and policy"

Knowledge gaps by NIFA Knowledge Area Topics
"How we are going to develop soil-based wastewater treatment in areas where the groundwater table may rise due to sea level rise and due to increased rainfall. A higher water table means that there is less non-saturated soil to provide treatment."
"I did not have enough funding to characterize the habitat of northern populations of Spisula solidissima similis (in NY and MA), previously known only South of Cape Hatteras. Their habitat needs should be determined and then surveys along the mid-Atlantic coastline should determine whether geographically intermediate (stepping stone) populations occur."
"Impacts of stressors on diseases insects carry. Impacts of stressors on the larger, combined food web."
"implementation with existing legal framework, economic incentives"
"Integrating incentive programs with project objectives--work in progress"
"Local scale knowledge on climate-water-human interactions."
"long-term impact of forest pest interactions"
"Management practices vary from regions to regions and they play an important role in animal agriculture in mitigating environmental concern. Besides, testing and evaluation of new technologies are important under different environmental and management conditions."
"Many of our findings suggest site-specific impacts of these activities on wildlife resources, thus as new activities arise or are proposed, site specific examination may be required."
"Many."
"More awareness of our information gathering efforts by stakeholder communities is needed."
"Need additional variation in annual weather to simulate future climate change"
"Need for continued measurement of impact of potential climate change on crop production."
"Our next question regards how sub-cloud air influences precipitation on its way to the surface, how it influences downdrafts in thunderstorms, and how these are observed by different radars."
"Production of high quality biochar at the rate needed for agricultural and industrial applications still remains a challenge. Steps should be taken to refine and improve production efforts. More soil types should be included in future investigations. Effect of biochars on soil biological and biochemical attributes should be investigated with reference to reactions that take place in the rhizosphere."
"Projections of how climate change/increased variability might impact agroecosystems in terms of yield, water and energy budgets, at high resolution over key regions."
"Still critical to learn the optimal level of evergreen shrub (big sagebrush) that can extend snowpack residence time WITHOUT depleting shallow groundwater levels. This knowledge can direct adaptive prescribed fire and grazing management protocols."
"Testing our models on empirical data -- and evaluating if our models are of interest and can be easily applied by stakeholders"
"The extent that forest fires affect air quality and the increasing importance of soil NOx emissions to regional air quality."
"The student results indicate we still do not know precisely how trees responds to drought or stress and modeling these impacts are difficult."
"There are many. One very large one is our understanding of the broader consequences of grazing systems on ecosystem services. Our focus in rangeland management for nearly a century has been to "improve" range condition and move plant communities toward a perceived high seral or climax state. The current popular grazing systems are designed to do this through very uniform use of plant communities, leading to greater homogeneity of habitat types in the landscape. We are already concerned about this regarding wildlife habitat (especially for grassland birds), however there are likely many more consequences to other ecosystem services such as watershed function and availability of native plant species to invade following disturbance."

Knowledge gaps by NIFA Knowledge Area Topics
"There are still many uncertainties regarding the tropical hydrologic cycle and its response to climate change on multiple spatial and temporal scales. Such uncertainties pertain to both basic understanding as well as our capacity to represent the tropical hydrologic cycle in climate models. Within the context of the latter, these uncertainties limit our confidence in future climate projection."
"This is just completed and not fully analyzed. We would need to repeat a larger study to go after the intriguing findings but that is not possible with the funding level."
"This project is focused on learning more about how gene expression in crop plants responds to imposed stress conditions that may become more common with climate change and its mitigation. Fundamental information has been acquired, but the knowledge gap that remains is how the observed gene expression changes confer adaptive traits or phenotypes. This will require additional research."
"This project just pays for my office telephone and my internet connection - expectations greatly exceed resources"
"Too numerous to count. New knowledge always generates a new generation of questions."
"Understanding of climate change risks that arise from extreme events and lack of prediction"
"Understanding of dynamic water distribution in the landscape environment and particularly \at the large-scale is still poor."
"Use of climatic information for engineers, scientists, and health professionals for better system design in each of their respective fields."
"water use; alternative water sources; strategies for dealing with drought"
"We are constantly dealing with the fact that we have vastly more data coming in than we have coherent information coming in. Separating the 'signal' from the 'noise' is becoming an ever larger problem. The need to do this is widely recognized. The critical question is how to go about it. Our ability to 'process information' continues to increase, of course, but those gains have far outstripped our expanding ability to "parse the meaning" of what we are seeing."
"we monitor for change over time, and the pollutants in the atmosphere continue to change, so we plan to monitor for trends other pollutants in precipitation that we do not yet monitor for"
"We're still sampling in other areas of the western U.S. for our golden eagle/wind energy development project as additional sampling is needed to further assess the threats the wind energy industry maybe having on the viability of eagle populations."
"Why are the wasp populations so volatile? Is their "crash" permanent or will they rebound? Are the dynamics drought-related?"
Non-food
"1. biomass conversion efficiency is still not high enough to make profits form lignocellulosic biofuels. 2. processing cost is still high due to catalyst efficiency and cost."
"How do we make these new technologies more affordable?"
"Logistics and harvesting of lignocellulosic feedstock to a centralized location"
"Market information, economics of business"
"Need more depth in most areas. Instrumentation and modeling would be good follow on incorporating fluid dynamics, light transmission, instrumentation, and time constants for system response. Incorporating physical and biological models."
"scale-up of new biochar based activated carbon need be done to improve utilization of agricultural residues and biochar."
"Understanding the properties of bio-char for high value applications."
Plant Production
"How to scale from research findings to on-farm application, and the climate impact of large scale adoptions (full LCA and technoeconomic assessment of practices identified in plots and small scale work). Holistic integration of agronomic, environment"

Knowledge gaps by NIFA Knowledge Area Topics
"1. Role of specific organic farming methods on nutritional quality and human health. 2. Link between organic farming methods and soil health, and 3. Link between soil health and crop resistance to stresses."
"a great deal of fundamental knowledge is lacking on how plants respond to stress and how one can use genes from other organisms to enhance stress tolerance. this was the fundamental goal of the project."
"Ability to understand environmental influences on results."
"Actual identification and testing and implementation of new management techniques"
"Aflatoxin, we and others have done lots and lots of work and it still is unpredictable. Missing heritability, even with very large populations we cannot identify most of the loci that would be predicted from the heritability. Phenotyping, it is labor intensives and inaccurate, we need better methods. Commercialization, our material is better than industries but we have very low adoption. Producer behavior, many producers say they are willing to lose money to not change the way they do things (to manage aflatoxin) that seems crazy to me."
"all of them."
"An understanding of the physiological/biochemical relevance of the results, i.e., does polyol accumulation alter abiotic stress tolerance."
"Association with additional traits. Incorporation of SNPs into Genomic Selection strategies."
"Best management practices for cover crops in dryland cropping systems in the project area."
"Climate interaction is a big one, especially in semiarid northern plains where annual variability dwarfs background trends. There are many unanswered questions with soil biology in this semiarid dryland cropping region and soil responses are slow in this region leading to a certain degree of hucksterism by non-research entities. Also, knowledge about the connection between agricultural land management and wildlife ecology remains surprisingly sparse. There are several more but this survey is getting pretty dam long"
"Collaborations among universities, institutes, USDA, and private companies"
"Comparisons with a wider variety of plant species"
"Despite the benefits of no-till (NT) systems, stratification of soil nutrients, organic matter, and pH tend to develop near the soil surface in long-term continuous NT. This problem can reduce nutrient availability and uptake by crops and increase the chances of nitrogen and phosphorus losses in surface runoff. In addition, the lack of effective herbicides for perennial grass weeds such and the emergence of glyphosate resistance weeds such as kochia and palmar amaranth pose challenges in NT crop production. Perhaps occasional tillage of NT cropping systems may be necessary to alleviate herbicide resistant weed issues, redistribute soil nutrients and soil acidification developed because of continuous NT. There is limited information on how occasional tillage on NT soils will affect perennial weeds, crop yields, nutrient stratification and soil quality in dryland crop production systems in the central Great Plains."
"Development of germplasm resistant to multiple stress(es) that will produce increased grain in diverse environments and production systems."
"Do molecular and genomic networks controlling symbiosis and nitrogen fixation in model Medicago truncatula extend to agriculture crops like alfalfa, pea and clover."
"Evaluating more species for North Dakota."
"Further understanding of the genetics underlying key traits in wheat."
"Future fundings for continuation of the project..."
"How the crops tested will perform on a wider array of site conditions, cost-effectiveness of converting the biomass into biofuels and bioproducts at industrial scale."
"How these findings translate to other drugs and food animals."
"How to engineer smart photoprotection in cyanobcateria"
"How to further purify egg yolk lipoprotein and how to produce egg yolk lipoprotein based nanogels at large scale for potential industrialization."
"How to sustain efforts on the regions reservations when personnel and funding are so hard to sustain."
"Impacts of climate change on the urban environment"

Knowledge gaps by NIFA Knowledge Area Topics
"Increasing transformation efficiency in switchgrass"
"It is still very difficult to assess root traits cheaply and accurately, so it is difficult for breeders to include them in breeding programs. We have made progress but much more progress is needed. Secondly, it is important to evaluate the impact of trait combinations in a variety of environments, which we attempt to do via modeling followed by empirical studies of a limited number of combinations. Not many combinations can be tested."
"Long-term effects of dust and dust effects on human health. Development of methods and acceptable practice to reduce disturbance created by pipeline construction."
"Many"
"Molecular genetic basis for abscisic acid synthesis/response in response to high temperature events. Why pollen viability is reduced. . . .is it related to carbohydrate limitation?"
"more mechanistic assessments are required to fully understand plant responses to extreme conditions and better develop successful management protocols"
"Need to gather more information on the social wellbeing of alternative and conventional farming systems. Also, need to come up with ways of measuring ecosystem services on farms and translating these services into dollar values in relation to farm gross returns."
"not sure. Need different methods / models to capture influence of climate / environment on weed biology and ecology responses in the field."
"Our project was based on model plant system - Arabidopsis. The biggest void is understanding how crop plants respond to climate change taking into consideration biochemical, molecular and physiological aspects comprehensively."
"Our results documented the need (1) to remove flowers and/or fruit early in the season to mitigate alternate bearing and the associated problems and to make plant growth regulators more effective in overcoming the negative effects of a high yield (large number of fruit) on return bloom, exactly how much fruit needs to be removed and the development of a cost effective reliable management strategy to achieve this level of fruit thinning remain knowledge gaps and (2) to improve the efficacy of plant growth regulator treatments so they completely, instead of only partially, overcome the negative effects of a high yield crop on return bloom is also a knowledge gap."
"Performance of native plant species, maintenance of native plant health."
"physiology-based crop management methods to decrease adverse climate-change effects on productivity that are applicable to subsistence farming situations; understanding of farmer confidence/'lack of' in adopting physiology-based technologies for crop production"
"Potential application of the gained knowledge in biotechnology."
"Project not funded"
"Response of other tree species to climate change besides the target species, loblolly pine, remains uncertain."
"The basic nature of the mechanisms of summer dormancy in cool-season grasses."
"The frequency and importance of rapid evolution/adaptation in the ecological dynamics of biological control systems. The response of biological control systems to 'atypical' climates"
"The knowledge gaps are in the minds of the stakeholders. We need fewer of them and better."
"The percentage of carbon sequestered in soil (vs carbon lost through soil disturbances) is not fully known. Further research may fill the gap in this area."
"The physiological, biochemical, and molecular bases for resistance/susceptibility to low temperature sweetening (LTS) and loss of process quality will contribute to recommendations for fine-tuning management practices to optimize at-harvest and out-of-storage quality and thus profitability for growers. Determination of the extent to which in-season management and stress during production affect retention of postharvest quality in new or soon-to-be-released cultivars from the breeding program."
"The project was an amalgamation of various activities over a long period, so this question is difficult to connect to the particular project."
"The role of climate in pinon-juniper woodland dynamics, and the ability to successfully transplant greenhouse-generated cactus seedlings for population augmentation"

Knowledge gaps by NIFA Knowledge Area Topics
"There are always knowledge gaps in long-term cropping systems research programs."
"There are several gaps in understanding the biological bases of fruit shelf life. Further research would help understanding these areas and fill gaps."
"There are still many areas to be targeted and issues to be addressed, following the concept that, the more we know, the more we discover and therefore new doors are open to new paths of discovery. It is difficult to narrow it to a single or just a few points."
"This is difficult to assess. There are always knowledge gaps. Irrigation management is partly engineering and partly biology, and there are many knowledge gaps in both, but I would say more gaps in the biology of crop response to irrigation."
"This is fundamental research and the research has generated more questions than final answers concerning heat stress."
"This project does not directly address climate change or climate change mitigation but will contribute to the knowledge of how climate variability impacts soil productivity and crop production."
"Too many to list."
"Too many to quantify - however, the foundation of knowledge is there and it is growing every day."
"Too many... More than we started. We don't know if the nighttime temperatures affect other plant species, what the molecular aspects are beyond transcription, can we replicate what we observe in the field in the lab- so far, no, but what variable are we missing? Is it the root temperature that is actually important?"
"We are focusing on the identification of drought responsible transcription factors using Chip-Seq assay and determine the epigenetic regulation of these genes. Beyond the project, the knowledge of the downstream genes, and how molecular elements interacting with these TFs remain to be discovered."
"We are an expanding collection, always in need of additional resources."
"We are screening for enhanced stress resistance in the potato breeding programs, but not specifically breeding for traits that would increase resilience to climate change. We need focused research to better identify opportunities to breed potatoes with enhanced stress resistance and increased nutrient and water use efficiency that would allow them to better adapt to projected environmental conditions in the future."
"We can always use more trial results and more varieties and experimental lines for testing. This is an on-going gap. There is also a gap in the testing of new crops or minor crops especially specialty grains. There are very few sources of funds for specialty grains such as emmer, einkorn, and spelt. Malting barley is also a specialty grain in NY."
"We need more knowledge of the plant genes that affect biofuel quality"
"We need to dissect functions of specific regulators of plant cytokinesis."
"We still do not know all components of signaling pathways induced during cell wall modifications caused by microbial cell wall degrading enzymes"
"We still do not understand the balance of top-down and bottom-up effects of climate change on ecosystem function."
"Whatever is not completed during the phase of the project has been continued in the next phase."
"When working on landscape-scale questions of ecological restoration and climate change, inevitably vegetation studies are critical but do not address all vegetation types or outcomes. Additional work is needed."
"With respect to climate change: We still do not know if our crops can adapt to their current geographic range rapidly enough to help farmers avoid the need to change crops/infrastructure."
"Works need to be done in advancing the area of sustainable production. Identifying tools and techniques which have limited impact on natural resources without compromising yield, quality and overall farm profitability"
Plant Protection
"Agriculture is an ever-changing system. Farmers face multiple challenges and in the near future research on the effects of drought and heat stress on plant productivity and entire farming systems will be needed"
"Application of results in mainland tropical forests with higher diversity"
"Distinct relationship at small and big scale of forest disease epidemics"

Knowledge gaps by NIFA Knowledge Area Topics
"Effect of climate change and urbanization on trees, tree pests, and ecosystem services"
"If tolerance can be used as a basis for a decision support tool since it is very variable"
"Implementation of Nanoparticle in nutrition must be developed with industry support in new development in formulations"
"New agricultural challenges such as insect/disease/weed resistance, invasive pests (insect, disease, weed). New urban challenges such as insect transmitted diseases and getting adoption of effective school and urban IPM practices. Educating society about the effectiveness and safety of technical agricultural advances such as GMOs."
"Probably not what is meant by this question, but I still struggle with maintaining and improving computer applications once grant funding has expired. I wish I knew more effective ways of accomplishing this, when grant funding is firmly tied to development of the new and unique. From a scientific standpoint, we have implemented a generic plant disease risk prediction model, but we lack some of the information necessary to parameterize the model for most diseases."
"Rapid detection of the pathogen would be very helpful in next generation disease forecasting."
"Several new research questions were raised by this project. This has spurred a new project funded by a Non-NIFA source."
"Sociological and economic barriers to proactively managing herbicide-resistant weeds. Lack of new chemical tools and/or lack of selective chemistry to effectively manage invasive plant species. Economic factors such as commodity prices and farm policy structural rules that limit crop rotation and effective long-term management of soil, water and other resources. Effect of junk science and fear mongering on agricultural policy and producer tactics for pest management."
"That is what we discuss and plan projects for every year. This question is too open ended for the type of project this is."
"The availability of more precise temperature monitoring within specific orchards would improve on the utility of this tool. Also, we have yet to incorporate an additional resource that has been developed for use with this website: A database-driven insecticide selection tool that incorporates IPM guidelines. This tool generates least-cost options that are subject to constraints such as rotation of pesticide classes for resistance management, label use limitations, and pre-harvest intervals as well as other types of user imposed constraints. This tool would be useful both for in-season decision making and pre-season planning that will allow growers to better benefit from pre-season bulk discounts. Users would have the option to change a default price list and select attributes that reflect their production environment. Macros written in Visual Basic for Applications (VBA) then perform the necessary calculations, execute various sorting algorithms, and implement certain heuristic decision rules to come up with a least-cost solution. The apple insecticide decision tool allows user to specify whether they can use restricted use pesticides, are located on Long Island (where certain insecticides are not labeled), wish to only consider materials that are OMRI approved, want to only use materials that are considered "below risk"."
"There is still a gap in knowing if marker assisted selection is a real option for breeding stocks of honey bees for grooming behavior."
"This project involved basic research, and as such, many knowledge gaps remain. Although focused on an applied problem, the research itself was not applied. We identified genes that two different fungal pathogens utilize to infect their hosts. Considerable future work is needed to bring this information to application.. I should also state that the project did not deal with climate change, so I am not sure why the project was categorized this way."
"This project is at the initial stages and the knowledge gaps to be addressed remain in question. Other research questions to be answered through future research will be identified in due course."
"Translating fundamental biological and ecological knowledge into management recommendations"
"Translating fundamental knowledge for mitigating crop losses due to pests and diseases in a sustainable, environmentally benign manner across variable cropping systems. How climate change influences disease dynamics and effectiveness of adoption of best management practices."
"Understanding how much additional and immediately applicable knowledge can be mined easily from the very large datasets acquired with UAV. Understanding how much farmer capacity can be improved with these datasets."
"We are just beginning to understand the complex microbial communities surrounding plants and how they impact disease development and growth. More tools for relating plant growth to factors on a spatial scale and to relate that to environment are now available. These areas will interact and hold great promise in future agriculture"

Knowledge gaps by NIFA Knowledge Area Topics
"We continue to have new farmers, new fields and new pests and diseases and management options. These will generate knowledge gaps each year but I feel our team is good at on-going assessment of these issues and addressing them the next growing season."
"We don't fully understand how to predict the potential range expansion of weedy and invasive plants because we don't fully understand the causes for that expansion."
"We have successfully modeled risk of invasive plant establishment across the continental U.S. with climate change. But, we still need to understand and predict risk of invasive plant abundance and impact - both under current and future climate conditions."
"We need to continue to disseminate relevant information on IPM and impacts of climate change to stakeholders, and there are many more individuals, businesses and organizations to reach."
Program & Project Support, & Administration, Education, & Communication
"Biology of invasiveness of new invaders we are dealing with. Controls technology."
"How to talk to dismissives"
"Learning is an issue of critical importance for research on climate change adaptation, but remains poorly defined territory owing to the lack of interaction between research fields (and domains of practice) focused on learning and those focused on adaptation to climate change. Although I believe that the research and publication activities stemming from this project will have an impact on this problem, a larger initiative will be required to (1) clarify what learning means in the context of adaptation, (2) apply lessons from multi-disciplinary research on learning to problems of adaptation, and (3) form lasting connections between these two complex and diverse scholarly fields."
"There is still a need for communication researchers to better understand the conditions under which seemingly subtle differences in issue labeling (e.g., "global warming" vs. "climate change," "fracking" vs. "hydraulic fracturing") influence the perceptions of the general public."
"We are currently trying to figure out the best way to recruit participants and how to structure the workshop. This involves not only the participant group size, but also length of training modules (we delivered the 20 hour program over 3 days when we could have broken up the training over a longer period of time to better serve the needs of the participants."
"We still have to test the completed climate science curriculum."
Soil
"(1) the extent to which denitrification has removed nitrate in shallow groundwater, and (2) the temporal dynamics of that process."
"1. The impacts of invasive mostly non-native plant species has developed as a major post-fire theme. We need to evaluate how these plants impact re-establishment of native species particularly Ponderosa Pine. 2. Post fire water quality and sedimentation generation needs to be assessed and compared if possible to pre-fire metrics."
"1. How does the ratio of ammonia and nitrite oxidizing bacteria/archaea in soil influence trace gas loss during nitrification?\2. What is the physical and spatial organization of nitrifiers that best promotes the efficiency of nitrification?\3. What explains the prevalence of nitrite oxidizing bacteria in soil despite a 3:1 deficit in available energy relative to ammonia oxidizers?"
"1. What is the long-term impact of perpetual groundwater abstraction on phreatophytes? 2. What is the impact of accelerating sea-level rise and sea-water intrusion on phreatophytes in coastal watersheds? 3. How does the prolonged California drought impact groundwater levels in coastal watersheds to the detriment of riparian vegetation?"
"A number of mechanisms of ecosystem response that could be addressed with typical student and grant length studies, and long-term ecosystem function that requires continuation of ongoing long-term studies, which relies on additional external grants to happen."
"A range of responses by soil type is needed"
"Beneficial use of byproducts to reduce greenhouse gas and sequester carbon (permanently)"
"biodiversity for N2O emissions and community responses to environmental factors"
"breadth of outcomes, beyond the specific sites and ecosystems studies."
"Data gaps on the pest biology and population dynamics"

Knowledge gaps by NIFA Knowledge Area Topics
"Data on use with wood samples to extend the more theoretical tests."
"Developing predictive systems and risk assessment and decision tools at various spatial and temporal scales to support climate, crop, hydrologic and livestock production systems"
"Effect of reduced physical disturbance (i.e., reduced tillage and higher carbon inputs) on soil redox properties"
"First knowledge gap is the direct measurement of root respiration rate, or soil microbial respiration rate under field conditions. A major limitation of the trenching method used in this project is that after trenching and removal of above-ground photosynthate input, the microbial activity can be affected due top lack of continued carbon supply. New sensing technology is needed for in situ measurement of soil respiration under field conditions."
"How much US agriculture will be impacted by future climate change is not still known in detail."
"How to further the production of switchgrass for environmental and agricultural friendly purposes"
"How to manipulate cultural practices in order to improve plant stress tolerance"
"Hydropedology is geographically variable. The extent to which is still uncertain."
"Interaction of various management practices and weather on quantitative measure of greenhouse gas emissions."
"It is too early for me to answer this question. Our project started July 2016."
"It still remains contentious whether or not bioenergy cropping systems can be managed such that the system is carbon neutral or carbon positive."
"Knowledge gaps remaining include how changing pasture species composition from perennials to annuals and cool-season grasses/legumes to warm-season grasses affects adaptation to climate variability and pasture and soil health across long-time periods and ."
"Long term climate records"
"Many, the answer belongs to new proposals. I cannot find the motivation to be expansive here."
"Mostly, I don't feel like there are so much gaps as unknowns just beyond where the project has reached. There are a number of very specific unknowns that require researchers to take the next step to figure them out. Not sure that those specifics are what is wanted here."
"Much of my research involves use of irrigation. However, I have strong concerns that in a high rainfall climate such as the Southeast (and other regions) that we need to move toward using the resources we get more efficiently. In other words, if we can use rainfall most of the time, then let's avoid using irrigation. This means that we need to work harder to improve soil cover. However, many farmers find this a more difficult management system. We need more research to understand how to produce high yielding crops with minimal irrigation. Keeping soil covered and accurate monitoring of soil moisture will be critical. In addition, soil cover often changes pest and nutrient management strategies. Crop rotation and cover cropping will also be needed in a truly conservation approach to high output crop production. I feel that is critical to the future of agriculture and the environment."
"My project is occurring on two sites; more sites would expand knowledge considerably."
"Need future funding to resurvey lakes and determine how they have changed over time and in relation to climate change..."
"Need more work. small iterations on farming operations."
"Needs more time to evaluate some wheat for their suitability in Alaska."
"Not sure"
"Phenotyping data"
"Regarding the agricultural sustainability up-to-date data has shown us that land application of compost has more agronomic and environmental advantage as compared with the application of synthetic fertilizers. However, one of the questions that the stakeholders are frequently asking me is that; is the application of compost economical as compared to the application of synthetic fertilizer in the current production system? I cannot answer that question convincingly as I have not done any study to assess the feasibility of compost application for crop production as compared to fertilizers use on crop lands."
"SOC stock changes since settlement."

Knowledge gaps by NIFA Knowledge Area Topics
"Soil spatial variability characterization and impacts on science"
"Still need to complete analyses before arriving at final conclusion"
"Still need to determine the stability of the candidate wheat for their suitability in Alaska. Need time to confirm this. Also baking quality needs to be evaluated with those wheat."
"Still unclear exactly how tamarack mediates ericaceous shrub-Pica interactions in field settings."
"Surface-atmosphere exchange of cover crops in dryland agroecosystems."
"Temporal variation in soil carbon and sequestration rates needs more evaluation\the impact of variations in no till management also needs to be evaluated."
"Terminology in this survey is very confusing. I never know if you mean the entire regional project, or just the parts I was working on. All kinds of gaps remain because in my opinion, we never really came together on this project."
"The lack of understanding of management effects on the long term soil sustainability and the relationship between soil resiliency and management practices to combat climate change."
"The optimal stock plant types and management conditions needed to improve rooting success.\The optimal environmental conditions to improve rooting success of cuttings."
"The project is still ongoing. There are gaps regarding ecosystem services provided by grassland mixtures for pollinators. Other gaps include understanding below-ground dynamics of grass/legume mixtures, SOM formation and its link with below- and above-ground litter, and mitigation of greenhouse gas emissions from soils and livestock."
"The project was completely unsuccessful, so all perceived knowledge gaps that the project looked to fill remain."
"There are a lot of them."
"There are many. Specifically the response and recovery times in soil systems."
"There are still many unknowns regarding risk related to using cover crops."
"There is a need to collect long-term tillage vs. no-till data on soil C."
"There is still a large gap in long-term research on this topic. Most studies are 3-5 years in length. But we don't determine what might happen after say 10 or 15 years of these practices being implemented."
"There is still a large knowledge gap concerning how carbon moves through coastal wetland sediments. This will be a key piece to managing coastal wetland for carbon storage."
"Too many to list here"
"Understanding impact of irrigation. Excessive rainfall in 2015 confounded results"
"Unsure"
"We still lack any type of understanding of the quantitative effects of irrigated agriculture on many soil processes in the Western USA."
"What the new administration will do to government programs and funding."
Water
"Downscaling climate change projection is still very rough and since agriculture operates at a smaller scale (e.g., field scale), this becomes a problem."
"Feedbacks between climate and multiple land uses; sensitivity of water quality and quantity to climate change in frequently disturbed/legacy disturbed landscapes; persistence of disturbance to water resources"
"How does climate variability influence water quality in headwater streams, and how does this then propagate downstream to critical water bodies."
"How soil contamination and remediation may affect soil quality, sustainable agriculture and climate change."
"Incorporating uncertainty."
"interaction of water quality and quantity on aquatic ecosystems"

Knowledge gaps by NIFA Knowledge Area Topics
"Latent heat fluxes at regional scale are still not known and are included in climate research only with great uncertainty which questions the reliability of future climate scenarios."
"Long term impacts of human activities (land uses, population growth) and natural processes (drought and flood) on the water availability in a changing climate."
"More detailed data needs to be collected. The project was only designed to generate estimates."
"Small-scale spatial variability in precipitation chemistry is poorly understood"
"Still need to generalize to population of coordinated management efforts"
"The project is not yet complete, so it is difficult to say what knowledge gaps will remain when it is finished. However, I expect that we will still need a better understanding of the mechanics of post-fire hydrologic response and sedimentation."
"There are large gaps in the policy aspects of the management recommendations, particularly with regard to water yield. We also continue to seek generality about the rapid assessment proxies of management responses that can be monetized without expensive research investments. The transit times of solutes in our experimental catchments remains an important knowledge gaps."
"There are so many uncertainties while working in the field. There is a knowledge gap between what we know from the book and what is unknown in the real world. This makes our work facilitating, but challenging enough."
"Thus far, we have reviewed the literature and developed our procedures for data collection and analysis. The fieldwork is currently underway so we are yet to analyze results from the study."
"Too many to list"
"We still do not know how to extrapolate knowledge about freshwaters, in particular, water quality from one region to another."

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Table 25. Capacity - Largest contribution

Corresponds to open Q47: "In your opinion, what is the largest contribution of your project?" Codes ordered by frequency (n=415).

Code	Frequency (n)	Description	Examples
Quantification	103	Quantified, identified, clarified, documented	*"Quantification of conservation practices on soil carbon sequestration and distribution into carbon pools and nutrient cycling."* *"Demonstrating that the technologies produce high quality products at a viable yield using scalable processes."* *"Spatially explicit tree mortality and recruitment data."* *"Impact of land uses on water resources."* *"Documented ability to decrease adverse climate change effects on crop productivity through potentially practical physiology-based crop managements practices."*
Development	56	Developed technology/ method/element/tool	*"Development of crucial new technologies."* *"Development of sustainable non-chemical methods to improve poultry production efficiency including probiotics, vaccines and DFMs."* *"New process and system development."* *"Development of research-based management recommendations to farmers."*
Application	50	Provided to stakeholders or field that can or has been applied	*"Helps manage national park and US Forest Service resources in the [location]."* *"Better information for farmers and policy makers on the potential for expansion of locally grown produce."* *"Experimental application of a potential management tool in forestry during the restoration efforts following harvests."*
Better understanding	45	Insight, increased understanding	*"Increased understanding of weather/climate effects on tree growth and physiology and how growers can mitigate those effects."* *"Better understanding of surface water and groundwater interaction, strategies for conjunctives of atmospheric water (rainfall, snow), surface water (river, lake, ...), and groundwater (fresh and brackish water)."* *"Increase in knowledge by targeting new and challenging areas and using new technologies, which although might have high risk, also have high pay offs."*
Advancement	36	Improved/advanced element	*"Spatially constraining GHG emissions, vadose zone nitrate hydrology."* *"Better non-insecticidal management of on-farm storage of cereals in a strongly temperate climate."* *"Enhanced curation capabilities for USDA material being stored and being integrated."*

Code	Frequency (n)	Description	Examples
Discovery	25	Implication of new finding	*"We figured out how to genetically design crops to maximize their use of the environment. The problem that remains is that of an environment that is changing faster than we can adjust to it."* *"That making major environmental improvements to degraded land can greatly improve profitability and resilience to future events (economic downturns, climate change, disturbances to land cover)."* *"Our work revealed that excited triplet states, a poorly studied class of oxidants, can be very significant in cloud- and fog-drop chemistry. We also revealed that copper in airborne particles is likely responsible for the bulk of oxidant generation in lungs after particle deposition."*
Foundational	23	Baseline/foundational data/knowledge	*"Baseline SOC stock measurements for forest and prairie sites."* *"Provided basis for well-informed regulatory discussions at highest level of ag policy making."* *"Provided foundation information for nitrogen management in orchards."*
Awareness	20	Highlighted issue /element, brought to attention	*"Promoting need for, value of, and developing fundamental biological and ecological knowledge about weedy and invasive plants."* *"Drawing attention to the influence of below-ground characteristics and management in urban forest ecosystem service provision and its direct and indirect influence on climate-related issues such as stormwater management. It has stimulated conversation and research activity in this area."* *"This project made significant contribution through research based information to increase awareness among farmers and agronomists of the conservation practices benefits including residue in protecting soil and reduced climate change effect."*
Education	20	Trained/taught/mentored students/post-docs	*"Having students involved and carrying on most of the research activities with myself is very rewarding. Students are really the largest contributors besides genetics tools and equipment."* *"Training graduate students who are very interested in pursuing a more advanced degree."* *"The MS student graduated."*
Stakeholder engagement	18	Outreach, worked with stakeholders	*"Relationship building and information sharing with forest products industry in the state."* *"Involvement of an important stakeholder to partner with university for early involvement in research activities to better understand the impacts of climate change on productivity."* *"Provided a ground to open a dialogue with farmers and other agency personnel that economic evaluation of BMPs is useful not just from a profitability perspective but also from an ecosystem perspective because ecosystem services do not have an implicit value that is greater than zero."*
Collaboration	16	Good working team, interdisciplinary team, established team	*"Fostered interdisciplinary collaboration in development and evaluation of learning systems and bioresource cycling systems for bioenergy and livestock production and urban waste management."* *"Collaboration among scientists."* *"To date, we have brought together campus researchers and off campus practitioners and educators to a much greater extent than other groups."*

Code	Frequency (n)	Description	Examples
Ongoing	16	Too early to determine	*"It's hard to say. One study that just got under way during the last year of this project has been continued in my newest McIntire-Stennis project, and we're developing a decision support tool that I feel pretty excited about."* *"Still too early to say. Project just started."* *"Still compiling data."*
Confirmation	12	Confirmed, proved, validated, illustrated, demonstrated	*"Validating no-till as a viable production practice."* *"It confirms modeling outcomes from the [NAME] Experimental Watershed."* *"It is a rare example of using empirical evidence (from framed field experiments) to test the extent to which our theoretical models of information adoption are valid."*
Publications	11	Publications	*"Publishing findings of 1) urban temperature variation and the influence of vegetation, 2) high temperature pulsed emissions of NOx that can influence regional O3 concentrations from agriculture."* *"Dissemination of knowledge gained through journal articles, popular articles and conference/training presentations."* *"A comprehensive review of aflatoxicosis in poultry was compiled and published."*
Database	10	Data set created	*"Long-term data on a mammal in relation to climate change."* *"A database of water quality on ~10,000 lakes and their associated watershed characteristics to begin to develop a better understanding of the role that land use plays in determining water quality in different regions and through time in the face of changing climate and land use cover."* *"A solid dataset over multiple environments and geographical area."*
Implementation	10	Initiated/started/ established element	*"The largest contribution is the establishment of a long-term forest regeneration project…."* *"Directing placement of wind energy facilities that reduce impact to wildlife in northern Arizona."* *"Initiate research in the climate change issues."*
Commercialize	3	Produced a commercial product, or potential to commercialize	*"Development of a product that has commercial value."* *"…commercial products."*
Leveraging	3	Led to other project/gain	*"The largest contribution of this project is leveraging funds to study the feasibility of cover crops in dryland cropping systems in [location]."* *"Provided sufficient seed funds for the necessary preliminary data to secure multiple follow-up grants that led to several publications and the licensing and use of the technologies by stakeholders."*

Code	Frequency (n)	Description	Examples
Extension	2	Extension materials or use of extension	*"Extension materials on irrigation management for optimum crop productivity and water/nutrient use efficiency."* *"Organization of extension programs (field days, webinars, workshops, etc. for growers."*
Don't know	1	Not sure	*"Don't know."*
None	1	Nothing	*"This project just pays for my office telephone and my internet connection - expectations greatly exceed resources."*
Not coded	24	Unclear, vague, irrelevant	*"Research."* *"I would prefer to not answer at this time as I would want to reflect more fully on this question."* *"Some flexibility to continue research activities."*

Table 26. Capacity - Rewriting grant proposal code frequencies and descriptions
Corresponds to open Q48: "If you could rewrite one element of your grant proposal, what would you change?" Codes ordered by frequency (n=350).

Code	Frequency (n)	Description	Examples
Nothing	111	No change necessary	*"I felt very satisfied that we had accomplished the goals that we had set out and achieved excellent results that substantially advanced the state of the science. No other additional goals would have been feasible during the 3-year time frame of the project and the funding level."* *"Nothing would be changed."* *"Nothing -- it is pretty broad and allows flexibility to be opportunistic in rapidly identifying and responding to issues."* *"None."* *"Nothing. For a Hatch project (which is what this is) it was broad enough that I could respond to emerging science and needs but narrow enough that it was clear what my scope was."*
Expand	53	Increasing scope	*"Add testing efficacy of improved nutrients in animal models."* *"I would have broadened objectives concerning improvement of management of bioenergy crops to include sugar & forage crops. . . . because the funding declined for bioenergy crop management research during the course of the project."* *"I would add a watershed component to our studies."* *"I would make its focus more broad and apply it to multiple aspects of land management. I underestimated the potential for leveraging funds for climate change research."*
Don't know	27	Not sure	*"I don't really know."* *"Don't know."* *"Not sure."*
Reduce scope	25	Reducing objectives/ tasks	*"Remove goals that were not addressed."* *"I would have minimized the objectives - my first impression was I will be funded for writing a Hatch Project and so I thought I will have one postdoc per objective."* *"Reducing the number of objectives and sampling sites to reflect the funding amount."*
Funds	23	Increasing funds	*"Add in money for more sorting and a taxonomist."* *"Request funds for whole genome sequencing."* *"I would triple the budget."*
Emphasis	23	Modifying emphasis	*"Emphasis on urban gardens would be reduced."* *"Would have addressed climate change more explicitly."* *"Greater focus on grafting as an alternative propagation technique."*

Code	Frequency (n)	Description	Examples
Methodology	22	Modifying methodology	*"Methods to develop better predictive models."* *"If money was not a barrier, I would have conducted the studies using an animal model rather than a cell-culture based model."* *"I would not use a crossover design."*
Collaborators	20	Increase collaboration or add collaborators	*"This project involved a few faculty from different institutions. If I could rewrite my proposal I would make more coordination with other project leaders to conduct a more focused research on the topic of climate change impact on on-site wastewater management."* *"Invite a geologist to help map subsurface bedding planes and fracture pathways which probably contribute a great deal to groundwater storage and transfer."* *"I would seek more collaborators across the Southern US rather than just scientists in my own university."*
Budget	7	Modifying or including budget distribution	*"Salary support for additional personnel in charge of this project."* *"Increase FTE for project management."*
Staff	7	Adding dedicated staff	*"If it would have been possible to incorporate the dedicated efforts of a web programmer from the start of the project, we should have been able to effect a more integrated website improvement process of several elements concurrently, rather than having to focus on individual aspects in a piecemeal fashion."* *"I would have written in more personnel to help manage the wealth of information."*
Advanced technology	6	Using advanced technology	*"Increase emphasis on new genetic technology to improve project efficiency and enhance understanding of plant response to stress."* *"Add genome-wide research through new technologies such as whole genome sequencing and gene-editing."*
Ongoing	6	Too early to tell	*"The data are not in yet so it is difficult to assess what to change."* *"It is too early for me to answer this question. Our project started July 2016."*
Project length	6	Requesting longer timeframe	*"The number of years I had to work on it."* *"If I could guarantee funding for a longer term, say 10 years, I would do so."*
Research dissemination	6	Including resources for research dissemination/outreach	*"More resources for outreach."* *"…better plan for science communication"*
Flexibility	4	Allowing for flexibility	*"I would have made the project field description a bit more vague to allow for new knowledge to affect treatment design. Since this was my first project at this experiment station, there were operational restrictions to field work that I wasn't aware of prior to writing the hatch plan."* *"… I should have added something like 'if we don't identify sufficient genetic variability to enable barley to survive Montana winters (we didn't), just wait 30 years. We're getting closer every year."*
Impact analysis	4	Determining potential impact, evaluating impact	*"I would probably examine more closely the potential impacts of the project."* *"This was a multi-state project with a large number of contributors so the writing process is very cumbersome. Based on this survey, I would include more assessment/evaluation into the project/proposal."*

Code	Frequency (n)	Description	Examples
Training	4	Increasing training	*"I would train myself to gain more expertise in one or more of the following…"* *"More training for undergraduate students."*
Specificity	3	Increased detail	*"Be more specific about focus on Cage-free research goals."* *"Our sampling protocol was not sufficiently discriminating to account for the stratification known to exist in no-tillage soil environments relative to tilled environments."*
Extension	2	Integrating Extension	*"I would explicitly include more extension and outreach."* *"Integrating extension to a greater level."*
Personnel	2	Modifying personnel	*"The collaborators."* *"I would have worked with a migrant and seasonal service providing organization to identify a bilingual employee who knows the target audience and is interested in becoming CERT trainer and conducting the training. This would have minimized our reliance on an English speaking trainer and increased our project flexibility and participant access."*
Miscellaneous	11	Miscellaneous project specific activities and/or interactions	*"To increase time and energy put toward safeguarding valuable collections."* *"More clear synergy between different climate-related elements of the proposal."* *"Develop a more robust plan for leveraging additional funding."*
Not coded	13	Irrelevant or vague	*"Funding is arbitrary and extremely low."* *"This was not a grant proposal - this was a multi-State Hatch project."* *"Insist on formula funding from HATCH and or Smith Lever source vs USDA and local authorities doing what they want."*

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3.1.7 Project Director Information

The average (mean) age of PDs was 53.0±10.4 years (Table 27) and were predominately male (75.3%; total n=542; Q50). PDs, at the time the project was funded, were likely (41.8%) to be "full professors" (Figure 19). Specified other titles are included in Table 28. The majority of PDs identified as a "life scientist" (61.1%; Figure 20). The other specified scientists/professionals are presented in Table 29.

Table 27. Capacity - PD age
Corresponds to closed Q49: "What year were you born?"

	Respondents (n)	Mean (year±sd)	Range (year)
Age	540	53.0±10.4	29-80

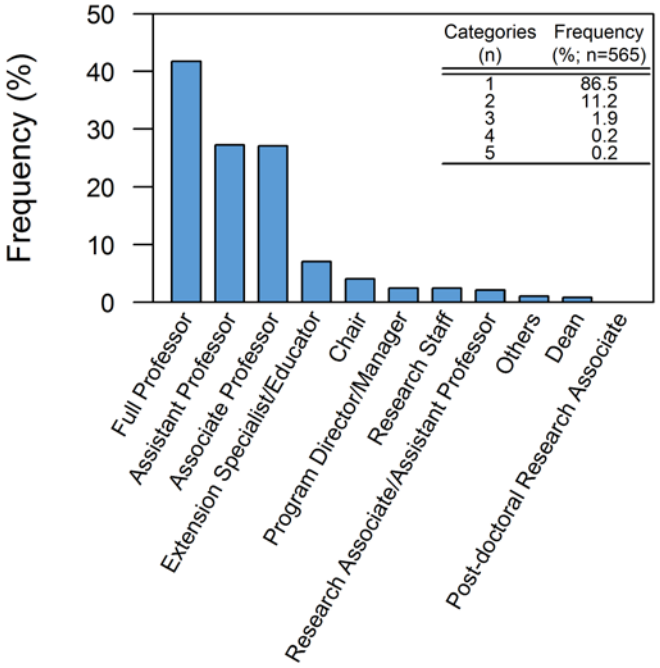

Figure 19. Capacity - PD job title
Corresponds to closed Q51: "What was your job title when this project was funded (check all that apply)?"

Table 28. Capacity - PD job title open response codes
Corresponds to open portion of Q51 (n=6): "What was your job title when this project was funded (check all that apply)?"

Code	Frequency (n)
Director (non-program)	1
Distinguished Professor	1
Provost	1
Miscellaneous[a]	3

[a] Miscellaneous includes academic specialist, coordinator, and department head.

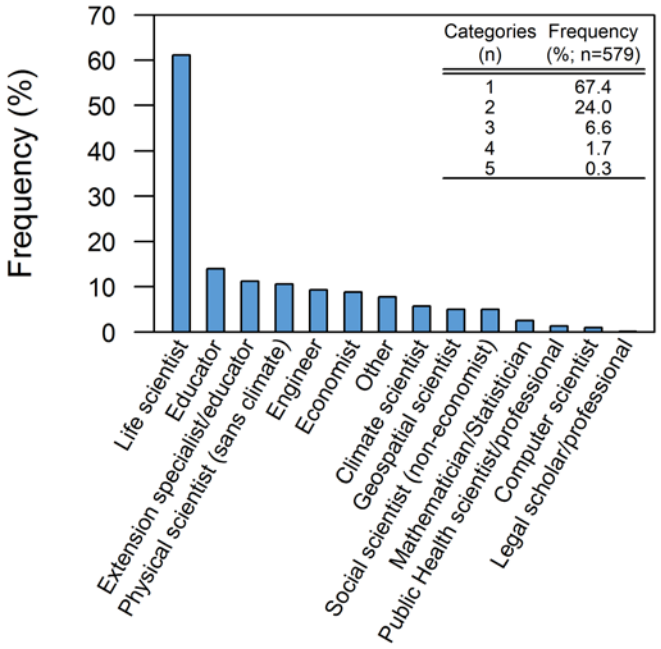

Figure 20. Capacity - PD scientist/professional
Corresponds to closed Q52: "Please specify the type of scientist/professional you are (check all that apply):"

Table 29. Capacity - PD scientist/professional open response codes
Corresponds to open portion of Q52 (n=45[a]): "Please specify the type of scientist/professional you are (check all that apply):"

Code	Frequency (n)
Agriculturist[b]	18
Business	1
Environmentalist	1
Range Scientist	1
Soil Scientist	21
Miscellaneous[c]	4
Not specified	1

[a] Respondents indicated >1 "other" codes, which is included in the frequency table resulting in an n greater than the n of respondents.
[b] Agriculturist includes aquaculturists, agronomists, crop scientists, and horticulturists.
[c] Miscellaneous includes atmospheric scientist, communications, human-environment systems, and landscape architect.

3.1.8 Project Director Success

We were interested in understanding what elements contributed to project success. A total of 11 factors with definitions were provided as potentially contributing to project success (Q53). The PDs were asked to rank the top three most important factors. All 11 factors were identified as the top factor by at least one PD. Overall, the top three factors were identified as 1) "mission," 2) "personnel," and 3) "technical tasks." The top three factors ranked as number one were (in descending frequency) "mission" (35.4%), "personnel" (21.3%), and "institutional support" (19.4%) (Figure 21).

PDs were asked to score the importance of 34 project success areas out of a 1-5 (1="not at all important," 5="extremely important") point scale (Table 30). Overall, the projects rated as "moderately important" or higher with a mean Likert score range of 3.1-4.4. The highest (Likert mean=4.4 and highlighted in dark blue) ranked area was "publishing research results." The lowest score (Likert mean=3.1) was "improving policy making."

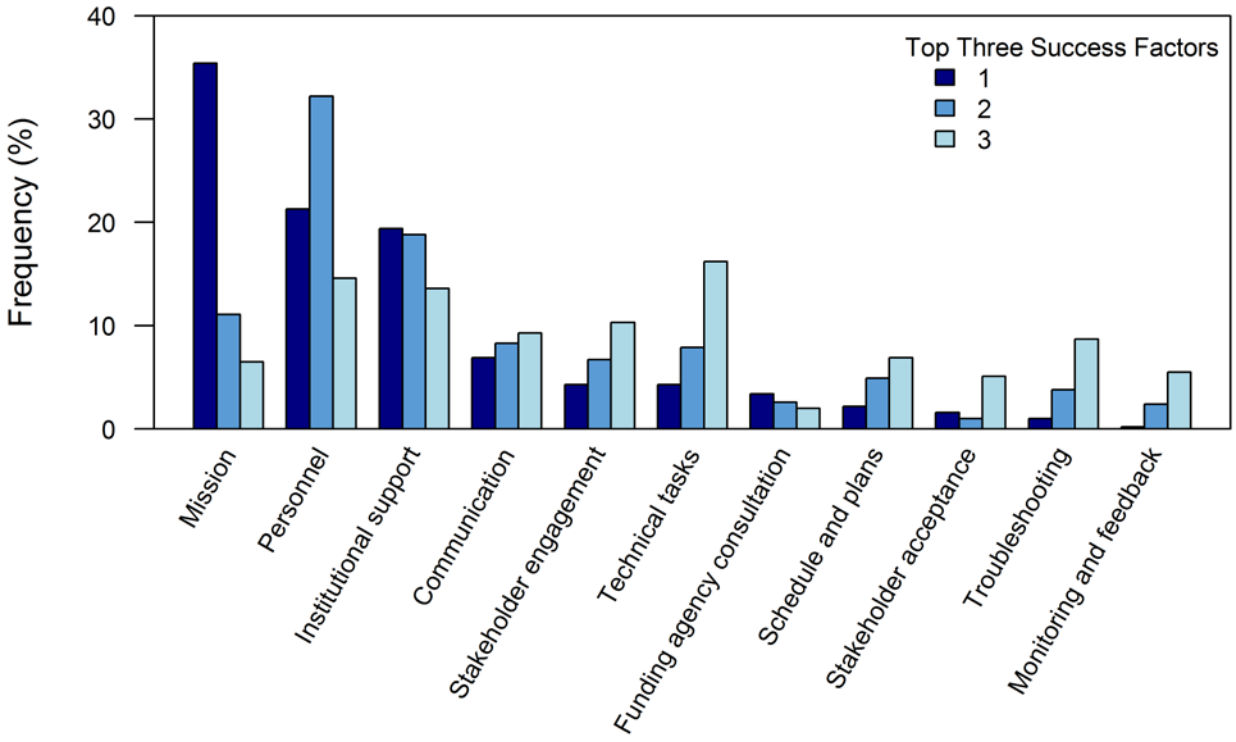

Figure 21. Capacity - Most important success factors to help achieve project success
Corresponds to closed Q53: "In your opinion, what are the three most important factors to help achieve project success?" Ordered by frequency of top success factor (n=494). Frequency calculated across ranking (e.g., number of PDs that selected "1" divided by n of respondents multiplied by 100).

Table 30. Capacity - Project area success advice

Corresponds to closed Q54: "If you were to provide advice to another PD, how important would the following areas be to the success of a project?"

Project areas	Respondents (n)	Frequency (%)					Likert mean[a]
		Not at all important	Slightly important	Moderately important	Very important	Extremely important	
Ability/flexibility to troubleshoot	523	1.1	4.0	25.0	49.7	20.1	3.8
Communicating with collaborators	523	0.6	1.1	12.8	53.7	31.7	4.1
Completing all project goals/objectives	525	0.4	3.0	28.8	46.9	21.0	3.8
Creating standardized protocols	517	4.1	10.3	39.3	37.1	9.3	3.4
Defining a lab/team/professional mission	521	3.8	7.1	27.1	44.1	17.9	3.7
Defining data needs/objectives prior to implementation	525	1.3	2.3	18.5	53.0	25.0	4.0
Developing detailed data management plans	521	1.9	11.5	34.7	37.8	14.0	3.5
Developing new relationships/synergies with other organizations	524	1.9	11.5	39.9	34.5	12.2	3.4
Developing quality assurance plans	522	4.8	15.5	35.8	33.5	10.3	3.3
Developing relationship with stakeholders	523	1.5	10.7	29.1	37.7	21.0	3.7
Early stakeholder involvement	522	2.9	15.5	34.3	31.2	16.1	3.4
Engaging in social activities with collaborators/peers	522	2.9	15.5	34.3	31.2	16.1	3.4
Enhancing project team relationships	523	1.9	11.5	33.1	42.4	11.1	3.5
Enhancing/developing relationship with stakeholders	519	2.1	12.3	34.1	41.6	9.8	3.4
Funding agency satisfaction with outcomes/progress	518	2.1	5.0	24.3	45.2	23.4	3.8
Having a project manager	515	8.3	11.3	30.5	34.0	15.9	3.4
Having institutional support for and authority to acquire resources	521	1.0	2.1	16.7	43.4	36.9	4.1
Having interdisciplinary project teams	521	3.5	9.6	31.5	38.6	16.9	3.6
Having sense of urgency	516	6.0	17.2	36.2	30.8	9.7	3.2
Impacting stakeholder behavior	519	4.2	15.4	35.3	34.5	10.6	3.3
Improving policy making	518	6.2	21.4	40	24.7	7.7	3.1
Increasing your reputation/value to funding agency	515	2.1	10.1	33.2	40.4	14.2	3.5
Involving project stakeholders early on in project design	520	4.2	16.5	33.5	36.3	9.4	3.3
Leveraging funds	517	0.8	4.8	23.4	47.8	23.2	3.9
Monitoring and receiving feedback from stakeholders	515	2.9	14.2	35.9	36.5	10.5	3.4
Open line of communication with funding agencies	517	2.7	8.1	35.8	42.4	11.0	3.5
Operating within budget	517	1.0	2.9	16.6	47.0	32.5	4.1
Overcoming technological limitations	516	1.6	4.5	25.0	51.4	17.6	3.8
Publishing research results	522	0.4	1.5	9.4	35.8	52.9	4.4
Recruiting personnel	516	2.3	2.9	14.7	37.6	42.4	4.1
Satisfaction with outcomes/progress	520	0.4	1.3	18.3	55.4	24.6	4.0
Sharing research results with stakeholders	521	1.0	3.6	16.3	46.8	32.2	4.1
Training university students	520	1.0	3.5	15.0	41.9	38.7	4.1
Using adaptive management techniques	513	5.1	9.7	33.9	36.5	14.8	3.5
Other[b]	40	22.5	5.0	27.5	30	15.0	3.1

[a] Calculated from Likert scale 1-5 (1="Not at all important" to 5="Extremely important"); shading corresponds to lowest mean=light blue and highest mean=dark blue. [b] The specified other areas are not detailed in this report.

3.1.9 Journal Articles and Additional Comments

Journal article publications provided in Q56 and 57 were consolidated and summarized by NIFA Knowledge Area Topic in Table 31.

Additional comments provided by PDs included how they were unsure of why they were considered part of the Climate Portfolio, specific project details, comments about capacity projects, how their projects were still ongoing therefore completing the survey seemed preemptive, comments about NIFA, and suggestions to NIFA. Feedback regarding the survey was not included in this report (Table 32).

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Table 31. Capacity - Journal assessment summary

Corresponds to Q56 "Please provide a citation list of products (e.g., papers, materials, presentations, extension, website, etc.) generated by this project to date using the upload option below" and Q57, "Please provide up to 5 products (e.g., papers, materials, model outcomes, presentations, extension, website, etc.) that you believe to be the most important products generated by this project to date." Summary presented by NIFA Knowledge Area Topic (n=88).

Knowledge Area Topic	Articles (n)	Number of authors (mean ± sd)	Journal Impact Factor[a] (mean ± sd)	Climate or Weather (%)			Publication Year (%)								
				Weather	Climate	Neither	1970s-2000s	2010	2011	2012	2013	2014	2015	2016	2017
Agricultural, Natural Resource, & Biological Engineering	19	3.74 ± 2.21	2.19 ± 1.72	5.3	0	94.7	0	0	0	15.8	26.3	15.8	15.8	26.3	0
Air	24	5.38 ± 3.1	2.49 ± 1.46	0	0	100	0	0	0	0	0	0	58.3	41.7	0
Animal Production	23	5.30 ± 2.03	2.37 ± 1.02	21.7	13	65.2	0	0	8.7	4.3	0	30.4	21.7	26.1	8.7
Animal Protection	27	4.30 ± 1.96	1.67 ± 0.78	3.7	3.7	92.6	77.7	3.7	0	0	11.1	3.7	3.7	0	0
Economics, Markets, & Policy	15	3.73 ± 1.53	1.58 ± 1.36	0	20.0	80.0	0	0	0	6.7	6.7	6.7	26.7	40.0	13.3
Food Safety	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Forest & Range Resources	270	5.73 ± 10.81	2.38 ± 1.85	11.1	20.4	68.5	24.9	8.1	7.4	17.4	11.1	11.9	7.8	10	1.5
Human Health	21	4.38 ± 2.96	2.33 ± 1.18	14.3	23.8	61.9	4.8	9.5	9.5	14.3	19	9.5	19	9.5	4.8
Natural Resources, General	99	8.29 ± 20.38	3.62 ± 3.92	12.1	33.3	54.5	3	4	2	15.2	14.1	12.1	23.2	23.2	3
Non-food	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plant Production	301	4.87 ± 3.52	2.98 ± 3.16	14	12	74.1	23.3	3.7	5.6	7.3	6.3	16.3	15.3	22.3	0
Plant Protection	52	4.90 ± 3.02	1.52 ± 1.02	0	13.5	86.5	1.9	0	1.9	3.8	3.8	0	46.2	38.5	3.8
Soil	221	4.19 ± 1.92	2.26 ± 1.34	8.1	14.0	77.8	61.6	6.8	3.2	2.7	4.1	4.5	7.7	8.6	0.9
Water	74	4.80 ± 3.72	2.64 ± 1.92	13.5	18.9	67.6	0	0	6.8	9.5	14.9	28.4	25.7	14.9	0

[a]5-year mean

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Table 32. Capacity - Additional comments
Corresponds to open Q58: "Please use the space below for any additional comments about this survey or NIFA projects and funding."

Code	Counts	Description	Responses
Question climate	18	Unsure why included in the portfolio or climate tangential within project	*"Given the political climate, I am suspicious of being asked about my work related to high temperature tolerance on crop productivity and yield. . . . . even though this is a very significant and important issue that impacts agricultural yield worldwide. In fact heat and water availability are the two leading factors reducing agricultural yield worldwide."* *"I did not realize that this project had a climate aspect to it."* *"I actually don't think my project applies here. When I began my faculty position in 1982 I wrote my first Hatch project; I then revised it every five years until my retirement in 2015. The program under which it falls was only recently renamed to climate change, and my program over my career did not focus on climate change. However, I have received reminders to do the survey so I did. Hopefully some of my comments are helpful!"* *"The focus of my project was not directly with climate. The goal is to educate landowners about sustainable forest management. If I were to promote my programs to landowners as opportunities to mitigate climate, very few would attend. Instead, by teaching them about sustainable forestry, directly or indirectly, the environment and (presumably) the climate will benefit."* *I honestly do not think this survey applies to me as I have no projects related to climate change or agro ecosystem. That does not mean these are not important topics. I suggest you contact other faculty in our research center, which includes agroecologists, hydrologists, soil scientists, among others who can provide a better assessment for your survey.* *"The reason I did not fill this out earlier was that we don't have a specific climate program. All of our efforts in forestry impact the climate, but we do not have a specific program."* *"It is not clear that the project is related to Climate Change - so perhaps it should not be included in your results?"* *"Our program is not closely connected with climate change research or outreach. We work on issues addressed by local Steering Committees. Climate Change has not been recognized as a priority. We continually address related issues related to pests, diseases, weeds and crop production."* *"This is not really a climate science project and probably should not be included. We are examining the effects of land use change and growing biofuel feedstock on water yield and quality. Nor is it a large Coordinated (CAP) project so many of the questions were not relevant."* *"Just a note to say that climate was not a major component of this research until just recently."* *"My project is only tangentially related to climate."* *"I am not sure how you got my project for this survey, but I have doubts about its appropriateness."* *"I'm not sure why I got it since my project is only minimally linked to climate and certainly has no climate scientist involved."* *"I am glad to complete this survey, but it is my opinion that my USDA-NIFA project does not really relate to climate area. Thanks."* *"My project has nothing to do with environmental climate change. I don't think I should be included in this survey."* *"This project does not address global climate change directly. However, global climate change will impact all agriculture sectors as pests and*

Code	Counts	Description	Responses
			diseases and pests move north win warming and as adapted varieties are lost due to changing weather patterns." *"This was not a climate project, thus I am not sure if my responses are relevant."* *"I can see a slight connection to climate change in terms of it's affect on water management, however, the project wasn't written to address that in any way."*
Project detail	14	Detail regarding project	*"This project was completed years ago and the final report with results and publications has been submitted."* *"I have nothing to mail in terms of publications. Our website is [website]. From this site you can link to the [name] network site where [state] observations can be found. You can also link to our snow event page that provides an example of a product produced using data gathered through this project."* *"This is long and it is hard to choose between long lists of good things."* *"The funding I received from this program offered leverage to the award [award name]."* *"There are no products or citations to share. This was a very limited hatch grant and no climate scientist was involved. The project ended a month ago so I don't think this was appropriate for me to be included in this survey."* *"The [name] projects pubs are [location]. We do not have an established project Web site repository at our Lab.* *"My project just closed a month ago so I am currently developing manuscripts. I also used the NIFA project to leverage other funding that is allowing me to expand the research so I will be collecting more data, which will extend the timeframe."* *"The project publications (2) are pending review and the student is defending his thesis in Nov. 2016."* *"This project was initiated last year and will soon be terminated. NIFA asked us to merge several small projects into larger "Umbrella" projects. I am now leading one of the "Umbrella" projects, which have just recently been approved by NIFA. Therefore, the previous project will soon be terminated."* *"I honestly have no idea how it is connected to the goals of NIFA and so my survey may be skewed due to my lack of knowledge. However, it's not due to lack of asking questions about the process..."* *"When working with folks who have septic systems, most of these people are not farmers, but live on the urban/rural interface."* *"It is hard to assess stakeholder impacts across the board. If I improve safe grain storage by reaching 45 farmers that store grain on-farm that represents storage of 80% of the grain produced on farms that average more than 2500 acres in size and produce an average of approximately 30 bushels per acre. That is a LOT of outcome for 45 farmers - 2.7 million bushels that can be better preserved. This just sounds a lot different than 45 farmers at a trade meeting."* *"Also, as the primary results of this project will not be published for some time, it is important to understand that results of a funded project may take several years beyond the duration of funding to be realized."* *"For those scientists studying plant response to stress, I was not sure how or why there was so much emphasis on the word climate throughout the survey. I understand it is good to include climate as one focus but the projects that many of us are working on extend way beyond climate (i.e., resource use*

Code	Counts	Description	Responses
			efficiency, economic sustainability, water use efficiency, tolerance to salinity, tolerance to biotic pests).”
Capacity project	13	Capacity project so difficult to respond or unclear why completing survey	*“I have an umbrella CRIS which means I do not have a federally funded project, so this really does not pertain to me.”* *“I would like to point out that the survey answers I provided are most likely not useful for you, since I only have a Hatch project and not a real USDA project that would require a project team, collaborators, evaluation of progress etc. You may want to consider in the future to exclude Hatch projects.”* *“I was very confused by this survey. The project [name] is a McIntire-Stennis project and did not seem to fit into this survey.”* *“I am not a climate scientist. It was very hard to get through this very extensive survey for just a modest multi-state project.”* *“Because this was Hatch funding and foundational to my program (supported only my salary), my answers do not apply to my more competitively funded projects. This biggest limitation I see to project success is sufficient resources to conduct the work.”* *“I'm not really sure how to interpret this study or what it wants me to send in. On the front end, I received no direct funds (that I am aware of) from Mac-Stennis to do the research and so I referenced a number of different projects in my proposal and in the 'products' associated with this proposal. Do you want those and if you do should Mac-Stennis get credit for funding those? I question whether they should or how much.”* *“This project, other than my salary, was self-funded. I was unaware that my project was counted as a NIFA project. I did do some reporting, but did as I was told. I received no support funds.”* *“I have intentionally left part of the survey blank as this project was a "shell" - a Hatch submission required by my Experiment Station director AFTER I received a USDA-AFRI grant on the same topic. I will report separately on that.”* *“This survey asked me to comment about my activities in a multi-state project, and many of the questions seemed more relevant to a project supported by competitive grant funds or in the Climate change area.”* *“This is a Hatch project that provides 25% of my salary. There is no other research support. As a result most of the output is joint with other projects/funding sources.”* *“Well, I'm confused about what you really wanted to know about. My answers are NOT based on our Hatch/McIntyre/Stennis funding and CRIS project, but a multistate CAP funded by NIFA.”* *“Also, because no funding for this project is provided at my institution, some of the questions did not seem applicable to my situation.”* *“When hired, I was instructed to write a hatch plan and make it easy to implement because I would not receive funds to conduct the research. I used my start up package to implement the project.”*
Ongoing	13	Project still ongoing	*“Still working on generating final products, so nothing to upload.”* *“Still compiling data -Funding should increase towards animal systems under grazing conditions”* *“This project just started...we do not have products yet?”* *“I think the survey timing is too early so it has been difficult to give feedback, the project is just beginning.”*

Code	Counts	Description	Responses
			"One of the challenges it that projects aren't complete when they are funded -- they get published etc. after the project period. That makes reporting, and also this survey, hard to do well. In other words, we are still underway and thus have no products to report." *"I currently cannot email you 5 products of this project because data analysis and manuscript preparation are ongoing."* *"This is still ongoing and we have not finished the study yet."* *"We are just beginning the second year of this project."* *"This project is only half way and we will have more products by the end of 2017."* *"This has been a good project but we are still working on products."* *"Also, it is ongoing (about half way through) so many of the questions were not particularly pertinent. I answered best I could, but honestly, I would consider dropping this from your analysis."* *"Here are no published documents from this project, which is ongoing. So I have none to e-mail you and may not for a couple of years."* *"This project just finished year 2 of 4, so there isn't much return on the project in terms of true products right now."*
NIFA comment	10	General comment about program or NIFA	*"I submitted a proposal and listed the papers I wrote every year, but got no money, so it seemed like a shell game, and a waste of my time. If NIFA actually wanted to fund my research, I would be more involved, but the times I submitted a proposal directly to them, I was not funded."* *"NIFA is doing a great job, the USFS is a disaster."* *"We appreciate and are grateful for these capacity funds. Without them, our ability to provide quality Extension programming on forest and rangeland resources would be seriously limited."* *"NIFA is extremely helpful regardless of the size of the institution. This allows scientist to attend to the needs of the small/limited resource or large client (stakeholder)."* *"This survey is typical of the onerous USDA reporting burden required to receive the paltry amount of travel money."* *"Hatch funding is very valuable for agricultural research to continue to be conducted at universities."* *"Projects are languishing under a mountain of reports that have been requested by departments, colleges, funding agencies ... There is a limit beyond which no work will be accomplished because bureaucrats request the researchers to do work that the bureaucrats can and should do."* *"We have enjoyed NIFA funding for years, and they seem to be very happy with the products that we provide."* *"NIFA screwed up when it eliminated its internal experts and decided to devolve program management and evaluation to leaders of large project, rather than single investigator projects."* *"Most of the collaborators on the project receive only funds to travel to a committee meeting. Without direct funds to support the actual research, it becomes a matter of borrowing from one source to fund the research for this project. That makes it very difficult to fulfill the scope of the research unless a competitive or industry grant is awarded that aligns with the objectives of this regional project."*

Code	Counts	Description	Responses
NIFA suggestion	6	Suggestion about program or to NIFA	*"NIFA needs to implement incentives and avenues for disadvantaged populations to gain access to resources."* *"NIFA should stop lying and be sincere when it advocate multi-state projects, fund them."* *"The effect of climate change and global change more generally should be addressed in urban areas and urban forests where most people live. The emphasis on field crops and big ag is old school. These areas of research already have plenty of money form industry, USDA, and other sources. Funding for IPM and climate adaptation in urban and suburban areas is almost non-existent but will have the greatest impact on people and their awareness of climate change."* *"Multi-state NC projects need to give state PDs control of the Hatch fund allocation in order to insure completion of project objectives."* *"I strongly suggest there be mentors or advisors for new investigators. My institution did not provide guidance and I feel the lack of progress and success is a direct result."* *"Large projects (see ARS relative productivity) achieve at best the median of the group of scientists involved, and at worst that of the least. Go back to single investigator projects and do your own management."*
PD factoid	4	Detail regarding PD	*"I retired in 2014, and so no further research or extension work on this project is anticipated."* *"I have already stated that I did not have an active role in this project nor did I receive any monies associated with it. I believe I was added as a "child" of a colleague as we were actively working in this area at the time."* *"I am not trying to shirk my responsibilities but I recently joined this regional project. I have not generated all of the information you want - e.g., five publications, etc.!"* *"I have been retired for 3 years now and am not current on the far-reaching impact of the project; therefore, I suggest you access the previous report."*
Miscellaneous	2	Miscellaneous project specific activities and/or interactions	*"Dear Sir or Madam, I am very interested in our research and development and have strong passion for science and technology. We hope we can make contributions for the society and community, and also want to make the project done successfully. Although we work very hard, the budget and funding is still a key factor affecting the project and also for the research and development. I wish we could have more funding to support our research and development in vegetable crops! Many thanks!"* *"You asked an interesting question in the survey - if a sense of urgency is needed. Probably yes, but thoughtful science is still needed. That requires a sense of tranquility. Things are so urgent that, through panels and journal reviews, I see a substantial amount of unneeded research proposals and paper submissions that try to study what we already know, a trivialization of past research. The system is failing at weeding out replication and at fostering synergies. Polite but rigorous science is needed now more than ever."*
Not coded	5	Vague or irrelevant	*"N/A" (n=5)*

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3.2 Competitive Funded Projects

3.2.1 Introduction

3.2.1.1 Response Rate

Competitive funded Climate Portfolio PDs completed (defined by responding to at least Q2) a total of 345 surveys. Each survey response is specific to a project (i.e., number of projects and not number of PDs since PDs could have multiple projects in the portfolio). Distribution consisted of 562 surveys, which included 17 bad addresses. Bad addresses include email addresses that bounced, were later identified as incorrect by receipt of an email from incorrect addressee, as well as respondents that indicated "No; I have no relationship to this project." The final response rate for 562 eligible recipients and 345 completed surveys was 61.2% (number of responses per eligible recipients by 100 [Vaske 2008]). Not all respondents answered all questions; therefore, response rates vary by question. Figure 22 presents the percent of projects within NIFA Knowledge Area Topic (as defined in USDA-NIFA 2013). The most frequent topics were "soil" (26.4%) and "general natural resources" (24.9%).

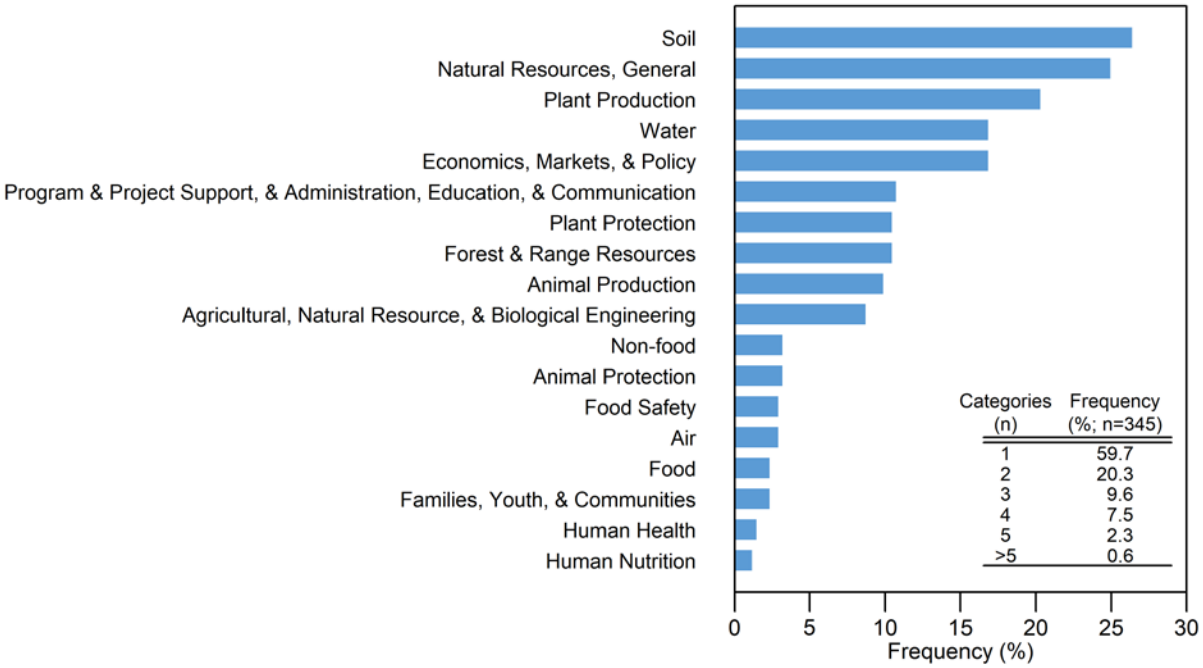

Figure 22. Competitive - Projects by NIFA Knowledge Area Topic
Inset table indicates the frequency of projects with ≥ 1 topic.

3.2.1.2 Respondent and Active Status

Nearly all (98.8%; total n=344) respondents identified as the PD or co-PD of the project (Q1). The remaining four respondents indicated their significant role in the project as a principal investigator, post-doctoral associate, and current chair (n=1 blank response).

The majority (69.0%) of the projects were still active at the time the survey was completed (Q2).

3.2.2 Project Summary

The majority of projects were categorized as "research" only (51.2%; Table 33). Of research oriented projects (i.e., those that indicated "research" in Q9), most (79.2%) projects were classified as "applied" (Figure 23). The geographical focus was primarily "farmland" (50.3%; Figure 24). Additionally, respondents indicated the majority (55.5%) of their projects centered on a single geographical focus (inset table of Figure 24). The most frequent "other" geographical focus area identified was coded as "broad" (i.e., cross-sectional or mixed) (Table 34). "Multi-state/multi-territory" geographical extent was the dominant extent for competitive projects (26.2%; Figure 25). A single extent was most (80.5%) frequently selected by PDs (inset table to Figure 25). Within the

competitive project portfolio, work was being conducted in all states and territories, slightly favoring California (15.8%; Figure 26 and 27). The majority (44.8%) of projects were conducted in a single state (inset table of Figure 26).

Non-PD project scientists/professionals consisted primarily of "life scientists" (67.9%; Figure 28). The "other" scientists/professionals specified by PDs were coded and are included in Table 35. The average (median) number of PDs on a project was three and the number of PDs on project ranged from 1-50 (n=341; Q15). Co-PDs were predominately located at universities ("interuniversity" 50.6% and "intra-university" 49.0%; Figure 29). Co-PDs outside of universities and the government were in the minority, specified responses were coded and are included in Table 36. Most of the co-PDs were not from a minority serving institution (MSI) ("no"=81.9%, "yes"=15.3%, and "don't know"=3.1%; n=296; Q17). Additionally, most of the projects did not interact with MSIs ("no"=79.8%, "yes"=20.2%, and "don't know"=0%; n=242; Q18).

The project goals for most of the projects did not change over the course of the project ("no"=89.6% and "yes"=10.4%; n=337; Q19). For the projects that did modify project goals it was predominantly (n=9) due to knowledge gained during the project required the goals to evolve (Table 37).

The majority of projects did generate datasets and made the datasets public (78.9% and 70.3%, respectively). Most projects did not access privileged datasets and those that did, did not make them available after use (86.7% and 63.4%, respectively). The majority (56.7%) of projects did not use data created by other NIFA funded projects (Table 38).

Approximately one-third (31.6%) of the projects interacted with multi-state Hatch projects and more were likely (45.3%) to interact with other USDA funded initiatives (Table 39).

Table 33. Competitive - Project type
Corresponds to closed Q9: "Please specify the project type:"

Project Type	Frequency (%; n=344)
Education	5.8
Extension	1.2
Research	51.2
Education and Extension	3.5
Education and Research	9.6
Extension and Research	15.4
Education, Extension, and Research	13.4

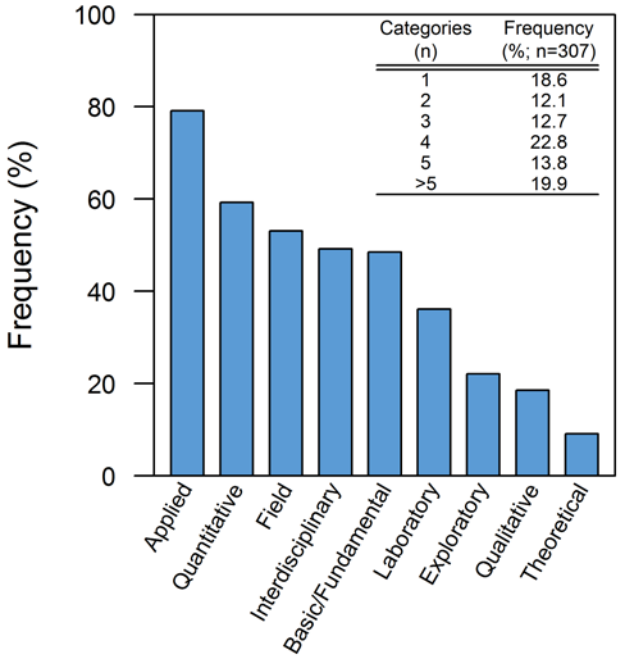

Figure 23. Competitive - Research classification
Corresponds to closed Q10: How would you classify this project's research (check all that apply)?"

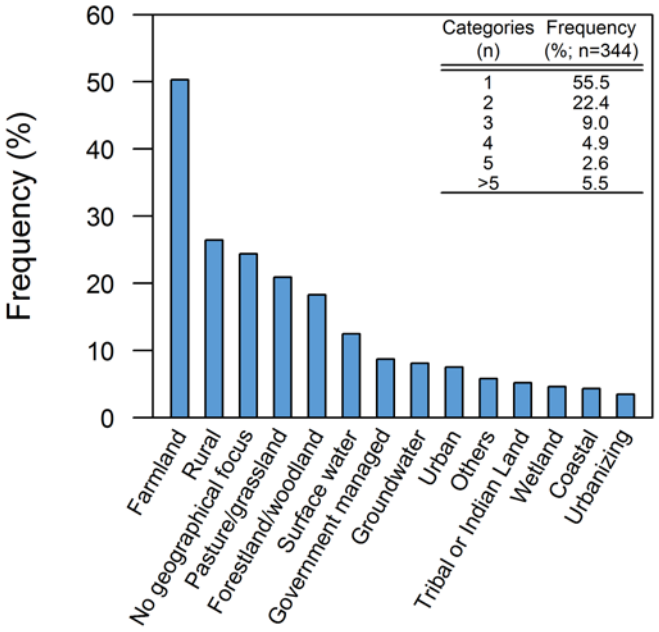

Figure 24. Competitive - Geographical focus areas
Corresponds to closed Q11: "Please indicate the geographical focus feature/area of the project (check all that apply):"

Table 34. Competitive - Geographical focus areas open response codes
Corresponds to open portion of Q11 (n=20[a]): "Please indicate the geographical focus feature/area of the project (check all that apply):"

Code	Frequency (n)
Broad (i.e., cross-sectional, mixed, not specific to any one feature)	9
Climate-specific (e.g., drylands, tropics)	2
Mines	1
Rangeland	5
Miscellaneous[b]	3
Not specified	1

[a] Respondents indicated >1 "other" codes, which is included in the frequency table resulting in an n greater than the n of respondents.
[b] Miscellaneous focus areas include marginal farmland, the urban wildland interface, and the built environment.

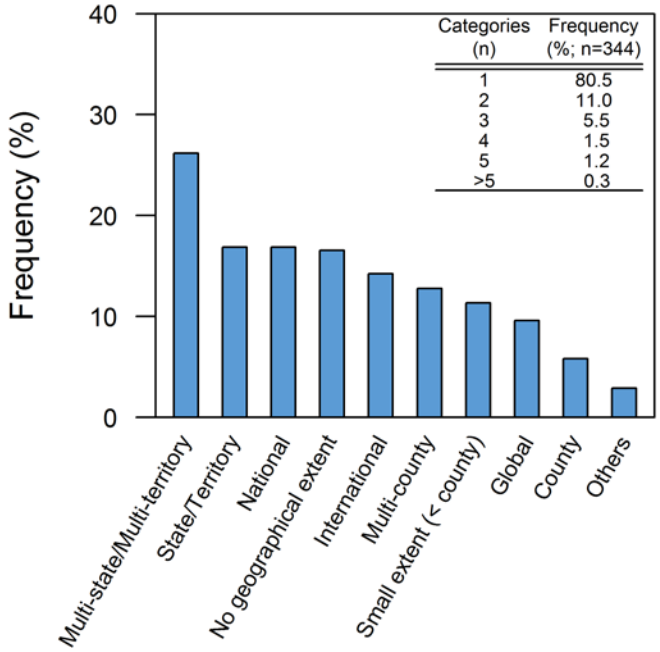

Figure 25. Competitive - Geographical extent
Corresponds to closed Q12: "Please indicate the geographical extent of your project (check all that apply):" The "other" responses include eight responses that were not coded due to being either irrelevant or vague and two non-specified responses.

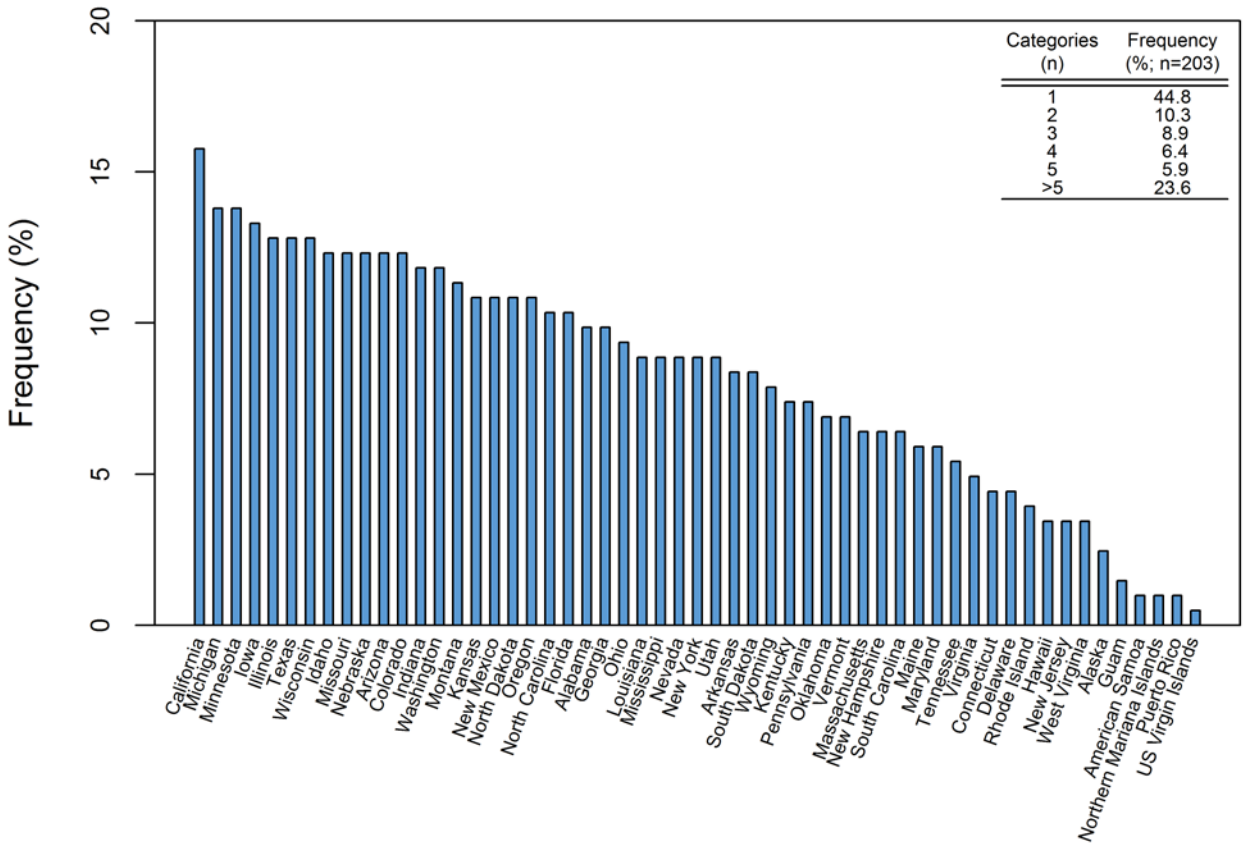

Figure 26. Competitive - States/Territories
Corresponds to closed Q13: "Please identify the state(s)/territory(-ies) included in the project's geographical extent (check all that apply):"

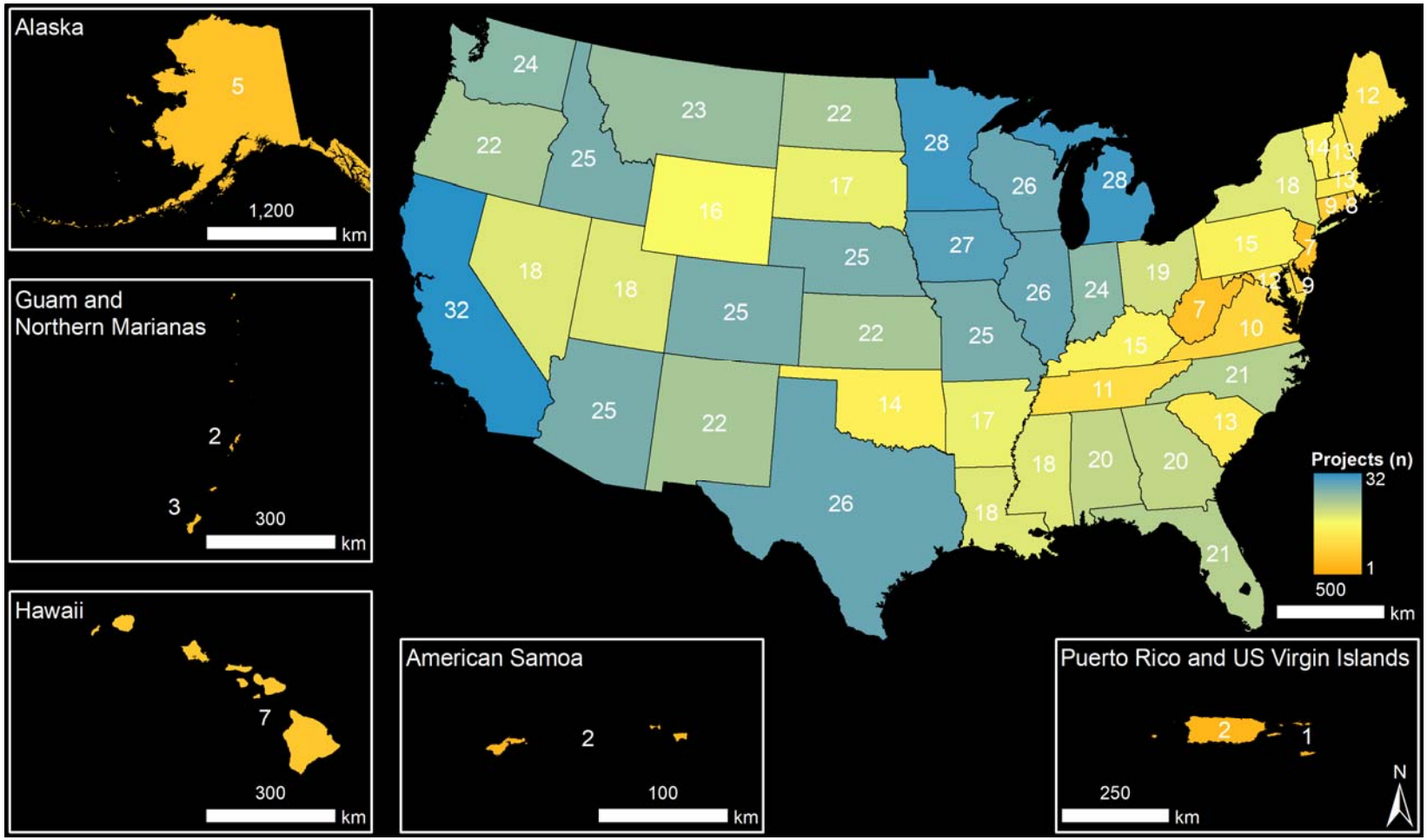

Figure 27. Competitive - States/Territories map
Corresponds to closed Q13: "Please identify the state(s)/territory(-ies) included in the project's geographical extent (check all that apply):"

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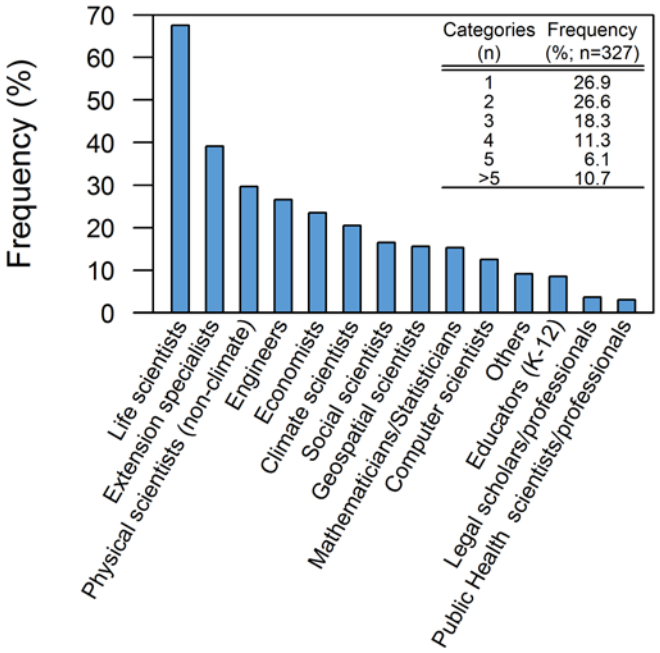

Figure 28. Competitive - Project personnel (non-PD)
Corresponds to closed Q14: "Excluding yourself as the PD, indicate the types of scientists/professionals included as part of the project team (i.e., funded by the project) (check all that apply):"

Table 35. Competitive - Project personnel (non-PD) open response codes
Corresponds to open portion of Q14 (n=30[a]): "Excluding yourself as the PD, indicate the types of scientists/professionals included as part of the project team (i.e., funded by the project) (check all that apply):"

Code	Frequency (n)
Agriculturists	6
Farmers/ranchers	4
Managers	2
None (i.e., no other personnel)	1
Soil scientists	6
Miscellaneous[b]	11
Not coded[c]	6

[a] Respondents indicated >1 "other" codes, which is included in the frequency table resulting in an n greater than the n of respondents.
[b] Miscellaneous scientists/professionals includes community organizers, computational modeler, culinary arts, evaluators, irrigation, philosopher, rural planning, tribal management, videographer, web marketing.
[c] Response irrelevant or vague.

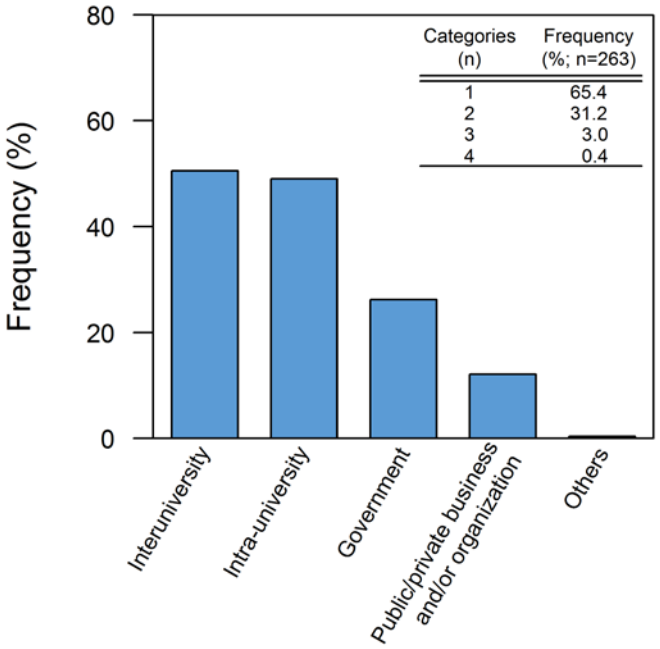

Figure 29. Competitive - Co-PD locations
Corresponds to closed Q16: "Please indicate where the co-PDs were located when this project was funded (check all that apply):"

Table 36. Competitive - Co-PD locations open response codes
Corresponds to open portion of Q16 (n=32[a]): "Please indicate where the co-PDs were located when this project was funded (check all that apply):"

Code	Frequency (n)
Public/private business and/or organization	
Agribusiness	2
Business	11
Conservation	1
Farmer/producers/ranchers	2
Research	9
Miscellaneous[b]	2
Not specified	7
Not coded[c]	3
Other	
International	1

[a] Respondents indicated >1 "other" codes, which is included in the frequency table resulting in an n greater than the n of respondents.
[b] Miscellaneous includes banks.
[c] Response irrelevant or vague.

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Table 37. Competitive - Rationale for project goal modification code frequencies and descriptions
Corresponds to open portion of Q19: "Have the project goal(s) changed over the course of the project? Yes (please explain how and why):" Codes ordered by frequency (n=35); respondents indicated >1 codes, which is included in the frequency table resulting in an n greater than the n of respondents.

Code	Frequency (n)	Description	Examples
Evolution	9	Knowledge gained during project required project to evolve	*"Some strategies were changed based on data collected throughout the grant and other published research."* *"Certain of the enzymes tested did not work as originally envisioned."*
Unanticipated event/barrier	6	Reacted due to unexpected event or barrier	*"Unanticipated obstacles necessitated a new selection method."* *"We were hoping to develop a couple of cross listed 400/500 level courses but [university name] did not allow it."*
Adapt	4	Project adapted due to outside influence(s)	*"Based on feedback from potential customers and technical findings the project goal pivoted to better serve farmers."* *"Updated based on evolving needs of the potato industry and consumers."*
Emphasis changed	4	Altered emphasis	*"From school district grants to post-secondary programming."* *"Has switched to thermotolerance."*
Personnel change	4	Project team member departed/replaced	*"One of the original CoPDs retired in the first year of the project unexpectedly, causing us to shift his work a bit."* *"One PD left the project before the initiation due to personal reasons. Another PD was brought on to strengthen the ecological research and education (in response to reviewer comments)."*
Expanded scope	2	Scope of work increased	*"They have expanded to include more focus on nitrogen metabolism."* *"The scope of the project grew beyond the original goals."*
Feasibility	2	Scope of work not feasible as planned	*"The scope of the project, as originally described, was quite large and allowed no time for troubleshooting."* *"The modeling aspect was over-ambitious, so I am hoping to achieve it through additional collaboration."*
Funding limitations	1	Lack of funding	*"The outreach goals were modified at the outset of the project based on initial resource allocation. Although some minor modifications were made to the project experiments the primary goals were achieved."*
Geographical scope	1	Location of work	*"Had a focus on four basins. Switched one of the basins . . ."*
Requirement	1	Required to change by NIFA or institution	*"Grant was modified by the new leadership of the institution."*
Not specified	2	No response provided	*"NA."*
Not coded	2	Vague or irrelevant	*"Each PD had different opportunities available to them to accomplish the general goals of the grant."* *"We are strengthening current Environmental Systems not changing to Environmental Science."*

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Table 38. Competitive - Dataset generation and use

Question	Respondents	Frequency (%)		
	(n)	No	Yes	Don't know
Did/Will the project generate datasets? (Q20)	336	16.1	78.9	5.1
Were/Will the datasets made/be made publicly available? (Q21)	263	16	70.3	13.7
Did/Will the project access privileged datasets (i.e., restricted/proprietary data)? (Q22)	308	86.7	13.3	0
Were/Will the privileged datasets made/be made accessible to the public? (Q23)	41	63.4	4.9	31.7
Did/Will the project use data created by other NIFA funded projects? (Q24)	335	56.7	24.2	19.1

Table 39. Competitive - Project interaction with other USDA projects

Question	Respondents	Frequency (%)		
	(n)	No	Yes	Don't know
Did/Will the project interact (i.e., share resources, ideas, or data, meeting attendance, and/or collaborate) with multi-state Hatch projects? (Q25)	339	42.8	31.6	25.7
Did/Will the project interact (i.e., share resources, ideas, or data, meeting attendance, and/or collaborate) with other USDA-NIFA or USDA funded initiatives that were not multi-state Hatch projects (e.g., CAP projects, climate hubs, etc.)? (Q26)	338	29.9	45.3	24.9

3.2.3 Project Success

The survey requested PDs to reflect on project success in a series of open questions. The PD responses regarding how their project was successful resulted in the development of 33 codes (Table 40). The majority (n=134) of PDs identified their project success was due to "knowledge gained" followed by "met objectives" (n=80). In terms of what could have made their projects more successful, their responses resulted in 25 codes; the two most common codes identified were "barriers" (n=49) and "project management" (n=47; Table 41).

Most (85.7%) of the PDs indicated that they evaluated project success (n=321; Q29). Project evaluations were primarily conducted annually (62.4%) and at the end of the project (62.0%; Figure 30). Specified other times projects were evaluated are presented in Table 42. Nearly all (98.5%) of PDs indicated that completion of objectives was the most common project element assessed (Figure 31). Specified other assessment elements are presented in Table 43. Most (72.5% and 71.4%, respectively) projects were evaluated informally or by reports; however, few (2.9%) projects were only evaluated by one method (Figure 32). Specified other evaluation methods are presented in Table 44.

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Table 40. Competitive - How projects were successful code frequencies and descriptions
Corresponds to open Q27: "Please tell us, in your opinion, how this project was successful to date:" Codes ordered by frequency (n=303).

Code	Frequency (n)	Description	Examples
Knowledge gained	134	Scientific knowledge gained, expand knowledge	*"The project has proven that the effect of temperature increase could affect bee-blueberry-mite interactions in positive and negative ways depending on geographic locations. So, our project was completed successfully."* *"We have learned strategies for reducing nitrogen emissions from farm systems. We also discovered a use for biochar in digesters to reduce operating costs that some operators are currently already testing in the field."* *"We are in the processes to develop a near real time drought forecasting model. Some preliminary analysis were completed."* *"The project demonstrated the feasibility and reliability of wide-area coverage estimates of tillage practice and winter cover cropping going back 10 years by primarily relying on remote sensing observations."* *"This project aimed to estimate the relative roles of anthropogenic greenhouse gases and natural variability in ocean temperature on the probability of the type of very severe drought that occurred in the central US in 2012. This project was successful in that it resulted in quantified estimates of the roles of these two influences, shedding important light on the impact that greenhouse gases are already having on such severe events in the US."*
Met objectives	80	Project goals accomplished	*"The success of the project is indicated by the achievement of its original goal and objectives as outlined in the proposal."* *"We achieved our aim to identify transcriptional profiles of peanut seeds permissive for aflatoxin formation."* *"Achieve two main goals outlined in the project: 1. Acquisition of a nitrogen analyzer; 2. Training of graduate and undergraduate students in agriculture related research areas."*
Collaboration	60	Beneficial partnerships, relationships, or interactions established/ developed includes reciprocal data sharing	*"Complementary expertise of PDs are important."* *"The project has forged productive collaborative relationships between researchers at four different institutions. This team has a unique combination of skills which is permitting us to bring new tools and insights to bear on the question of forest carbon sequestration. This has resulted in a number of very interesting papers currently under review as well as a couple of more in process. Also, as a direct result of this collaboration, one of the junior scientists has been hired by the Department in which one of the co-PD's resides. In addition to the original team, we have now drawn into the project a forest ecologist, who is offering new insights and data with regard to climate impacts on forests."* *"The project's success so far is indeed established based on the true nature of interdisciplinary collaboration -- Soil Scientist ([name]), Remote Sensing Scientist ([name]), and myself as a Civil/Electrical Engineer. We work in differently yet towards a cogently defined goal - to integrate, develop and validate …."* *"It has been very rewarding seeing the research team with various backgrounds come together to address a complex problem. I am beginning to see true interdisciplinary collaboration as the research progresses."*

Code	Frequency (n)	Description	Examples
Students	58	Undergraduate/graduate students were involved and/or funded includes educational curriculum developed, and training of students and post-docs	*"Project was successful in facilitating student participation in an international conference."* *"This project is successful in that it is training 4 new graduate students in four different applied science fields: entomology, plant pathology, plant physiology, and plant molecular biology, all with specific focus on enhancing our understanding of environmental impacts on citrus production inside and outside of the U.S.A.* *"This project supported several undergraduates and one graduate student."* *"We completed curriculum development workshop. Developing the new course."*
Publications	54	Project led to research publications includes presentations	*"We have already published one paper and this project is ongoing."* *"We have presented many talks at National and International meetings on the project. We have published many papers in the top journals of our field. Our data set was used and published as part of a large meta-analysis in the journal Nature."* *"Animal trials complete and several manuscripts produced, accepted for publication."* *"Successful conduct of science and production of scientific and non-scientific (extension) publications [see our annual reports to USDA for numbers, topics, and content]"*
Stakeholder engagement	50	Project engagement with stakeholders and/or extension includes sharing results with stakeholders (can include researchers)	*"The most successful aspect of the program were connections made between program participants and other people, financial resources, and land resources."* *"Large number of farmers/trainees reached, especially through conferences and online resources."* *"The project has reached a wide audience of stakeholders including wheat and canola growers in the region, industry personnel, commodity groups and crop buyers."* *"This project effectively engaged producers in developing adaptation strategies to cope with climate variability and change."*
Sustained outcomes	43	Project led to increased awareness, commercially available product, change in behavior, stakeholder adoption	*"The [name] project has been successful in changing behavior, particularly for the ag service sector."* *"The project is also having success in educating farmers and ranchers on climate change and how to mitigate."* *"The project has made significant strides in pursuing this vision and has demonstrated that it is commercially feasible."*
Foundational	25	Provides a "foundation" for further research, preliminary research, provides guidance, generated results that can/should be applied	*"The project has made multiple basic discoveries that would not have been possible with typical routes of funding."* *"The project solved some of the most fundamental problems with our technology. Namely, we identified a successful attachment mechanism to secure the nitinol rods into the generator."* *"Generating novel data/datasets, variety of data collection efforts."*

Code	Frequency (n)	Description	Examples
Usefulness	19	Result are perceived by the PD as useful to scientific or stakeholder communities; includes publications being cited	*"Global emission projections are critical elements in understanding future climate impacts at global and regional scales."* *"High impact research: it can change the way farmers manage their land and adopt technologies on their farm."* *"…these tools could be used for other projects in the future."*
Leveraging capability	17	Ability of project to be leveraged for either new funds or research	*"It provided data and findings that are being used for ongoing research including another NIFA grant."* *"Funding received for this project provided data required for conducting more advanced projects and to be competitive for additional funding."* *"Led to potential new projects now that the needs and opportunities were assessed."*
Positive reception	17	Community (either scientific or stakeholders) view the results/publications positively; community acceptance includes news coverage	*"The project generated additional interest among scientists, extension specialists and agricultural organizations in the use of bioreactors and wetlands for nitrogen control."* *"As a result, it garnered five major media news including one in the front page of leading US national laboratory."* *"With the successful demonstration operation, we have received inquiry from companies which would license our technology and build commercial plants."*
Develop or sustain research site, center, program, or project	14	Develop, establish, sustain, and/or maintain a center, program, project, site, or station	*"We progressed from R&D to building and running a pilot plant to building and running a demonstration plant."* *"This project is successful in distributing funding to over 100 projects that are exploring improving the economics, environmental impacts and social benefits of agriculture."* *"The project has grown to over 300 experimental sites across 23 countries."*
Ongoing	13	Project ongoing and respondents indicated too early to judge project success	*"Project is in early stages so success of project cannot be classified."* *"Primary data collection has only just begun. It is not clear how successful the project will be until those data are analyzed."* *"This project is still in the first year of data collection."*
Project management	13	Management of tasks, within budget, on time	*"The project was initiated with a set of clear hypotheses and we developed a well-thought out experimental design for testing these. The clarity of the scope of the project and its defined goals made it easy to successfully carry out the objectives of our project."* *"To encourage the project members in a multi-university interdisciplinary research project, regular basis communication was crucial on our success under project PI's coordination. We had been communicated with each other monthly to ensure that stated objectives are met on time. In the teleconference, all team members were discussed progress of individual research efforts, and to synchronize interconnecting parts of the project."* *"The objectives, audiences, and work products are well-defined and frequently reviewed. Our approach is to do sound science that is focused on the data needs for engineering and system design, then apply disciplined design and laboratory testing/validation of intermediate elements of the solution. As a private firm, we are able to approach technology development with the commercial applications constantly in focus, thus be mission and timeline driven."*

Code	Frequency (n)	Description	Examples
Minorities	10	Employing and/or training minorities	*"I also consider student recruitment to be successful, with two U.S. graduate students, both white females who do not come from affluent backgrounds. One student is from a farm background. In addition to recruiting students from under-represented minority groups, I think it is important to make an effort to reach out to non-minority domestic students from low- and middle-income families as much as possible."* *"We successfully recruited and trained several women and racial and ethnic minorities."* *"We recruited for 1.5 years, an undergraduate minority student to work in the lab. She has now graduated and is pursuing medical school.'*
Policy	8	Project led to a policy change includes guideline and inventory equation(s), BMPs, developing policy changes, talking with policymakers	*"It has introduced the main PD to working in both Federally and State managed properties and has formed professional connections between the PD and federal and state officials working with natural resource management."* *"We developed novel techniques that serve as a new paradigm for integrated studies of regional agricultural and urban climate systems on decadal timescales, which are critically important for policy makers."*
Broad application	7	Large application or potential application of results	*"The proposed non-toxic approach to prevent biofouling of aquaculture gear will improve production efficiency, and thus increase profitability of aquaculture in the United States."* *"Large scale application of system approach."*
Lessons learned	5	Knowledge or understanding gained by experience that has a significant impact; experience may be either positive or negative.	*"It has been successful in eliminating the proposed objectives as feasible. We have pivoted our focus to new topics, that are still pertinent to the original question, and we are making progress with that."* *"The project has been somewhat successful. The initiation of the project has been significantly delayed because of unexpectedly high lethality of chickens during the application of environmental heat stress and therefore the IACUC intervention. We have adjusted the heat stress conditions and included additional measures to prevent their death, which led to the IACUC re-approval. Finally we have successfully raised chickens with minimum death and harvested blood and breast muscle samples for the study and are analyzing heat stress parameters in them."*
PD professional development	5	Learned/developed new skills	*"This project has been successful in that it has contributed greatly to my development as an independent researcher and faculty member."* *"The project has supported the professional development (both as a college instructor and research scientist) of the main PD [name]."*

Code	Frequency (n)	Description	Examples
Adapting	4	Flexibility to adapt to changing needs	*"The project experienced setbacks including drought and intensive heat, compounded by aggressive weed competition at the inception of the project (2011 and 2012). This delayed establishment of eastern gamagrass and switchgrass. Poor competitiveness is a well-document feature in the establishment of native warm season perennial grasses. The rains arrived in the subsequent years (2013-2015) and together with aggressive weed control regimen led to a successful project."* *"We've made improvements consistently based on feedback.*
Personnel staffing	4	Hiring of post docs and/or research staff	*"I consider it a success to have found a postdoc with highly relevant technical experience (qualitative PCR) and strong knowledge of soil nitrogen cycling processes."* *"Training staff."*
Exceeded expectations	3	Outcomes exceeded proposed objectives	*"This project is exceeding the objectives."* *"Peer-reviewed papers exceeded the proposed number."*
Integration of pre-existing projects/interests	3	Developed broadly to incorporate multiple PD interests, integration of pre-existing projects or data	*"Topic of project intrinsically interesting."* *"Ability of project to leverage ongoing activities by project co-PIs.*
Job placement	3	Student or project personnel acquired relevant jobs	*"Seventeen undergraduate students at the [university] have been employed to provide field work assistance. Three have gained meaningful employment at places such as the USDA Natural Resources Conservation Service (NRCS), Saguaro National Park, and Grand Canyon National Park, in part due to the experience they gained."* *"All graduated students (except one that took a year off to write) are working in industry or academia, documenting the demand for [organization] students."*
Leadership	2	Positive leadership	*"We've got a strong leadership team."* *"The determination of the PD to keep the organizing committee on track and find speakers was another key factor."*
Mission	2	Established a mission for PD	*"The project has enabled the PI to establish their lab and has given preliminary data for new research areas."* *"I have switched organisms and altered my field of focus."*
Outside funding	2	Outside funds were necessary	*"We've leveraged additional funds."* *"Our efforts have been bolstered by additional funding."*
Overcame obstacles	2	Troubleshooting capability	*"We overcame obstacles."* *"We've been able to respond to unexpected requests."*
Recognition	2	Awards or new program recognition	*"Won a national USDA award and an award through [university]."* *"A key feature was creating a 'community' -- an official designation -- within the American Society of Agronomy.*

Code	Frequency (n)	Description	Examples
Extended scope	1	Ability to expand project to a larger area (either geographically or disciplinarily)	*"A plot-scale study of manure application has been replicated in North Dakota, South Dakota and Nebraska. The three sites are providing variable weather and management conditions that will add variability to model validation later in the project."*
None	1	No success to report	*"This was a planning project to write a proposal. The proposal was not funded."*
Miscellaneous	6	Miscellaneous project specific activities and/or interactions	*"The yearly meeting in Washington DC has been very instrumental."* *"Presence of adequate supporting resources (e.g., experiment stations, etc)."* *"Organized special session in the American Geophysical Union meeting."*
Not coded	9	Vague or irrelevant	*"This was a very large CAP project and has been extremely productive by all of the usual measures used in research, education and extension."* *"Moderately successful."* *"Excellent."*

Table 41. Competitive - How projects could be more successful code frequencies and descriptions
Corresponds to open Q28: "Please tell us, in your opinion, how this project could have been more successful to date:" Codes ordered by frequency (n=286).

Code	Frequency (n)	Description	Examples
Barriers	49	Barriers related to conducting tasks such as politics, natural phenomenon, mandated work, etc.	*"The good weather has not cooperated in most years with inducing the stress needed for screening. Lower commercial interest than expected (has to do a lot with consolidation of industry, outside of our control)."* *"We would have been able to more thoroughly test the snow accumulation and melt out benefits of variable thinning if our project had occurred during a period of normal winter precipitation. We were delayed one year because prescribed fire treatments were not implemented until November 2013. There just wasn't a suitable burn window during the fall of 2012 or the spring of 2013. We made the choice to collect data through the summer of 2016. Therefore, fewer of the publications we proposed have been completed. However, the quality of those publications will be higher, due to the longer time frame post treatment."* *"Recruitment of diverse graduate students is very difficult because there are not good recruitment pipelines from undergraduate agriculture and natural resources programs. Therefore, we were able to recruit four females, but I was unable to recruit any graduate students from minority-serving institutions. I attempted to connect with faculty from two HCBU schools after the grant was made, but it would have been more successful if there were existing recruitment pipelines for underrepresented students into graduate programs.*
Project management	47	Increased and/or improved project management, study design, and/or preparation	*"More effective communication plan."* *"Minimize start up time by identifying a better suited candidate to perform the day to day experiments."* *"We have been somewhat behind schedule (by about 3 months). Being more on schedule would have allowed us to be more productive."*
Expansion	36	Increased/broadened project to include or expand project element (e.g., outreach, scale, tools used, scope, participants, project team personnel, and/or evaluation)	*"By collaboration with other PI's institutions / national labs, commercial stake holders (industries). Such opportunities can be created by sponsors."* *"Projects can be more if a successful project can be expanded and continued once the first project was found to be successful. The techniques could have been used on other biofilters and other conditions. It would have been nice to build on the success."* *"Higher replication numbers would have provided greater statistical power but wasn't possible within the scope of the project."*
None	36	No change would have helped the project be more successful	*"Can't think of any ways it could have been more successful."* *"The project has been extraordinarily successful. I can't imagine it being more so. We were given adequate resources to work with and a great deal of direction by NIFA. That guidance encouraged us to accomplish more than we had set out to do and was instrumental to the success of the project."* *"The developed methodology worked better than expected. I don't think it could have been more successful than it was. The original study plan development was the key to success."*

Code	Frequency (n)	Description	Examples
Funding - higher	27	Additional funding	*"Lack of money restricted our progress."* *"Projects related to biological research are very costly. Increased funding will help these projects to be more successful."* *"Funding size is a major limitation considering the change of policy on Postdoc's salary."*
Collaboration	20	Improved partnerships, relationships or interactions with others in the project team, including continued collaboration	*"More and strong integration with all researchers on the project."* *"With the participating students from multiple campuses, it is not easy for them to have convenient exchange and share of ideas and learn from each other.* *"Industry collaboration is always difficult and the larger the company the more difficult it is to reach agreements on confidentiality and disclosure of findings made by those companies. I don't have a solution for this but I am not sure if NIFA is getting its value out of money that goes toward industry partners in an attempt to get matching funds for the grant."*
Support	16	Increased support from scientists, extension, stakeholders, industry, institution, and/or USDA	*"If University can provide more support, such as personnel and facilities, it will make this project go more smoothly."* *"We struggle with technologies that update continually. It is difficult to keep up with technologies. We could use help with this."* *"If we had same group of administrators and have fulfilled the intuitional commitment they have assured during the submission of the proposal, the project would have been successful."*
Personnel change	15	Project team member died, fell sick, retired, or transferred jobs causing setbacks to project goals and outcomes	*"It could be more successful without scientists relocations et al."* *"The main challenge we had was that one student who worked in this project quit after a year. That is the main setback."* *"The cooperator has moved to another university and a new person is my contact at the cooperating university."*
Staff	15	Additional staff (not Extension) to complete project work which includes students	*"Better selection of employees."* *"An additional graduate student to focus on the barn data collection would have helped propel that part of the project faster."* *"The data set is rather limited in part because of limited graduate student support. As a seed project, the grant only provided for a year and a half of student support. In hindsight, this wasn't enough time and made it harder to attract a capable student to the project."*
Extended project length	13	More time is required to achieve project objects; current grants too short to complete work	*"We needed more time to develop the GIS interactive interface."* *"If we had more time in the project (that had a no-cost extension to 5 years) we would have done more during the period, however we have slowly followed up in project results in the lab without continued funding in successive project proposal applications."* *"If we could have five years instead of three, because this project involves field studies and we can only grow one season per project year."*

Code	Frequency (n)	Description	Examples
Stakeholder engagement	11	Additional participation by stakeholders	*"Aspects of engagement with stakeholders have not been as successful as they could have been."* *"The only place that this project could have been more successful is in our outreach efforts and relationship building with local agricultural industry. Although the team made significant efforts here I believe we could have done more to build additional relationships during the duration of the project."* *"I wish I better communicated my research findings to stakeholders during the duration of this project. Because I synthesized my results at the end of this project, I was unable to simultaneously find new communication outlets and complete my dissertation."*
NIFA constraints	10	Programmatic/funding agency barriers/ limitations/restrictions includes the type of project not being funded by NIFA	*"This project could benefit from more interactions with USDA NIFA scientists."* *"I wish there was some concerted effort from NIFA to bring PIs from similar projects together and also connect us with other larger projects funded by NIFA (e.g., Climate CAP)."* *"A follow-up call for proposals maintaining the original objectives. The progress was good but there were several results that could be extended successfully into the future, but that had to be abandoned because of changing objectives of the USDA's new call for proposal (the new objectives were also valuable, but forced a change)."*
Publications	10	Increase in publications	*"We need to get findings published in peer review."* *"I would like us to have more peer-reviewed publications at this point, but they are in progress."* *"It could be more successful by publishing its more useful research data in the white literature. Currently it is submitted to the USEPA for pesticide registration purposes."*
Additional resources	8	More resources required, does not include what specific resources are needed	*"Additional investment in terms of resources."* *"The scope of the award was quite limited. It is quite difficult to make a lot of progress quickly with limited resources. We were quite fortunate that the postdoc hired for the project was extremely productive and good at engaging faculty within the program."*
Ongoing	7	Project ongoing and success cannot yet be judged	*"Project and experiments are still in progress, so this is challenging to assess at this time."* *"Not applicable, too early in project."*
Time management	7	Not enough time in day to complete work, administrative duties take too much time away from project goals	*"There are a lot of reporting requirements which are burdensome."* *"Scientific, outreach, and engagement impacts are limited by the amount of time the PD and co-PIs need to spend on cultivating additional funding to cover all costs and keep the project going."*

Code	Frequency (n)	Description	Examples
Funding - delay	6	Funding received later than expected	*"Was delayed in getting money due to bureaucratic hang-ups that impacted the timing and scope of field surveys."* *"By reducing the lag time between grant application and grants awarding. The long process period within project Phases and between Phase I and II causes major logistics and funding complications that can be fatal for small companies."*
Funding - PD allocation	6	Funds to be spent at the PD discretion without restrictions	*"These projects (foundational program) are restricted to research only, therefore I cannot use funds to support extension activities and have to find ways to do that outside of the project."* *"The NIFA post-doc program is unique in that, at least during the time my project was funded, the PD can only ask for salary money. Not being allowed to write money into the grant for other aspects of the project (e.g., field work, travel to conferences, lab work) makes it tough to excel at all proposed tasks. I was fortunate to have some supplemental support from my mentor and other outlets.*
Increased leveraging capability	5	Project needs to result in additional projects and acquiring additional grants, follow-up proposal funded	*"The project identified greater nitrous oxide emissions from organic systems which prior to the original design was not an expected outcome. With this current knowledge, this project could have been more successful if the follow-up proposal had been funded to identify the practices that are the greatest contributors and the investigation of alternatives within or to these practices that could reduce those emissions. Methods to reduce the greater nitrous oxide emissions from organically managed corn-soybean-wheat rotations have yet to be investigated to provide solutions to organic farmers."* *"As a small institution leading this effort, we are hoping that the seed grant nature of this project will allow us to move forward and be competitive for larger grant opportunities."*
Impact	4	Broader impact and adoption of project results/outcomes	*"It could be more successful if the integration of results could be further improved and other parameters could be measured from non-available instruments."* *"Funding towards commercialization execution would help us achieve traction and market validation more quickly."*
Funding - full	2	Allotted full funding as requested	*"To have been more successful over the past years, funding needed to remain within the initial funding request range of $2M to $4M, which would have allowed uninterrupted use of independent laboratories for regular calibrations (which helps detect incipient and/or gradual loss of functionality of the sensors), plus allowed uninterrupted use of the various instrument manufacturers for repairs and upgrades. Additionally, this funding range would have allowed more in-depth research into a broader range of cultivars, more interdisciplinary scientific collaborations, and more participation at international and national conferences and meetings."* *"It was my first USDA project and I was overly ambitious with the planned projects, especially in the context that we were not awarded full funding. In retrospect, it would have been wise to scale back the project and drop one or more experiments to improve timeliness of completion."*
Funding	1	Funding issue, broadly or no specific detail included	*"Funding of graduate students is always a challenge on these grants. We rely on graduate students to carry out much of the work on the projects, but they are incredibly costly to fund on grants. At the same time they have so much to learn to be effective as scientists, that their initial progress is slow. If we had additional sources of funding for graduate students we could be more efficient and effective with our grant funding."*

Code	Frequency (n)	Description	Examples
Funding - stable	1	Funding consistency	*"Stabilize funding to guarantee the activities continue."*
Miscellaneous	11	Miscellaneous project specific constraints	*"More success would have involved using the newly developed model to conduct scenario analyses related to the impact on global agricultural markets and land allocation resulting from changes in market conditions and policy initiatives."* *"This project would have been more successful if the graduate students had better training in generalized linear mixed models, and the philosophy of model selection approaches."* *"The pilot study could help develop more suitable heat stress conditions for the study. However, this is a seed grant, so that this experience and the data that will be produced will help us develop improved proposals."*
Not coded	18	Irrelevant or vague	*"Our project was a seed grant, and now we have submitted a full proposal to another USDA-NIFA program."* *"Not sure."* *"Successfully leveraged additional funding for additional graduate students/staff to collect, manage and analyze data."*

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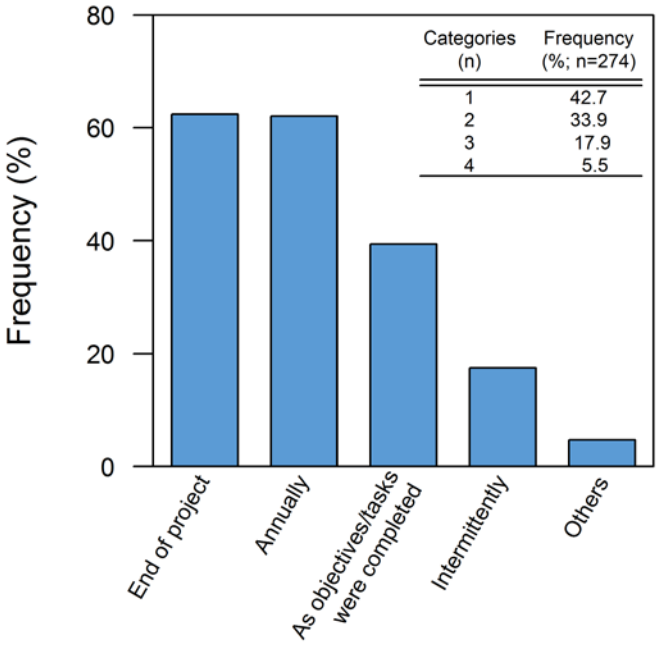

Figure 30. Competitive - Project evaluation timing
Corresponds to closed Q30: "When was/will the project's success evaluated/be evaluated (check all that apply)?"

Table 42. Competitive - Project evaluation timing open response codes
Corresponds to open portion of Q30 (n=13): "When was/will the project's success evaluated/be evaluated (check all that apply)?"

Code	Frequency (n)
Between 2-6 times	3
Biweekly	1
Continuously	2
Monthly	1
Post-project	1
Not coded[a]	5

[a] Response irrelevant or vague.

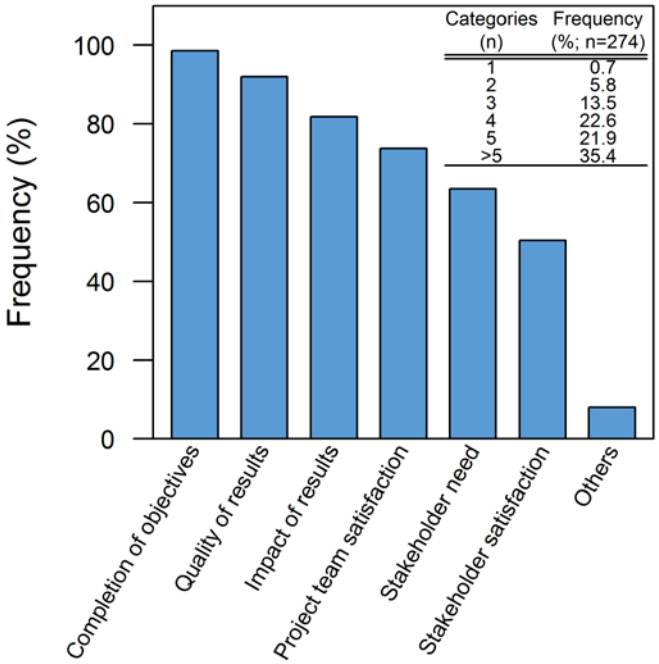

Figure 31. Competitive - Project evaluation elements
Corresponds to closed Q31: "When you evaluated/evaluate project success were/will any of the following project elements assessed?"

Table 43. Competitive - Project evaluation elements open response codes
Corresponds to open portion of Q31 (n=22): "When you evaluated/evaluate project success were/will any of the following project elements assessed?"

Code	Frequency (n)
Applicability	1
Commercial potential	4
Funding agency satisfaction	1
Methodology	1
Publications	4
Scientific contribution	2
Students (learning and/or training)	3
Team performance	1
Miscellaneous[a]	1
Not specified	2
Not coded[b]	2

[a] Miscellaneous includes intellectual property opportunities.
[b] Response irrelevant or vague.

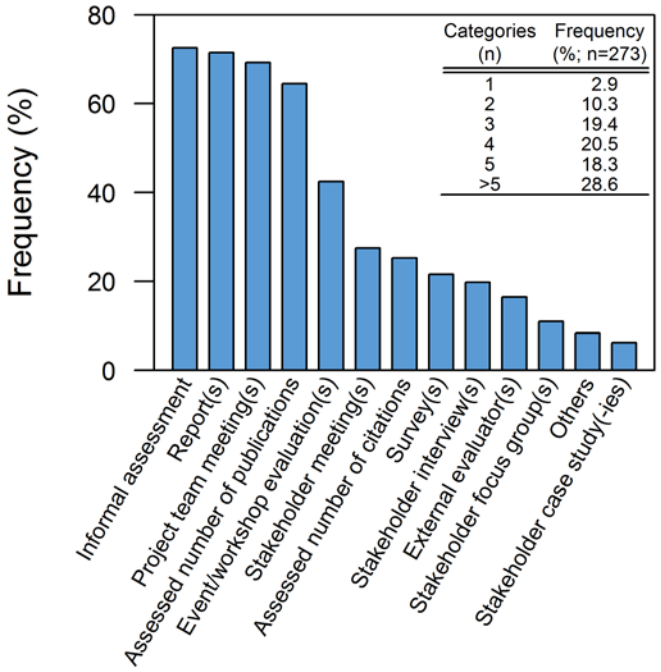

Figure 32. Competitive - Project evaluation methods
Corresponds to closed Q32: "The following methods were/will be used to evaluate project success (check all that apply):"

Table 44. Competitive - Project evaluation methods open response codes
Corresponds to open portion of Q32 (n=23[a]): "The following methods were/will be used to evaluate project success (check all that apply):"

Code	Frequency (n)
Institutional review	1
Sales	2
Students (training and/or graduation)	5
Web traffic	2
Miscellaneous[b]	5
Not coded[c]	9

[a] Respondents indicated >1 "other" codes, which is included in the frequency table resulting in an n greater than the n of respondents.
[b] Miscellaneous includes student job placement, new potato variety, statistical methods, number of advanced fingerlings produced, social media analysis, and network mapping.
[c] Response irrelevant or vague.

3.2.4 Project Stakeholders

The primary project stakeholder groups were researchers, NIFA, and college/universities (86.7%, 86.3%, and 83.5%, respectively; Figure 33). The majority (75.2%) of projects had more than five stakeholder groups (inset table of Figure 33). Specified other stakeholder groups are presented in Table 45. The most common type of project knowledge disseminated to stakeholders were "results" (84.9%) followed by "methods/models/technologies" (51.6%; Figure 34). Specified other knowledge types are presented in Table 46. The most frequent dissemination methods were "conferences" and "publications" (76.5% and 74.3%, respectively; Figure 34). The majority (55.9%) of PDs used more than 5 dissemination methods; specified other methods are included in Table 47. Websites that were used to disseminate project knowledge were primarily (44.4%) "available/accessible to the public and updated regularly" ("not regularly updated"=25.9%, "under construction"=26.7%, and "not available" = 3.0%; n=135; Q36).

The survey requested PDs to reflect on the successful strategies for communicating with stakeholders. PD responses regarding stakeholder communication strategies resulted in the development of 18 codes (Table 48). The majority (n=95) of PDs use multiple communication methods and these methods are similar for all of their stakeholder groups.

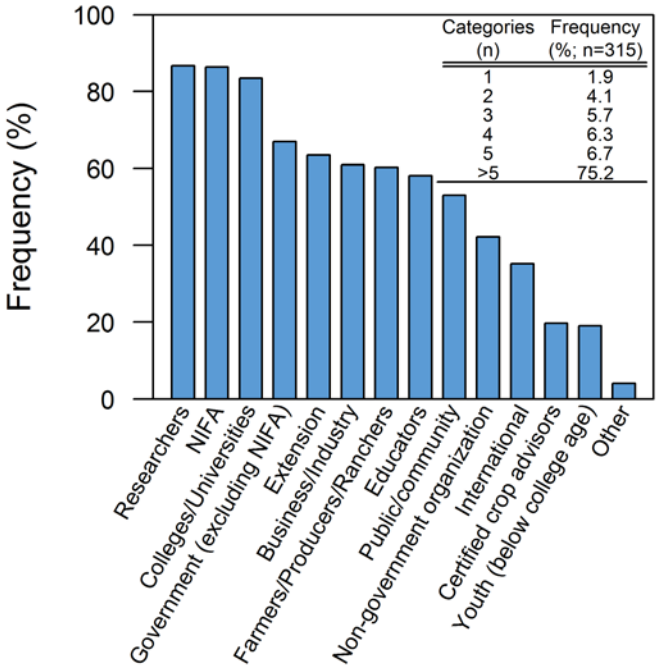

Figure 33. Competitive - Stakeholder groups
Corresponds to closed Q33: "Were/Will the following stakeholder groups informed/be informed of project knowledge or not:"

Table 45. Competitive - Stakeholder groups open response codes
Corresponds to open portion of Q33 (n=19): "Were/Will the following stakeholder groups informed/be informed of project knowledge or not:"

Code	Frequency (n)
College students	4
Miscellaneous[a]	1
Not specified	1
Not coded[b]	7

[a] Miscellaneous includes beekeepers.
[b] Response irrelevant or vague.

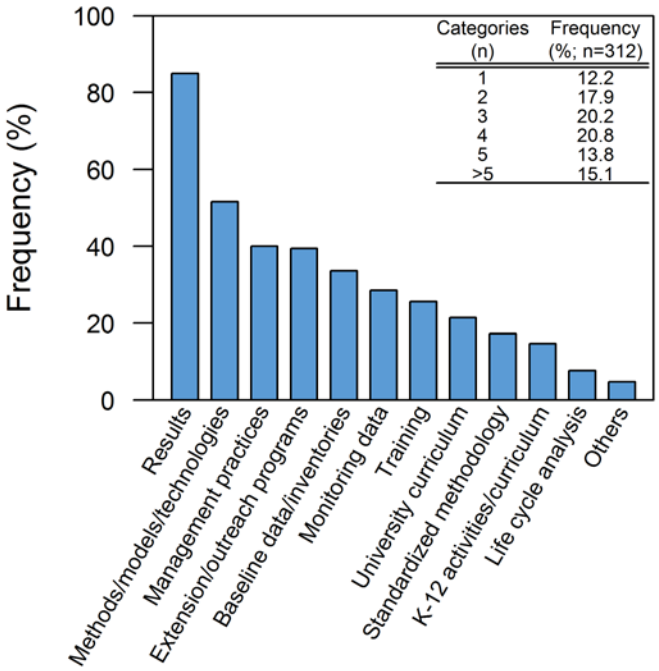

Figure 34. Competitive - Disseminated project knowledge types
Corresponds to closed Q34: "What type(s) of project knowledge was/will be disseminated to stakeholders (check all that apply)?"

Table 46. Competitive - Disseminated project knowledge types open response codes
Corresponds to open portion of Q34 (n=15): "What type(s) of project knowledge was/will be disseminated to stakeholders (check all that apply)?"

Code	Frequency (n)
Miscellaneous[a]	6
Not coded[b]	9

[a] Miscellaneous includes graduation rates, metadata, opportunity for academic/career path, germplasm, interactive online games or assessments, and meeting announcements.
[b] Response irrelevant or vague.

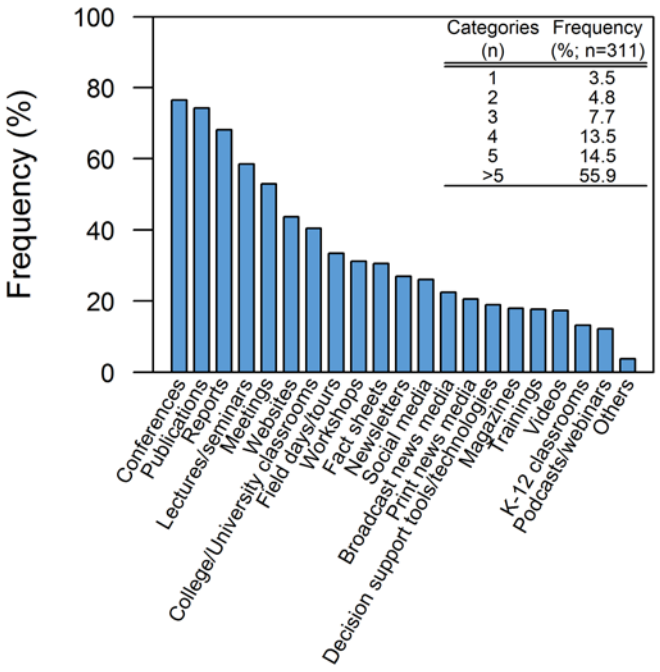

Figure 35. Competitive - Dissemination methods
Corresponds to closed Q35: "The project team disseminated/will disseminate project knowledge to stakeholder groups through the following means (check all that apply):"

Table 47. Competitive - Dissemination methods open response codes
Corresponds to open portion of Q35 (n=12[a]): "The project team disseminated/will disseminate project knowledge to stakeholder groups through the following means (check all that apply):"

Code	Frequency (n)
Application	1
Commercial products	1
Email	4
Miscellaneous[a]	4
Not coded[b]	3

[a] Respondents indicated >1 "other" codes, which is included in the frequency table resulting in an n greater than the n of respondents.
[b] Miscellaneous includes direct mail, dissertation, non-classroom K-12, and phone calls.
[c] Response irrelevant or vague.

Table 48. Competitive - Stakeholder communication strategy code frequencies and descriptions
Corresponds to open Q37: "In your opinion, what is the most successful way to communicate with stakeholders? How, if at all, does this method change for different stakeholder groups?" Codes ordered by frequency (n=280).

Code	Frequency (n)	Description	Examples
Similar for all stakeholders - multiple methods	95	Same multiple method used for all stakeholders	*"The most successful way for us has been through conferences, meetings, publications and farmers conferences. We recognize that we have not used the new emerging technology and that is something we are now starting to use, especially for our young stakeholders."* *"In person conferences and workshops are often the most effective, in my experience. Face-to-face discussion encourages interaction and dialogue. This is true for almost all stakeholders. The downside is the high cost of travel and scheduling."* *"Email followed by face to face to meeting."* *"The most effective means of sharing project information were meetings of interested stakeholders and field days."*
Stakeholder dependent - multiple methods	62	Unique multiple methods used per stakeholder group	*"University faculty and students are best communicated with through conferences and journal articles. Non-university stakeholders must be approached through organizations with their interests in mind, such as commodity groups for farmers. Business parties can be approached through professional advocacy organizations such as trade associations."* *"Effective communication with stakeholders depends on the stakeholder group being engaged. Growers/farmers most often respond most to talks at regional field days and on farm meetings or publications in trade journals. Academics most often respond/engage with presentations at professional meetings and refereed publications. Policy makers most often respond/engage with reports, trade publications and sometimes presentations at meetings targeting them."* *"Symposia and electronic communication are likely the most effective way of communicating with stakeholders outside of academia. Inside academia, the most effective means of communication are peer-reviewed publications, symposia, and electronic media (i.e., website)."* *"The answer to the first question is implied by the second. It depends on who you are communicating which methods are successful. The traditional methods were all used and worked well for their audiences. We incorporated social media and web videos and have been astounded by the analytic data. It has allowed us to reach a relativity large audience that we did not communicate effectively with before."*

Code	Frequency (n)	Description	Examples
Similar for all stakeholders - single method	58	Same multiple methods used for all stakeholders	*"Hands on field tours have been the most successful for my own programs. They receive the most positive response and stakeholders feel they leave with a tangible skill or idea. The method does not change with the stakeholder group in my opinion, only the content changes."* *"Attending conferences related to the project target audience is being looked at as the optimum way to communicate with a number of stakeholders in this specific field."* *"Interactions with stakeholders at conferences which foster opportunities for personal engagement with individuals. This setting creates opportunities for dialog that enable us to better understand each others' needs, experience, and observations."* *"You must go to where they are - to their meetings and their special interest groups."*
Stakeholder dependent - single method	24	Unique single method used per stakeholder group	*"For farmer groups, the best approach is small group communication. For extension, it is through fact sheets and conferences. For researchers it is peer-reviewed publications and conferences."* *"Outside the university, I think the most successful way to communicate is through personal interactions, either one-on-one or in small groups. For 'stakeholder' within the university, traditional means publications in peer-reviewed journals is clearly the most valued."* *"Small, group meetings with interested stakeholders; education programs of extension staff."*
Stakeholder dependent	15	Method varies by stakeholder but types of method(s) not identified	*"There are different methods for different stakeholders. It varies widely by stakeholder group, to the extent that there is no overlap in some cases."* *"This is a fundamental research project, with few stakeholders outside the scientific community. The method definitely changes with stakeholder group."* *"Best methods vary by audience. Print can still be effective."*
Need based	10	Stakeholder needs drive communication strategy, includes context and situation, stakeholder indicates need/interest of information	*"Important to first listen to stakeholder needs before starting to communicate information to them. This is true for all stakeholder groups."* *"Successful communication requires nuanced analysis of stakeholder viewpoints and key concerns, values and attitudes, and then developing communications activities that successfully address those elements."* *"Communication must be tailored to each group. "Know your audience" is one of the most essential and effective guidelines."*
Targeted communication	9	Specific communication style/objective required for stakeholder communication based on PD perception	*"There is no one 'most successful way' - it depends on the nature of the communication (e.g., how technical)…"* *"More advanced discussion of technical data is limited to research-savvy audiences, whereas how these data may be applied to producers."*

Code	Frequency (n)	Description	Examples
Extension	8	Utilizes Extension	*"We based this project at a Research and Extension Center - this was an effective way to reach stakeholders because the center staff facilitates reaching stakeholders (e.g., field days, blog posts with accessible results summaries, etc.)."* *"To work with extension/outreach staff to communicate with stakeholders; through meetings (with meals), seminars, and/or workshops. Also, print/broadcast media is another avenue to reach out to stakeholders."* *"Through Extension contacts."*
Project needs	8	Project objectives drive communication strategy	*"Varies by project, project goals, and project resources."* *"Based on the nature of this project, I think that we need to utilize as many different communication methods."* *"Required reports are done as needed. Relationships (i.e., "stakeholders") are used and cultivated as required to get the job done, to do what is desired, appropriate, or allowed. Communication is limited by time, money, and resources, so the more of these things that are available, the more communication can be accomplished."*
Multiple methods	7	Uses multiple methods on one stakeholder	*"Participating farmers are our most important stakeholders at this stage, and are best communicated with by scheduling a meeting at their farm to present project results."* *"Yes. I will be contacting political leaders and sending them a factsheet about the outcomes of my research."* *"Face to face meetings combined with informal or formal presentations and/or printed material and graphics. I don't have enough experience with different stakeholder groups to comment on the second question."*
Early consultation	5	Communicates with stakeholders early or throughout process	*"We worked very closely with national forest managers. In general, forging close, iterative, on-going relationships is the most successful way to communicate with our stakeholders. We involve them during all stages of research: hypothesis generation, data collection, output analysis."* *"Some stakeholders should be involved even in the planning of the project. Then in various stages of the project and most extensively as results are completed. Some groups can offer detailed advice and even sometimes data to be used for example in the modeling and/or to evaluate results. Stakeholders will often have more confidence in the results if they have had input along the way."*
Time dependent	2	Constrained by time frame, depends on how soon stakeholders need to be contacted	*"Social media can be an effective way of "advertising" findings to large numbers quickly. For a less superficial way of disseminating knowledge, forming relationships through in-person interaction via workshops with 'small' numbers of participants can be very effective, but this is resource intensive."* *"Timing is everything."*
Trust dependent	2	Communication must be from trusted individual	*"We have participated in workshops where stakeholders attend and have organized meetings (non-conference) with key stakeholders to focus on their needs and answer their questions. Building this personal trust has proven to be a great success to communicate and work with stakeholders."* *"Face to face contact was crucial to build trust with adult tribal members."*

Code	Frequency (n)	Description	Examples
No effective method	1	Has yet to identify an effective tool for stakeholder	*"Agencies have been monolithic and essentially ineffective in adoption or integration; I have yet to see an effective communication method."*
None	1	No one successful method	*"Difficult for me to imagine there is a single 'most successful way'."*
Single method	1	One method is listed, indicates a single method for only one stakeholder	*"Our stakeholders are winemakers, the most effective method would be through trade journals."*
Miscellaneous	3	Miscellaneous project specific constraints	*"Long-term mentoring is key and we advocate for online student and industry scientist networks."* *"All communication is personal, and different individuals prefer different types of communication."*
Not coded	21	Irrelevant or vague	*"Our project was heavily focused on research activities to support modeling. The details were primarily of interest to other researchers. The results of the modeling using our data was of broader interest and was disseminated more widely--however, it was not part of our project."* *"Not applicable at this time."* *"This project consists primarily of fundamental research aimed at increasing understanding of the overall system and therefore stakeholders are not clearly identifiable."*

3.2.5 Project Outcomes

Funds used to seed PDs' climate portfolio projects were more likely from non-NIFA funds (43.8% relative to 20.5% of NIFA funds; Figure 36). PDs reported that their projects led to additional funding from non-NIFA (39.0%) and NIFA sources (21.6%; Figure 37). The most frequent publication type was journal articles; on average (median) projects published three journal articles (Table 49). In terms of outcomes not related to funding or publications, nearly all (90.4%) indicated that "science knowledge expanded" and most (83.7%) indicated "university students trained" (Figure 38). On average (median), four students were trained within each project (Table 50). It was likely (33.8%) that the students were from the same discipline as the PD (Table 51).

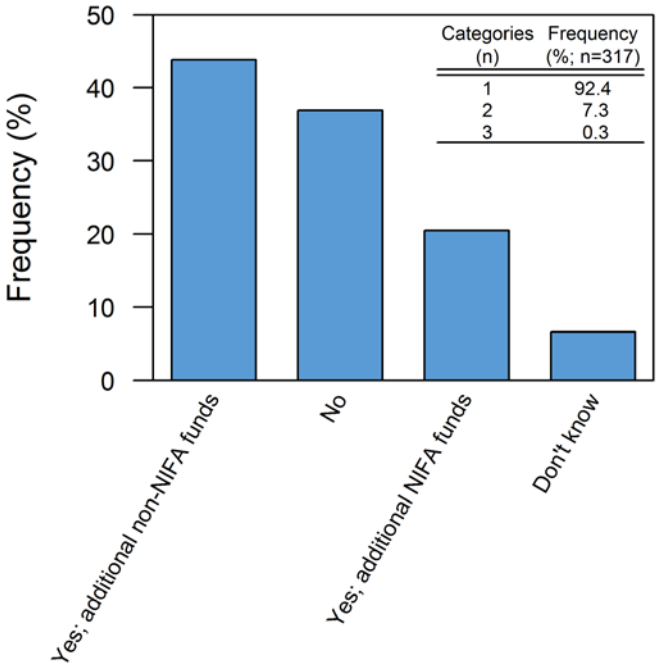

Figure 36. Competitive - Seed funding
Corresponds to closed Q38: "Were funds used to seed this project (if yes, check all that apply)?"

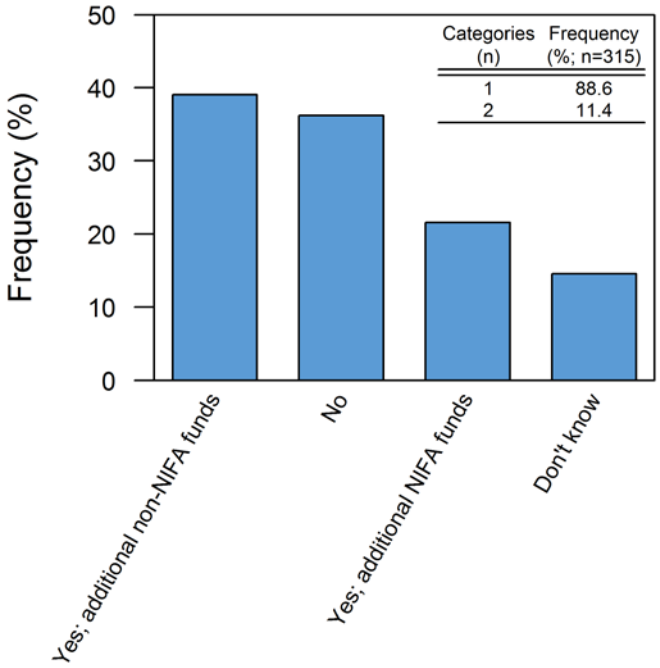

Figure 37. Competitive - Funding leveraged
Corresponds to closed Q39: "Has this project led to funding for (an) additional project(s) (if yes, check all that apply)?"

Table 49. Competitive - Publication types
Corresponds to closed Q40 (n=261): "Please indicate the following publication types and the number of each published from this NIFA project to date (if you do not specifically remember, please enter your best guess):"

Type	Respondents (%)	Median (n)	Range (n)
Journal articles	72.0	3	1-300
Theses/dissertations	53.6	2	1-70
Extension	32.6	3	1-250
Other[a]	36.4	NA	NA

[a]The specified other types are similar to the dissemination methods listed in Q35 and are not detailed in this report.

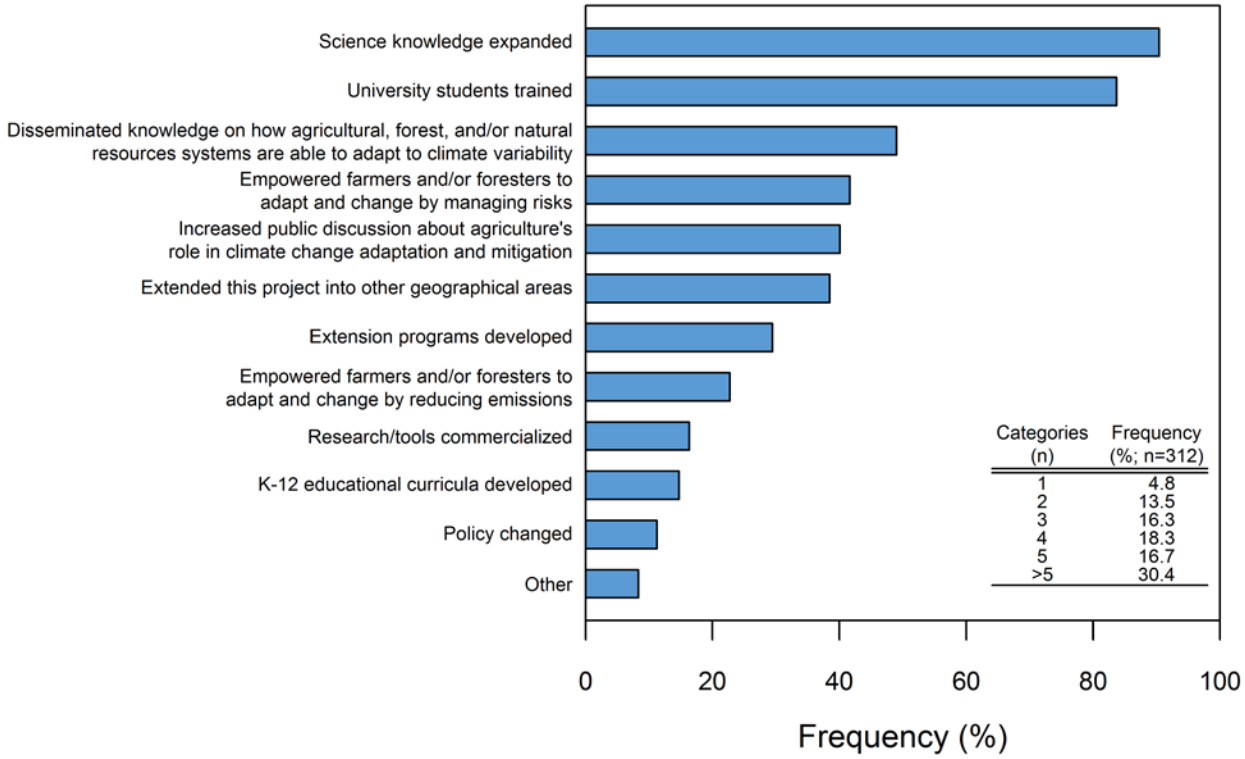

Figure 38. Competitive - Outcomes
Corresponds to closed Q41: "Have/Will the following outcomes been/be achieved or not?" The specified other types (n=26) are not detailed in this report.

Table 50. Competitive - Students trained
Corresponds to closed Q42: "You indicated university students were/will be trained through this project. How many students were/will be trained?"

	Respondents (n)	Median (n)	Range (n)
Students trained	259	4	1-600

Table 51. Competitive - Student discipline
Corresponds to closed Q43: "Were/Will the student(s) from/will be the same discipline as the primary PD?"

	Respondents	Frequency (%)			
	(n)	No	Yes	Some but not all	Don't know
Student discipline	260	19.2	33.8	46.2	0.8

3.2.6 Project Synthesis

In addition to open questions about project success, PDs were asked to rate their project's success in 31 specific areas on a 5-point Likert scale (1="very unsuccessful," 5="very successful"). Overall, the projects rated as just above "neither successful nor unsuccessful" to "very successful" with a mean Likert score range of 3.2-4.4 (Table 52). The highest (Likert mean=4.4 and highlighted in dark blue) ranked areas were (excluding "other") "communicating with collaborators," "defining project mission," "generating research results," and "training university students." The lowest score (Likert mean=3.2) was "improving policy making."

If respondents selected neither through strongly agree for "developing new relationships/synergies with other organizations" a follow-up question was asked regarding their new relationships (Table 53). Synergies/relationships resulted in an overall increase and/or improvement in the ability to influence with a Likert mean range of 3.6-4.0 out of a 1-5 (1="strongly disagree," 5="strongly agree") point scale. The highest score

(Likert mean=4.0) was for "leveraging additional funds." The lowest score (Likert mean 3.6) was the ability to "increase public discussion about agriculture's role in climate change adaptation and mitigation."

Q46, which requested PDs to identify knowledge gaps based on project findings, was not coded since the detail provided by the respondents is essential for understanding knowledge gaps. Rather than coding, the responses were organized by their NIFA Knowledge Area Topics (as provided in the portfolio database) in Table 54.

When PDs were asked to identify the largest contribution of the project, 23 codes emerged (Table 55). The majority (n=49 and n=48) of respondents indicated that the largest contributions of their project were to "quantify/ identify/document" (n=49) and "development" (n=48). "Stakeholder engagement," "application," and "ongoing" were the next most common codes (n=21, 20, and 20, respectively).

The survey requested PDs to reflect on their proposal and if it was possible to go back and revise it, indicate what they would modify. The PD responses resulted in the development of 22 codes (Table 56). The majority (n=56) of PDs indicated that they would not change anything about their proposal. Those PDs that would modify their proposals would "expand" their projects (n=42).

Table 52. Competitive - Project area success

Corresponds to closed Q44: "In your opinion, how successful was this project in the following areas to date?" The option to select "Don't know" and "Not applicable" was available to participants, which is included in Appendix Table 2.

Project areas	Respondents (n)	Frequency (%)					Likert mean[a]
		Very unsuccessful	Unsuccessful	Neither	Successful	Very successful	
Ability/flexibility to troubleshoot	263	0.8	0	8.7	52.9	37.6	4.3
Communicating with collaborators	293	0.3	0.3	7.2	45.1	47.1	4.4
Completing all project goals/objectives	288	1.0	1.4	10.1	55.2	32.3	4.2
Creating standardized protocols	214	0.9	0	26.6	49.5	22.9	3.9
Defining data needs/objectives prior to implementation	265	1.1	0	8.3	59.2	31.3	4.2
Defining project mission	286	0.3	0	2.1	50.3	47.2	4.4
Developing new relationships/ synergies with other organizations	272	0.4	1.8	17.3	45.2	35.3	4.1
Empowering stakeholders with science-based knowledge	254	0.4	3.1	23.6	43.7	29.1	4.0
Engaging in social activities with collaborators/project team	234	1.3	6.0	30.8	45.7	16.2	3.7
Enhancing extension capacity	196	1.0	5.6	38.3	40.8	14.3	3.6
Enhancing project team relationship	280	1.1	0.7	6.8	56.4	35.0	4.2
Enhancing/developing relationship with partner institutions	280	1.1	0.7	6.8	56.4	35.0	4.2
Enhancing/developing relationship with stakeholders	251	0.4	3.2	20.3	51.4	24.7	4.0
Funding agency satisfaction with outcomes/progress	211	0.5	1.4	12.8	55.9	29.4	4.1
Generating research results	277	0.7	0.4	6.9	46.9	45.1	4.4
Having an interdisciplinary project team	276	0.7	1.8	9.4	39.5	48.6	4.3
Having institutional support for and authority to acquire resources	264	1.9	4.2	20.1	53.0	20.8	3.9
Impacting stakeholder behavior	191	0	3.7	38.7	46.6	11.0	3.7
Improving policy making	139	1.4	10.8	58.3	23.0	6.5	3.2
Increasing public discussion about agriculture's role in climate change adaptation and mitigation	166	0.6	7.8	38.6	45.8	7.2	3.5
Increasing your reputation/value to funding agency	218	0	0	12.4	68.3	19.3	4.1
Involving project stakeholders early on in project design	234	0	3.0	27.8	44.4	24.8	3.9
Leveraging other funds	254	0.4	4.3	22.0	40.9	32.3	4.0
Monitoring and receiving feedback from stakeholders	230	0.4	3.5	27.8	48.3	20	3.8
Opening/having a line of communication with funding agency	281	0.4	7.5	27.0	49.8	15.3	3.7
Overcoming technological limitations	262	0.4	1.9	19.5	56.5	21.8	4.0
Project team satisfaction with project outcomes/progress	288	0.3	1.7	7.3	60.1	30.6	4.2
Publishing research results	265	0.4	1.1	27.5	44.2	26.8	4.0
Recruiting personnel	257	0.8	2.7	18.3	54.5	23.7	4.0
Training university students	270	0.4	1.1	6.7	44.8	47.0	4.4
Other[b]	8	0	12.5	0	25.0	62.5	4.4

[a] Calculated from Likert scale 1-5 (1="very unsuccessful" to 5="very successful"); shading corresponds to lowest mean=light blue and highest mean=dark blue. [b] The specified other areas are not detailed in this report.

Table 53. Competitive - Developed synergies/relationships
Corresponds to closed Q45: "New synergies/relationships developed through this project influenced your ability to:" The option to select "Don't know" was available to participants, which is included in Appendix Table 4.

Synergy	Respondents (n)	Frequency (%)					Likert mean[a]
		Strongly disagree	Disagree	Neither	Agree	Strongly agree	
Improve decision maker adoption of project results	202	0.5	3.0	26.7	56.4	13.4	3.8
Improve partner agency adoption of project results	193	1.0	3.1	33.2	48.7	14.0	3.7
Improve stakeholder adoption of project results	190	1.1	2.6	32.6	49.5	14.2	3.7
Increase public discussion about agriculture's role in climate change adaptation and mitigation	192	3.1	6.8	34.4	42.7	13.0	3.6
Leverage additional funds	225	0.4	4.0	17.8	55.6	22.2	4.0
Other[b]	10	0	0	60	20	20	3.6

[a] Calculated from Likert scale 1-5 (1="strongly disagree" to 5="strongly agree"); shading corresponds to lowest mean=light blue and highest mean=dark blue. [b] The specified other synergies are not detailed in this report.

Table 54. Competitive - Remaining knowledge gaps code frequencies and descriptions
Corresponds to open Q46: "Based on project findings what knowledge gaps remain?" (n=233)

Knowledge gaps by NIFA Knowledge Area Topics
Agricultural, Natural Resource, & Biological Engineering
"Accurate estimation of GHG emissions from a whole farms and a region"
"Additional advancements are required to demonstrate the stability and applicability of our integrated system at scales relevant to commercial scale dairy systems."
"As shown by actual heating performance data collected, standard solar energy analysis of easterly facing curtains, underestimates the actual heating capability of the east facing curtain in mornings after sunrise, with low sun angles. This has been an acknowledged challenge within the solar engineering community when using any of the standard 'horizontal' solar energy models available. The knowledge gap could be solved by addition of a new solar metering device facing east to collect early morning horizontal solar data that could be used with the standard model data available for 'direct beam' and 'diffuse' solar radiation. South facing curtains perform as expected using the standard 'horizontal solar models as opposed to south facing curtains. With only 2 solar curtains funded, only east and south curtains were tested. A westerly facing curtain should be tested as well as a southeast and southwest facing curtain. This would provide better data for use in analyzing curtains to be applied to the 70,000+ poultry houses which have walls facing at all different compass angles."
"Best markets"
"Effective commercialization of this technology for adoption with different stakeholders of this technology"
"Efficacy and viability of the mitigation strategy under field conditions"
"Efficient ways to use waste materials for fuels and products"
"How findings of policy efficacy at food-energy-water nexus generalize to broader questions of multi-objective governance of nexus issues."
"How to economically develop a feasible imaging fluorometer for crops light use efficiency monitoring."
"How to fund continued R+D of new startup company"
"In order to better implement variable rate irrigation decision support systems (DSS), we need to better understand the relationship between soil water status in the root zone and crop water stress, not necessarily transpiration rate but stress. There is a fairly large body of work on the relationship between soil water status and transpiration, but no general consensus on how to successfully model that relationship. There is much less literature on the relationship between soil water status and plant stress. Understanding that relationship is important because we can easily sense and map crop stress using a variety of optical sensors aimed at the crop canopy, but it is difficult and in practical terms so far impossible to similarly map soil water status in the root zone at the density required to inform variable rate irrigation system DSS. Better understanding of the relationship between soil water status and crop stress could enable us to cokrige on high density crop stress spatial data and low density soil water status data to build high density maps of soil water status that would inform DSS and allow better control of runoff and deep percolation, saving water and reducing nutrient outflows from agricultural fields."
"Many. We still have a gap in our understanding the exact model of pheromone perception. The role of pheromone-binding protein (PBP) as a transport protein is clear but what is the role of sensory neuron membrane protein (SNMP). Does PBP and SNMP together play a role in pheromone perception? How is receptor activated? Just by pheromone or PBP-pheromone complex? Is the pheromone specificity is only at the level of receptor or also at the level of PBP giving the fact that PBP can bind many hydrophobic compounds? We still need to develop a much better model that explains the details?"
"One of the main project goals was to extend the biochemical understanding of nitrogen fixation to a wider number of bacterial species. Future work should focus on extending research even further to more diverse, unrelated sets of bacteria with potentially different nitrogen fixation mechanisms."
"The primary issue is to better understand the issues associated with scale up. Ultimately, we need to better understand of either of these plants can be financially viable. This will likely require an industrial partner to assist in this process."
"Time and work"

Knowledge gaps by NIFA Knowledge Area Topics
"We have identified the following knowledge gaps: (1) Adaptability and resilience study of the proposed technology (Aerial robotics-based hyperspectral imaging and computing) in the general context of multi-hazard agriculture environment due to global climate changes. Specially, drought and human-related hazards (such as overuse of industrial treated water).(2) The developed technology aims at bare farming land. The use of the proposed technology may help to explore soil hydrophobicity and other soil-water properties through crops sensing and monitoring as proxies. (3) Advanced learning-based technologies, such as the use of deep learning, require construction of large-scale farming database."
"What are the precise/dominant mechanisms that impart stability to enzymes? What is the theoretical potential for stabilization of an enzyme to produce practical enzyme biosensors? How does hydrostatic pressure affect electrochemical crystallization and polymerization?"
Air
"Application of techniques developed to other cases and situations."
"Causes of relationships between methane production and consumption. Broad-scale applicability of our findings. Relationships between methane production and nitrous oxide production and nutrient cycling and causes of them."
"Manure is highly variable. Process-based modeling will need better estimates of manure surface properties for the variety of housing and management practices in use."
"The role of plant itself in the relation between above canopy ammonia emission and fertilization need to further resolved."
"We are still refining the models we need to explore the influence of resource management decisions on land-atmosphere interactions and this area is ripe for additional methods and new scientific insight."
Animal Production
"Although we use forest slash and agricultural residues as feedstock, some environmental organizations strongly believe that eventually we will use the whole tree."
"At current stage fish breeders for future crosses are being raised. The data on sex ratios and color segregations in crosses, their genetic variability and growth rate will be obtained at the further stages of project fulfillment."
"Findings are still to be generated. We got some preliminary results from the first in vivo trial and the development of the second in vivo trial. The first in vivo trial aimed to see, among others, if milk would affect fat deposition in tissues. We did not find any effect of milk on thickness of subcutaneous fat. We found however that milk tended to increase size of the brain. We leaned also that provide only isolcaloric diet as control is inappropriate and we are now preparing to have a isocaloric and isonitrogenous diet as control for the repeat of the first in vivo trial. For the second in vivo trila we discovered that tracing stable isotope is quite challenging and we are forced to come up with new approaches,that, if successful, will contribute substantially to provide new methods."
"Food allergy is a complex health problem. There are many gaps of knowledge that exist and will continue to exist even if we greatly exceed our goals with accomplishments. The results we are acquiring are opening up new ways to look at food allergies and new approaches that we believe will yield significant advancements in how food allergy is investigated and assessed."
"How do muscle cells -- in contrast to satellite cells --- respond to thermal challenge?"
"How to maximize agriculture production in high tunnel greenhouses. How much energy may be offset with renewable energy from solar. How to best integrate knowledge from this project into a classroom environment. One year (of three) of the project is complete"
"N/A"
"Need additional finer-scale genetics and genomics work focusing on the biology behind climate adaptation."
"The etiology of events. In other words, we still don't know exactly what initiates the negative consequences of heat stress."
"The intention of the project was to assess the efficacy of a specific probiotic. The remaining gaps in knowledge are a more technical understanding of the bacterial strains used."
"This was not a research project, so creating new knowledge was not a goal."

Knowledge gaps by NIFA Knowledge Area Topics
"We still need to have a better understanding of and measurement strategies for feed intake of cattle on pasture/range. This has been a persistent problem for decades. Feed intake is a major driver of enteric methane emissions, and has implications for understanding the resource use of cattle (e.g., how much and what type of plant material are cattle consuming on a regular basis, how might this be affected by a changing climate?)."
Animal Protection
"Market competition"
"Novel nontoxic photoactive release coating for biofouling control protects aquaculture gear from biofouling in North American waters for at least six months during summer months. We do not know how this technology will perform in other regions of the world."
"Species differences in responses to CO2 and argon gas exist, and biological mechanisms are unclear."
"We are repeating the honey bee portion of the study on a regional scale."
Economics, Markets, & Policy
"Define gaps based only on one project?!? Who cares what one project finds relative to the entirety of science? Who cares what a PD thinks based on the PD's own project, only?"
"How to move to more sustainability planning at the local level\How to address social equity in sustainability actions. Role of state level policy or federal policy (specific policies) in motivating sustainability action"
"Improvements need to be made in water supply and quality data, in particular, for agriculture. It was difficult to find farm enterprise budgets (an excellent source of financial data for farms) for this 16 county region (Everglades), irrigation data, and water supply and demand data. Difficult to measure (with a degree of accuracy) when the water use data is difficult to quantify."
"Interesting question. We are not at the end of the project yet, but we are surprised about the inability of the main climate models (CMIP5) and globally gridded crop models (AgMIP) to reproduce aggregate spatial patterns. We emphasize that aggregation is important to study global questions where the welfare of US producers is tied to global markets, and where US agriculture may have a preponderant role regarding food availability in grain scarce regions."
"More work needed on managed grazing and soil carbon and climate change. More work on cover crops in the northern areas."
"One of the biggest knowledge gaps that remains is consumption rates of the products we are providing to our participating stores. We can infer, based on our sales data, that individuals are purchasing and consuming the produce we are making accessible through our project, but we have no real way of quantifying that information at this moment."
"The impact of food science/safety."
"The knowledgeable gaps that remain is the foundation of food codes and food policies for the tribe."
"The time it takes for the benefits of the transition to realize is too short for the funding period and a high possibility of a drought in this region."
"The value of water quantity and quality to agricultural and other users of water resources (e.g., drinking water and recreation). How climate change will impact agriculture and adaptation responses to a changing climate."
"There are inherent uncertainties associated with emerging biofuel markets. Data availability and consistency are limited and time series for biofuels data is short, making econometric estimations difficult. Furthermore, cellulosic ethanol markets are not fully developed, leading to great uncertainty concerning their viability, yields, and returns."
"Two major needs: 1. A good disaster damage database to do better validation of our RIM indices 2. Need to investigate the dynamics of resilience."
"Utilizing DayCent-Economic model integration to optimize regional and national policy incentives for carbon sequestration and greenhouse gas management."
"While this was an educational project designed to increase the number of social scientists working in this area, it was also designed to stimulate research by graduate students and their advisers. There are obviously many knowledge gaps that these researchers can and will address. In terms of the educational objective, there are still gaps in our knowledge about appropriate methods for comparing policies in different countries, states and communities."
Families, Youth, & Communities

Knowledge gaps by NIFA Knowledge Area Topics
"To what extent will rural communities embrace our technology once commercialized."
Food
"Several studies are required to understand the role of metabolites in beef color. Metabolite profile varies between muscle type. Other factors such as temperature, storage condition, pre-harvest factors can influence metabolite changes."
Food Safety
"How do changes in weather and climate influence the spatial extent of pathogen reservoirs in farm fields?"
"If a genetically modified yeast could degrade Ochratoxin-A. It seems that we have successfully determined that degradation of OTA can be naturally selected for in yeast."
Forest & Range Resources
"1) Our project connects many dots in ecology (from animal behavior, to population density, to disease seroprevelance), and in our work we did not investigate uncertainty in all of our measurements. The next step would be to assess uncertainty in our models and use that to identify future research priorities and where and when our predictions are strongest and weakest."
"Helping all extension agents understand the role of forest in carbon sequestration and wood products in carbon storage and that they have a role in encouraging the use of wood products."
"How best to implement software in an extension-like capacity."
"How variable thinning influences snow accumulation and melt-out should ideally also be tested during average to above average snow fall years. This is when the greatest differences among treatments are likely to be found."
"I think there are two key issues. First, we still need to improve quantification of uncertainty in a standardize way. This issue is not specific of this project as the scientific community is devoting large efforts to define, describe, and quantify uncertainty. Second, we have applied several machine learning techniques to calculate soil organic carbon across North America. One of the new findings (that open knowledge gaps) is that the spatial scale resolution (e.g., 1x1 km vs 250x250 m) has large influence on carbon budgets. Our preliminarily results suggest that global models systematically underestimate soil carbon due to the coarse spatial resolution used in input datasets."
"If changes to ponderosa forests occur as predicted under a warming climate, how will the Hualapai Tribe adapt culturally and economically to the loss of this species on their tribal lands? Is the Tribe's system of thinning and prescribed burning, which does well at mimicking historical fire regimes, going to help maintain their ponderosa forests in the longer term?"
"Interactions between weather fluctuations and grazing management decisions cannot be studied in a 3 - 5 year context. Rangeland ecosystems respond slowly to management decisions (often over 20 - 50 year time scales) while fluctuation annual in response to weather. So many knowledge gaps remain at the longer (decadal) temporal scales."
"Need to know more about on-the-ground changes in access to land by local residence now that new owners without local ties to the land and the community are in charge. Work on this topic was stymied when a grad student became ill and dropped out."
"Our findings indicate that we are modeling plant response to climate change before we have a basic scientific understanding of how plants are responding to climate. Our models make some very basic assumptions, but the results of this project (and we are only finishing year 1) indicate that some of those assumptions may be wrong. Therefore, rather than creating more models, I suggest spending more time examining plant response to climate BEFORE creating predictive models of what may happen to plant growth under climate change."
"Our primary project goal was to create a new academic/career track at UNM-Taos in Natural Resources that not only shepherded students through degree completion and work experience to be competitive for jobs with federal agencies such as the US Forest Service; but also, to ensure that these same students gained a high level of climate change literacy. For this particular program, in this particular setting, the primary knowledge gap to be filled is simply awareness of this new program at UNM-Taos. This academic/career path is the right fit for this location, but getting the word out takes time. Now that we have success stories of youth from this community getting degrees and jobs in natural resources, we are focusing on telling their stories so that those we can serve will seek us out."
"Still significant work to be done regarding the role of heterotrophic respiration in forest carbon balance."
"The coarse resolution of downscaled climate projections is one significant limitation in understanding how topography will moderate changing climate and influence the species persistence and biogeography."

Knowledge gaps by NIFA Knowledge Area Topics
"The project was delayed in implementation. Surveys have not been completed yet. Identifying active and reclaimed mine areas are in the process. The knowledge gap relates to the direct relationship between surface mining activities and quality of life and local environmental parameters including water quality, human health, soil and vegetation loss. These questions are included in the survey and survey data will be analyzed soon to find answers and knowledge gaps."
"There remains great uncertainty about the impacts of climate change on forest growth and die back (forest fires). The results which we are drawing up now suggest strong and conflicting impacts (faster growth/greater die back). However, when compared to the work on crop impacts of climate change, the forestry work seems quite immature."
"This project examined how soils of different forests respond to nitrogen fertilization over a few years. The full impact of this perturbation will take longer to manifest. In addition, we have not yet determined how tree seedlings and older trees will respond."
"Uncertainty about future projections; influence of policies; connection to stakeholders."
"Understanding why some biocontrol agents fail to exert strong impacts on target weeds."
"We are in year 3 of 5 and actively pursuing knowledge gaps."
"We focused mainly on cover and biomass production - would like to broaden to other ES. We only manipulated annual rainfall - increasingly seasonal patterns seem very important."
Human Health
"n/a - our project is not about filling knowledge gaps, it is about action."
"The project is still very early, but early project findings illustrate that feral hogs are a very important disease vector in forested ecosystems."
Human Nutrition
"NA"
"The level of consumption for each food needed to reliably detect each biomarker and what the variables/other exposures or populations will reduce the validity of the candidate dietary biomarkers selected."
Natural Resources, General
"A key knowledge gap is a better understanding of how deficiencies in climate models effect their ability to simulate how extreme events (e.g., severe droughts) will be affected by increased greenhouse gases."
"Communicate the new science findings and modeling tool to the stakeholders."
"Comparative study of bio-based materials based on different platforms. Our work was on soybean oil as platform material. While we demonstrated creation of value to the materials we are not aware if other bio-based resources are inferior, comparable or superior to soybean oil as platform material for coating applications. We feel this is significant gap and having filled this gap allows scientists, stake holders and sponsors to direct their funding and efforts in the right directions. Also there is a gap in understanding supply-chain issues related to the product developed. We were constantly asked by our stake holders (companies that might manufacture these products) about the supply-chain issues - availability, commercialization potential cost trends..."
"Despite literature reports on nitrate ammonification occurring in agricultural soils, we don't know to what extent or how NA might be used to counteract nitrous oxide production by denitrification. We don't know all the sources and kinds of bacteria that carry out nitrate ammonification. We don't know what soil conditions are most conducive for nitrate ammonification. We don't know how soils can be managed to promote nitrate ammonification"
"Direct impact the model may have on future policy for managing water and agriculture."
"Final analysis of sustainability of supply of biomass for bioenergy without impacting ecosystem structure and function."
"How reliable are climate chance projections in the regions with complex topography. Uncertainty with earth system modeling of the climate feedback of wildfires."
"How well prairie strips perform on large farmer fields."
"Hypotheses and results generated from modeling efforts remain to be tested and validated."
"Incorporating high resolution data at human scale."
"Increased confidence in seasonal and 10-day + weather forecasts."

Knowledge gaps by NIFA Knowledge Area Topics
"Knowledge of the degree of contribution to nitrous oxide emissions in organically managed corn-soybean-wheat rotations that result from the practices that are different than a conventionally managed system which has less emissions."
"Ongoing research is laboratory based. Upon proving the concept, we need additional funding to test the mitigation technique at the field scale."
"Our ability to predict drought is still rudimentary."
"Our analysis was limited to orchard growers in Central Valley floodplains. Other regions may have different cost-benefit relationships with habitat, carbon credits."
"Project is in initial stages so not ready to address knowledge gaps. But, this project is targeting assessment and understanding of land-use impacts on climate under different climate regimes, which remains poorly quantified."
"Quite a few. We are only really beginning to understand how expected changes in winter climate will influence recruitment potential in managed and natural forests. Of particular importance is the role changing late winter and early spring conditions have on recruitment dynamics within nurseries and reforestation efforts on recently harvested land. The role biotic and abiotic extremes play in meeting management objectives in both these arenas is informed generally by this work, but specific experiments evaluating how different land management strategies are influenced by winter climate change is still to be determined."
"Separating the relative roles of different human alterations to the landscape on the physical environment."
"The NOAA NWS 8-15 day forecasts are not digitally stable for applications such as ours. Also further work could be done with finding ways to adequately create "pattern based" forecasts in gridded (spatially related) formats. One way that is commonly used is to use numerical weather forecast models (such as WRF). That would involve further investment and may be the subject of future grants. Also we are exploring ways to visualize uncertainty such as to simultaneously display multiple forecast results together in the same outputs."
"This work develops a coupled socioeconomic-technology model of future emissions to support climate mitigation and earth system management. This involves the development of models of technology diffusion, making use of the outputs from static or dynamic economic models. The major task of this work was the derivation of relationships between socioeconomic variables, which serve as exogenous scenarios and are the outputs of economic models, and technological changes, which characterize the fractional population of emitters having different emission levels. These relationships are difficult to determine and additional work could be undertaken to study how these relationships depend on the level of economic development in a given region and the interactions among different segments of society."
"Use of AD manure derived coproducts by crop farms."
"We do not yet know the sensitivity of regional emissions to climate variability - but we are starting to make progress as we obtain longer time series of key variables."
"We still can't capture all of the greenhouse emissions over time to give an accurate appraisal. All we can do is compare treatments within a snapshot of time."
"We still need to develop more efficient breeding methods for potato. In the genomics era, new opportunities are emerging."
Non-food
"Not applicable."
"The gaps include the (1) separation of the natural protein structures and then determine which specific chemical groups contribute to the functions of the batter materials that we prepared. In the other words, we hope to gain in-depth understanding on the materials performance, (2) effects of the new bio-energy materials on the fabrication of batteries, as high performance batteries cannot be achieved through simply applying traditional battery assembly methods. Thus, the fabrication of batteries with the bio-materials (bio-electrolytes and bio-binders) should be studied."
"This project is designed to understand what inhibits cellulases in pine bark extracts to be able to better digest them into glucose and other components for biofuels and biobased product manufacturing. To deconstruct pine cellulosic materials using enzymes will require much more effort to understand how to remove these inhibitors to be able to use the feedstock materials."
"This remains to be seen, as the project is still in its initial stages."
Plant Production

Knowledge gaps by NIFA Knowledge Area Topics
"[UV Climatology] Stratospheric ozone is one of the main absorbers of the ultraviolet (UV) portion of the solar spectrum. The depletion of stratospheric ozone, initially discovered in 1985 over the Antarctic, led to a series of global efforts to reduce the impact of harmful ozone depleting substances. In recent years, the discovery of intermittent losses of columnar ozone above the Artic support the concern over potential harmful effects of increasing levels of UV-B on agriculture, ecosystems, and humans. Moreover, the complicated interactions between changing climate and UV-B levels on Earth's surface may result in enhanced detrimental effects, especially on agricultural production. To date, uncertainties within ground solar UV measurements dominate in the observed trends of solar UV levels, thus longer time series of records are needed. Furthermore, complex interactions between clouds, aerosols and solar radiation are not yet fully understood, and changes in land use may affect the surface albedo and thus the overall UV levels. Although global monitoring is now available through satellite measurements, their low temporal availability and high uncertainties in UV are still imposed limitations. Furthermore, satellite retrieval algorithms need to be validated and/or further improved using ground-based measurements. On the other hand, higher spatial coverage is difficult to achieve using ground monitoring stations due to costs and required technical support. Thus satellite- and ground-based data are of equal importance for global monitoring. [Climate-Crop Modeling] 1. Modeling algorithms for crops within different regions, various cultures or crop production management practices are not sufficiently known at national scales. 2. Surface albedo is a crucial parameter in crop modeling, but current land surface albedo models are over-simplified and/or contain substantial biases from observations, and consequently cause serious uncertainties in modeling climate-crop interactions.3. The components of the crop models used for predicting the soil thermal and hydrological processes have formulations which are generally empirical and typically lack full interactions with atmospheric dynamics, and thus limit the model performance.4. Irrigation water demands contain large uncertainties under future climate change as projected warmer air temperature and precipitation patterns shift. [UV-B Effects and Response Studies]Despite progress in understanding how crops will respond to UV-B radiation and other environmental stress factors, considerable gaps in knowledge remain. Beyond the major agriculturally significant crops (e.g., cotton and corn), functional algorithms describing UV-B and other stress factors on growth, development, and yield for most plants are still unavailable. The negative effects range from heritable deleterious mutations in DNA, lipid and protein denaturation, and direct and indirect changes to several physiological and growth functions, and vary among species. These effects were at times observed under unrealistic light conditions (PAR<300 µmol m-2 s-1) that are now known to produce results that differ from those in the field. The positive effects include improved nutrition, greater hardiness to drought, and increased resistance to oxidative damage from excess light. These effects interact with other abiotic factors and are not well understood. These effects also extend to root architecture, a critical element of crop modelling as root architecture determines the efficiency of soil nutrient and water acquisition. Although these effects have been studied in a number of crops, they have not been well translated into dose response functions for developing algorithms for crop models."
"Additional safe pesticide application protocols for minor use crops."
"Applying our results to crop plants."
"Bioinformatics requires strong skills/understanding of biological problems and appropriate use of computational tools for solving SUV problems. However, we found out that Life Students are strong at biological concepts but they are very poor at writing programming code."
"Characterization of genetic basis of germplasm diversity for drought-tolerance"
"Commercialization of the system we are working on is limited by the high costs of producing, transporting, and storing biomass as well as the relatively low value of fuel products that are produced from it. We have concluded that it is essential to continue to work on lowering production and logistical costs, but are aware that there is limited potential for improvement. So in addition to this work, it will be necessary to develop higher value products that can be produced from biomass. There is tremendous economic potential for developing value-added products from biomass. Finally, because there are significant environmental benefits derived from growing perennial energy crops on marginal land and conservation policies need to be developed to provide economic return for the ecosystem services that are provided."
"Comparing conservation tillage options in terms of value for climate adaptation/mitigation. Improving cover-cropping in interaction with conservation tillage options. How cover-cropping, conservation tillage and biomass harvest interact"
"Considerable work needed in addition on rodent damage in drip irrigation technology. This is probably the Achilles heel of this technology in alfalfa. We also likely would like to know more about the economic issues and risk management with regards to crop revenue - over the time of this project we've had record high and record low prices, which create considerable uncertainty about the technology's value. Knowledge gaps also include the role of plant nutrition and nutrient management under drip irrigation, and the role of deficit irrigations. We are still learning about the methods of soil moisture monitoring and aerial photography which may enable better management of irrigation schedules - still a lot of questions there."

Knowledge gaps by NIFA Knowledge Area Topics
"Do these findings apply to other crops. Developmental states."
"Does the findings we see here apply to other crops!!!"
"Flux of unusual fatty acids during vegetable oil synthesis."
"Genetic mechanisms of ozone tolerance; environmental interactions with ozone stress and their impact on crop productivity."
"How necrotrophic pathogens are equipped to survive, and even thrive, in environments hostile to biotrophic pathogens."
"How to better engage international students."
"In Phase I program, we achieved feasibility demonstration of the proposed concept. We need to demonstrate engineering feasibility and economic viability by building and operating engineering prototype greenhouse. this is exactly what we proposed as the Phase II program."
"It is to be determined whether 'markers' identified in current breeding populations will be effective in future breeding populations and whether there will be additivity of different genes when integrated in into one genome and disease resistance of future cultivars will be superior to current ones."
"Life cycle analysis- though it was not a part of the project\Aggressive extension based delivery."
"Long term economic assessment. NOT feasibility rather the tools to evaluate inclusion of livestock in farm systems on farm by farm basis."
"Look at a larger number of inoculants and hay storage methods for alfalfa in the southern USA."
"Mechanistic data on the ways in which symbiotic microorganisms increase abiotic stress tolerance in plants."
"More field studies need to be conducted."
"Much of the research to date has focused on higher-order genetic phenomena. We are presently extending the research to processes at the molecular level."
"N/A"
"Not applicable as this was a conference proposal."
"Project identified substantial knowledge gaps in the role oxylipin signaling and specific molecular species that play either positive or negative roles in transpirational water loss."
"Project is in progress so cannot access at this time."
"Putting the finding into practice using a forward breeding approach to improve waterlogging stress."
"specific local knowledge about practices/systems that increase resiliency of agriculture; information about cover crops, perennial crop production and markets, on-farm energy use, alternative livestock systems and markets, reduced tillage, resilient grain crops."
"The genetic basis for resistance to aflatoxin contamination is complex and will require multiple approaches to analyze and apply selection in breeding effectively for this trait."
"Understanding how plant genome responds to drought is still incomplete."
"Understanding of genotypic variation in soybean responses to elevated CO2, which could be exploited to adapt soybean for enhanced future performance."
"We found is that there is significant population variation in circannual signals and the timing of phase for specific genes. Our sampling was inadequate to determine whether this variation is associated with specific source environments (warmer, colder). If it is predictably associated with source, this could be the main reason for the difference in gene expression between populations (e.g., a shift in phase, rather than simply a difference in amplitude). The direct connection between transcript abundance and a downstream product (protein; metabolic compounds) is a long-standing question with gene expression studies, and it is a core question/concern of ours. There are very strong seasonal patterns of transcriptional accumulation, and it would good to know whether the downstream signal is proximal or distal from the time of transcription."
"We have been working on plant immunity and the plant response to abiotic stress. Knowledge gaps remain in molecular details of these systems."

Knowledge gaps by NIFA Knowledge Area Topics
"We have used a transgenic system to improve water use efficiency, drought and heat tolerance in rice. As transgenics are not going to come into the market in the near future we have to find natural variation for the HYR locus in rice or other plants, so that classical specific Gene-marker-assisted breeding methods can be implemented for improving cultivars."
"WE identified the chromosome regions affecting water and nitrogen use efficiency, but we did not went down to identify the causal genes. That would have required an additional cycle of funding and would provide a more in depth understanding of the molecular and physiological mechanisms, and eventually the possibility to engineer rather than breed more resistant crops."
"We looked at the natural genetic variation in wild tomato species; I think knowledge of not just genomic differences but also gene expression differences are still to be examined. The variation present in domesticated varieties such as heirloom tomatoes is also yet unknown and could harbor generic resources for farmers and breeders."
"We still do not have a solid link between light sensing and root response leading to enhanced drought response. After undertaking a series of drought experiments to test our conditions, we realized that we still did not have all the tools needed to complete the experiments. Being in a new system, I underestimated the time it would take for tool generation and the time and complexity of drought experiments."
"We still lack the ability to reduce feedstock cost to a level that would supply an energy market. This is limited first by outside competition by other higher value crops and secondly by the energy crop's yield."
"We still need to concretely identify which wheat varieties cause allelopathic yield detriment to canola varieties and continue testing new germplasm. We need to continue developing best management practices to improve canola stand establishment in the Southern Great Plains."
Plant Protection
"A major knowledge gap is how to control the weather. We set up the experiments for success but favorable growing conditions did not cooperate. The experiment is so large that there is no way that rain out shelters would work, and since high humidity and drought is needed, the locations cannot be moved. Alternatively: How do we simulate environments expected under a changing climate at a scale that is meaningful for testing, given limited resources? Another knowledge gap is understanding the causes of interactions between different control methods we have tried. We expected synergistic or at worst no effects but found many antagonistic effects within different treatment genotype combinations."
"Application of climate change scenarios to migration model projections."
"Basic research to understand the intersection of pests and climate. Applied research for individuals and organizations to have tools for management. Policy change addressing the critical factors associated with the damage to ecosystems and the loss of revenue from pests increasing in impact in a changing climate."
"Basic research to understand the intersection of pests and climate. Applied research for individuals and organizations to have tools for management. Policy change addressing the critical factors associated with the damage to ecosystems and the loss of revenue from pests increasing in impact in a changing climate."
"Develop basic knowledge and models to predict degree of pest invasiveness in different ecological systems. There is also need to asses risk of pest and pest management strategies in agriculture, urban and natural resources"
"Development of small scale hydraulic motors to convert harvested energy into electricity."
"Effective use of different cover crops for organic rice production."
"For spotted wing drosophila: under what background volatile conditions are particular semiochemical attractants most effective. For codling moth: can attract and kill devices be modified to provide stronger visual cues to increase contacts."
"Implementation of monitoring for Bagrada bug invasion."
"It would be useful to develop environmental impact profiles for more pesticide products, especially with regard to human health. These profiles would include pesticide fate and transport and sensitivity of different populations of humans and wildlife exposed through air, water, and soil."
"Not relevant."
"Optimal native species mixes for cogongrass suppression"
"Strategies to avoid disruption of IPM practices when invasive pests arrive\Strategies to expand climate monitoring tools to more aspects of IPM research and outreach"

Knowledge gaps by NIFA Knowledge Area Topics
"The primary objective of the project is to understand whether ecological or evolutionary factors (or their combination) are more likely to influence the successful establishment of biological control agents. We're currently using a static dataset collected during a single year, but ecological interactions are likely to change through time as a result of climate change."
"The resilience of alternative systems to climate change. The impacts of pests weeds and pathogens on modeled yields under climate change. How stakeholder attitudes may be changing in years immediately following the project. GHG emissions from alternative production systems not monitored within the project. How great are influence of noneconomic considerations in affecting stakeholder decisions.. Soil health implications of climate change and alternative production systems"
"Tools for more realistic validation of research results."
"Understanding of the pest behavior under natural conditions."
"We are seeking further funding to run additional validation on our findings and confirm these results in other locales and with additional potato crop varieties."
Program & Project Support, & Administration, Education, & Communication
"Economic viability of energy crops in this region."
"Effective, practical approaches for agriculture to cope with the complicated effects of ongoing climate change need to be developed and extended to crop growers."
"How well do models reflect the tradeoff between greenhouse gas emissions and water quality impacts?"
"N/A" (n=2)
"Need several more years to change behavior our communities Traditions are important and need to be integrated with adaptation changes."
"The National Needs Fellowship program is not a traditional knowledge gap type of grant. It is directed towards increasing the diversity of agricultural and natural resource scientists - as such, we educated four student, but given the lack of diversity among professionals in this field, the biggest knowledge gap is that the workforce remains dominated by white, males. Although agriculture does do very well with educating first-generation students."
"The project was focused on increasing the capacity of current and future university faculty to teach about globally-relevant topics. We were successful in doing so however the format of the RLO still needs work to develop students' abilities to think critically about complex issues."
"The stakeholders in our research are transient - undergraduate and high school students. With time, gains in knowledge about USDA Priorities while still applicable to the students served are reduced in our target populations. Materials need updating to attract new students to agriculture from the allied science."
"There are always more things to do and know. We are satisfied. All project activities are continuing with other funding sources."
"We are only part of the way through year 2 and still have a lot of research and evaluation yet to do. It's premature to respond to this question. The overarching question is: what difference does integration of 4th wave systems thinking (ST) into water research, education, Extension/outreach and policy make? Then another set of questions around how to we measure ST? What difference did our project/resources make in integrating ST or building capacity?"
"We struggle with getting the word out about our project."
"Will impacts continue through grade 12?"
Soil
"1. Completely understanding the mechanism of N uptake by different biochars. 2. Developing more field based studies that has rigorously tested the designer biochar concept. 3. Being able to disseminate production guidelines to stakeholders."
"A clearer business case illustrating the value of early detection of chronic or acute healthcare situations in the rural senior population."
"A remaining knowledge gap is how to scale up our results to a regional scale. A general model for the regional scale would be helpful."

Knowledge gaps by NIFA Knowledge Area Topics
"A ton. We are in year 3 of this project."
"Addition of formal evaluation would have helped us determine best ways to disseminate information. Based on timing, I think separate grants for evaluation post-grant might make sense. This would give folks time to get things out and then evaluate impact following a suitable time period."
"Based on project findings we believe gaps still exists in linking enzymes activity and microbial diversity with cycling and availability of nutrients. We also believe that a coordinated and a consortia approach to examining the impacts from different regions of the world will give a better picture of how results can be applied."
"Detailed protocols for use of technologies in individual crops."
"Food requirements for various early life stages of fry produced out of season"
"For farmer-trainees, here and elsewhere, the most common knowledge gaps appear to involve business planning, financial management, record keeping, etc."
"How do we move beyond adoption by a single group to broader adoption by the entire community of forest managers?"
"How landuse and legacy will interact with changing climate (positive and negative feedbacks) to affect our terrestrial and aquatic ecosystems into the future? What types of restoration practices can be implemented to address extreme climate events? How best to make a convincing case about climate change impacts to the public and shape government policy?"
"How root mass affects soil C content makeup and whether root mass can be measured by the Intense Pulse Neutron method?"
"How soil P pools builds up and remobilization/retention impact legacy P."
"Knowledge gaps remain in techniques: how to capture very short but highly important 'hot moments.' Multi-million-dollar automated equipment allows round-the-clock monitoring of gas fluxes but still have terrible variability and environmental interferences. I no longer trust models. We need much more validation and regional modification of model outputs."
"Knowledge gaps that remain are: 1. The impact of grazing on greenhouse gas emissions and soil C storage."
"Large-scale implications for micro-scale processes of soil organic matter stabilization."
"Long term impacts of prairie strips on:--soil carbon and dynamics--impacts of pesticides on beneficial insects attracted to prairie strips."
"More in-depth understanding of the system before the management plans are designed."
"None"
"Not sure"
"Numerical representations of soil microbial processes remains challenging."
"Our data, which are still being processed in the lab, are likely to show that endophyte effects on soil C sequestration and greenhouse gas fluxes vary across space and time and depending on plant-fungal genetics. So plenty of knowledge gaps remain, trying to understand when and where this might be employed as a useful climate mitigation tool."
"Our results demonstrated an alternative pathway for building soil organic matter and how certain agricultural management practices influences the strength of this pathway. However, there remains some fundamental uncertainties about how temporal and spatial variability influence this pathway of soil carbon and what the direct drivers that affect the outcome of this pathway for a particular agricultural management practice."
"The levels of antibiotic leaching from manure fertilizers are not determined in this project. In addition, expression profiles of soil communities responding to organic fertilization should be studied."
"The project is not research-oriented. However, still right choice of curriculum in environmental system is a big question especially to address needs of the employer both industries and government."
"The tradeoff analysis has been inconclusive due to a limited number of sites."

Knowledge gaps by NIFA Knowledge Area Topics
"The uncertainty associated with indirect N2O emissions resulting from fluxes of nitrate, ammonia and nitric oxide that are converted to N2O after leaving the fertilized field. It was not possible to quantify the fluxes all three of these species in addition to N2O due to the massive labor and time requirements, nor was it possible to quantify within the scope of this study the processes occurring outside of the fertilized field."
"There are no knowledge gaps, we need more funding to support students."
"There are some key processes of N incorporation in soils that are not understood, for example abiotic N incorporation in to soils and N stabilization on mineral soil surfaces."
"There is still quite a bit of basic research needed on characterizing and modeling spatiotemporal variability at multiple scales. This understanding is particularly needed to optimize monitoring and sampling designs for both research and improved field management."
"This is a phased project and we are at the mid-point of the second of three phases. Thus, knowledge gaps remain related to integration of dryer control models with commercial scale dryers, validation of the operational, economic, and life-cycle benefits, and assessment of the user interface by industry operators."
"translation of results"
"We are still at the early stage of research, and cannot answer this question."
"We have not yet started the research component of the project so this and many other questions are not yet relevant to this project. In addition, this project does not have an explicit Climate Change component so not sure this project should have been selected for this survey."
"We know have a solid understanding of how topography influences nitrogen availability, but we lack the molecular work to explain which suite of microbes are responsible for the different rates of mineralization."
"We need to know a lot more about corn based cropping system variations and how farmer/stakeholders can better address C, N, and water relationships and manage the landscape as an agroecosystem producing livelihoods and ecosystem services."
"What are the limits of these remote sensing-based estimates of ag conservation practices? Indiana, where the system was applied and evaluated, is primarily wheat, corn, and soy. How well will the system function in regions with other cropping systems?"
"What BMPs to use where"
Water
"Accurate crop production data."
"County agent(s) will be able to communicate technical issues on pollution abatement to local clientele(s)."
"Engine manufacturers have to include warranty for using biodiesel and levels more than B-20 blend (B-50, B-90, B-100) etc. and if necessary make suitable modifications to the engine and fuel lines so that they are compatible with both biodiesel and fossil diesel. General public seems to be have little awareness of the two broad categories of biofuels ; bioethanol and biodiesel and their potential use in gasoline (SI) and diesel (CI) engines and the impact they may have on reducing global warming."
"How does climate warming affect nitrification/denitrification rates/processes?"
"How to adapt bioreactors to more situations beyond tile drained croplands."
"Incorporating economic factors in the APEX and SWAT models is still very challenging and missing. Need to move beyond just crop yields. Additionally, there is a huge need for quality stream data. Better staffed and managed watershed stations should be a priority going forward in terms for future modeling of water quality in watersheds."
"Multiple studies remain to further grasp bacterial transport in karst environments. More work can be done examining other microorganisms as tracers, other molecular markers, differing moisture conditions, and differing complexities in geology, just to name a few."
"Need to expand to other regions and include national datasets."
"Not applicable"

Knowledge gaps by NIFA Knowledge Area Topics
"The dynamics of surface water-groundwater interaction are still little understood, and in particular the ecological impacts instream."
"This grant focused on two areas of research and development; both moving towards commercialized products. Although these products are very different the original intent of the project was that they could preferably be used in combination with each other as standalone products. Currently, the coated seed product has lagged behind the control product due to production issues with our technical cooperator. We have recently changed cooperators and hoping to refine and streamline that area of the commercialization process."
"This will be the first study to explore the robustness of multiple cities that are using dynamic risk-of-failure (ROF) planning triggers. A challenge and unique contribution of this work is that the ROF-based pathways more effectively use scenario information (e.g., supply capacity and demand dynamics) to develop highly adaptive, probabilistic infrastructure pathways."
"Translate scientific information to stakeholders requirement."
"Understanding what is the most likely future climate."
"We are still in the process of implementing our proposed activities and aggressively disseminating information to our targeted student population."
"We are working to improve the water security of agriculture in the Colorado River basin. Much remains to be done as policy and science advances."
"We used multiple models and results in a couple cases were significantly different and further examination of the components of the models need further investigation."
"What will producers in the Colorado River do as water shortage becomes more acute? How will they work with other sectors that need water?"

Table 55. Competitive - Largest contribution
Corresponds to open Q47: "In your opinion, what is the largest contribution of your project?" Codes ordered by frequency (n=270).

Code	Frequency (n)	Description	Examples
Quantification	49	Quantified, identified, clarified, documented	*"Quantification of the effectiveness of altering fertilizer source in reducing direct N2O emissions on a site-specific basis."* *"Documentation on effectiveness of prairie strips from a variety of perspectives."* *"The identification that organically managed corn-soybean-wheat rotations have greater nitrous oxide emissions than the comparable conventionally managed system. Cover crops other than red clover have no impact on nitrous oxide emission in either management system."*
Development	48	Developed technology /method/element/tool	*"The development and refinement of a linked modeling framework for the analysis of the agriculture-energy-environment system, as it relates to the development of the biofuel markets, and thus, the markets for diverse types of biomass feedstock from agricultural lands."* *"We developed methods that can be used to predict hydrologic and agronomic drought."* *"Providing pesticide use protocols for minor use crops."*
Stakeholder engagement	25	Outreach, worked with stakeholders	*"The largest contribution so far has been the outreach component. Our project created a zone of agreement among diverse stakeholder groups formerly at odds with each other, illustrating how forest management might be accomplished at a larger scale and with fewer lawsuits. Providing stakeholders with the opportunity to see the results with their own eyes has been invaluable for breaking down barriers and increasing trust. The idea of managing for heterogeneity as a way of generating greater resilience is being incorporated into many different projects on this National Forest and beyond, in part as a result of this study. The study units are along paved roads not far from major population centers and the project area will likely be the focus of tours for years to come."* *"Engaging and sharing climate and hydrologic knowledge with stakeholders. Stakeholders are now thinking outside of their traditional ideas on how to increase sustainability."* *"Improved communication with stakeholders"*
Application	21	Provided to stakeholders or field that can or has been applied	*"Providing the mechanism and approach to using apps to make irrigation decisions."* *"Healthy food choices for the community and sustainable agricultural practices"* *"How to help producers to have high quality forage with reducing nitrogen fertilizer inputs."*
Education	20	Trained/taught/mentored students/post-docs	*"Student training."* *"The goals of integrating simulation modelling into the curriculum were to help students understand the complexity and dynamic nature of the agroecosystem and to provide tools for helping students learn to adapt to changes within it. Doing so has greatly enhanced their learning and understanding to the system."* *"Training 3 PhD students to think about forests holistically, from a systems perspective."*

Code	Frequency (n)	Description	Examples
Ongoing	20	Too early to determine	*"The project is still in progress and it is too early to say."* *"We are still at the early stage of the project (10 months into the 48-month project), and cannot answer this question."* *"The project is still on-going, so that the question cannot be answered."*
Better understanding	19	Insight, increased understanding	*"We have provided new insights regarding emission factors and have shown that indirect emissions are very important."* *"Our largest contribution is helping to extend the understanding of agricultural practices on below ground processes."* *"Improved understanding of various ways in which land use and land management can impact climate and biogeochemical cycling under varying climate regimes."*
Advancement	18	Improved/advanced element	*"Re-defining the dose response of modern soybean germplasm."* *"Improved risk assessment of migrating pest insects."* *"Incorporating soil microsite heterogeneity into a model of soil microbial trace gas production and consumption."*
Awareness	17	Highlighted issue /element, brought to attention	*"Our largest contribution is probably getting community markets to understand the value of carrying and selling produce. We feel that this project is making them more aware of the existing demand for fruits and vegetables."* *"Spreading the word that using wood is good for the environment."* *"The project helped build awareness within campus community and K-12 systems with regard to biofuels, climate change, precision agriculture, remote sensing and environmental stewardship."*
Collaboration	17	Good working team, interdisciplinary team, established team	*"The greatest contribution to the completion of our project was the relationships created among team members."* *"NGOs, agency personnel, ranchers, and scientist all learning from one another about the challenges and complexity of managing for multiple ecosystem services."* *"The value of this project stems from having very different disciplines apply their perspectives to a problem traditionally only viewed from the lens of veterinary practitioners or regulators."*
Confirmation	14	Confirmed, proved, validated, illustrated, demonstrated	*"Proving that a remote sensing based system can provide historical estimates of ag conservation practices across wide areas; and, therefore, getting valuable information into the hands of project evaluators, greenhouse gas inventory, science researchers, and others."* *"Validation that a crop protection technology developed for drought / water stress protection can positively impact crop yields."* *"Verified a new method to measure soil C content."*

Code	Frequency (n)	Description	Examples
Discovery	14	Implication of new finding	*"No-tillage is more important than cover crops in reducing greenhouse gas emissions."* *"The finding that no-till soils are a stronger methane sink than conventionally tilled soils because, counter-intuitively, greater gross methane production in no-till soils stimulates much greater gross methane consumption."* *"Discovered some surprising links between technology change (shift from horses to mechanized transport) and climate change."*
Foundational	10	Baseline/foundational data/knowledge	*"Fundamental knowledge of how the AHL genes work in plant development."* *"Basic information to guide policy regulations regarding genetically modified crops."* *"Pioneer such evaluation in US agricultural production especially in sugarcane production."*
Implementation	7	Initiated/started/ established element	*"The creation of an educational demonstration farm."* *"Establishment of the network has created a foundation to build upon."*
Database	6	Data set created	*"A regional research data base with baseline measurements using standardized protocols from biophysical measurements over 32+ sites across a large region that have potential for assessing change over time in and grounding climate-agronomic-human management models in real data to improve forecast accuracy"* *"Individual animal database for developing robust enteric methane prediction equations."*
Commercialize	4	Produced a commercial product, or potential to commercialize	*"We have a strong potential to commercialize the results of this research but we lack the funds and patent expertise to take it to the next level."* *"This was also patented."* *"Taking some quite abstract research ideas through the commercialization…"*
Extension	2	Extension materials or use of extension	*"The extension efforts developed as a result of this project."* *"They were highly engaged with the Extension team who made the information available through workshops, field days, fact sheets and bulletins."*
Minorities	2	Supported minority	*"Having four female students enter the workforce or continue their education."* *"Training Hispanic students in sciences to be prepared for science careers."*
Don't know	1	Not sure	*"There are several specific outcomes in different disciplines. I'm not well placed to compare them and identify which represents the largest contribution."*
Leveraging	1	Led to other project/gain	*"The NOAA funded project that grew out of the NIFA planning grant."*
Publications	1	Publications	*"Our published results to date are informing policy discussions at the state level in California about forest and fire management in the context of the Governor's climate action plan."*

Code	Frequency (n)	Description	Examples
Miscellaneous	3	Miscellaneous	*"Providing funding for projects that directly address grassroots agricultural concerns, and emphasize engagement of stakeholders in projects, from initiation of the idea, to designing approach, engaging in research and assessment of preliminary results and adjustment of project accordingly, to disseminating new knowledge."* *"Employ rural workers."*
NC	13	Unclear, vague, irrelevant	*"Please see impact statements given previously."* *"Knowing exposure. To scientists early change perceptions."* *"Not applicable."*

Table 56. Competitive - Rewriting grant proposal code frequencies and descriptions
Corresponds to open Q48: "If you could rewrite one element of your grant proposal, what would you change?" Codes ordered by frequency (n=242).

Code	Frequency (n)	Description	Examples
Nothing	56	No change necessary	*"I cannot think of anything I would change."* *"Nothing."* *"I tend not to look at the past this way. I am pretty happy with the proposal. We did well given our knowledge at that time."* *"None."*
Expand	42	Increasing scope	*"The opportunity to expand the project to other locations with different soil types."* *"I would plan and budget for a large field data collection of observations of crop residue cover and winter cover crops specifically designed and collected to validate remote sensing observations."* *"I would not necessarily change any of the existing components. If I could add new components - maybe the use of biomarkers to characterize POM sources."*
Methodology	25	Modifying methodology	*"Develop one integrated model as opposed to linkages between two pre-existing models (a more ambitious endeavor)."* *"The animal species we proposed to work with are lower value species. Need to change them to higher value species so that the economics of the work is improved."* *"I would have started on temperature and not salt."*
Emphasis	18	Modifying emphasis	*"I would focus more squarely on the geospatial aspects of site-specific management. Non-geospatial experimental results proved challenging to apply in a geospatial framework, and develop into products that growers could use."* *"Less emphasis on Hudson Valley as the farming destination for our apprentices post-apprenticeship. Our apprentices come from all over the country, and sometimes outside the country; while many have stayed and taken up farming careers here, more have started farming elsewhere, often returning to their roots."* *"I would have studied more experimental replicates of fewer genotypes."*
Reduce scope	16	Reducing objectives/tasks	*"I proposed an intricate conceptual model that I wanted to fully probe. I think I would either pull back on the amount of novel theory in that model or the amount I would probe in it, instead being more clear about the specific relationships I would investigate and how."* *"Scale back user interface."* *"I would reduce the number of experiments proposed since some of them are redundant and not necessary for the completion of the project."*

Code	Frequency (n)	Description	Examples
Funds	14	Increasing funds	*"Maybe more money so I have clearer leverage over people's time. Everyone pitches in and does the work, barring unexpected departures, but I can never claim that this project rises to the level of top priority for anyone."* *"Limitation in funding is the major challenge to do more research."* *"Total funding."*
Collaborators	13	Increase collaboration or add collaborators	*"More emphasis on interaction with the forest ecologists."* *"Invite a faculty/research on food culture/history to be part of the team."* *"We would seek more partners from a broader spectrum of soil and temperature classes on examining the impacts studied."*
Project length	13	Requesting longer timeframe	*"It would have allowed more time to complete the work. We finished up mid stride. Gap in funding lost us some momentum with farmers who wanted to immediately implement changes."* *"If possible, I would have asked for a later start date or more time- because we couldn't actually start this project when we proposed it!"* *"We would request additional time to implement our project activities in order to benefit more students in experiencing these unique opportunities."*
Staff	11	Adding dedicated staff	*"I'd write in a project manager at my institution."* *"I would add another person to work solely on climate change issues in the model."* *"A 'data manager' explicitly devoted for this project, but it would have been difficult to fit under the cap budget."*
Budget	10	Modifying or including budget distribution	*"Structure funding such that each disciplinary focus area had directed funding or full-time postdoc or staff member responsible for coordinating that area 5 days/week."* *"This would have changed the budget allocation a lot, but I would have been more explicit about GxExM effects, their measurement and integration into solutions."* *"I would probably only fund 1 graduate student (rather than 2) and complete the rest of the work via technical staff, thereby relying more on PI/co-PIs for data analysis and writing publications. The complexity of managing 2 graduate students working on complex, inter-related questions has been a challenge. At the same time, 2 graduate students bring twice as many new perspectives and ideas to the project as 1."*
Personnel	7	Modifying personnel	*"I would have excluded one or two researchers that did not deliver as expected."* *"Some of our consultants have not come through, so I would instead hire more personnel."*
Don't know	6	Not sure	*"Not sure."* *"Don't know."*

Code	Frequency (n)	Description	Examples
Specificity	4	Increased detail	*"As I noted the reviewers are made of very diverse areas and what is obvious for those engaged in CEA study is not necessarily obvious to those reviewers. Therefore, we need to educate those reviewers. I would add to my proposal a basic introductory remarks on the basis of our proposal."* *"Re-instate material from the original grant proposal that had to be deleted to meet funding restrictions."*
Stakeholder engagement	3	Involving stakeholders earlier	*"Involve local stakeholders (farmers) in the planning of the project."* *"Make a stronger effort towards engaging with the media and farmers/growers."*
Extension	3	Integrating Extension	*"We would include extension people in the team as a contact point of the stakeholders."* *"Incorporate more involvement with Extension."*
Advanced technology	3	Using advanced technology	*"…use even newer sensor technology."* *"Provide additional supercomputing capacity for the modeling component, which is needed for the necessary restructuring and recoding of the modules, and to run the model itself."*
Flexibility	2	Allowing for flexibility	*"Experimental methods. Gene expression methodologies change so rapidly that one should not allow their project to be locked into a specific methodology. We should have used the phrases 'for example' and 'for instance,' rather than proposing a specific method. I think this narrowed our thinking to the point that we were following the proposal, rather than the best available technology."* *"While writing a project, one tends to cover various goals in a similar way, but quite often the results in one direction are so strong that one tends to concentrate research in that direction. Should have given that as an alternative in writing the proposal, which was in essence much broader in context, while the results in a specific direction were of much higher quality and also needed different expertise (e.g., more systems biology than physiology)."*
Ongoing	2	Too early to tell	*"Too early to judge."* *"Not yet determined."*
Research dissemination	2	Including resources for research dissemination/ outreach	*"We would add an element of 'advertising.' We need to get the word out."* *"Make a stronger effort towards engaging with the media and congressional staffers."*
Impact analysis	1	Determining potential impact, evaluating impact	*"We don't feel that there is anything we would necessarily need to rewrite entirely, but we would slightly modify a few sections. One being our evaluation goals. Because we overshot our goals significantly, we have had to increase capacity for assessing our successes very rapidly."*
Miscellaneous	7	Miscellaneous project specific activities and/or interactions	*"Rely less on private lands for project activity."* *"We did what we proposed. I wish there were more synergies with other NIFA funded projects."*
Not coded	14	Irrelevant or vague	*"The modeling work played out differently than anticipated."* *"Economics."* *"Elements relating to resources that were to be available for conduct of the project."*

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3.2.7 Project Director Information

The average (mean) age of PDs was 49.9±10.7 years (Table 57) and PDs were predominately male (71.2%; total n=295; Q50). PDs, at the time the project was funded, were likely (31.4%) to be full professors (Figure 39). Specified other titles are included in Table 58. The majority of PDs identified as a life scientist (60.7%; Figure 40). The other specified scientists/professionals are presented in Table 59.

Table 57. Competitive - PD age
Corresponds to closed Q49: "What year were you born?"

	Respondents (n)	Mean (year±sd)	Range (year)
Age	295	49.9±10.7	27-79

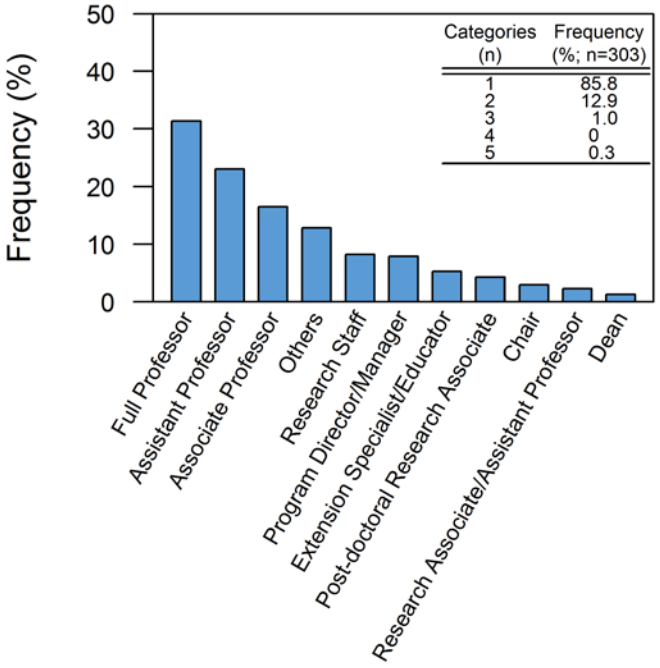

Figure 39. Competitive - PD job title
Corresponds to closed Q51: "What was your job title when this project was funded (check all that apply)?"

Table 58. Competitive - PD job title open response codes
Corresponds to open portion of Q51 (n=39[a]): "What was your job title when this project was funded (check all that apply)?"

Code	Frequency (n)
CEO/COO/CTO	6
Director (non-program)	12
Distinguished Professor	1
Extension Professor	1
Founder	3
Graduate Student	6
Instructor/Lecturer	2
Owner	2
President	3
Miscellaneous[b]	5
Not coded[c]	2

[a] Respondents indicated >1 "other" codes, which is included in the frequency table resulting in an n greater than the n of respondents.
[b] Miscellaneous focus areas include marginal farmland, the urban wildland interface, and the built environment.
[c] Response irrelevant or vague.

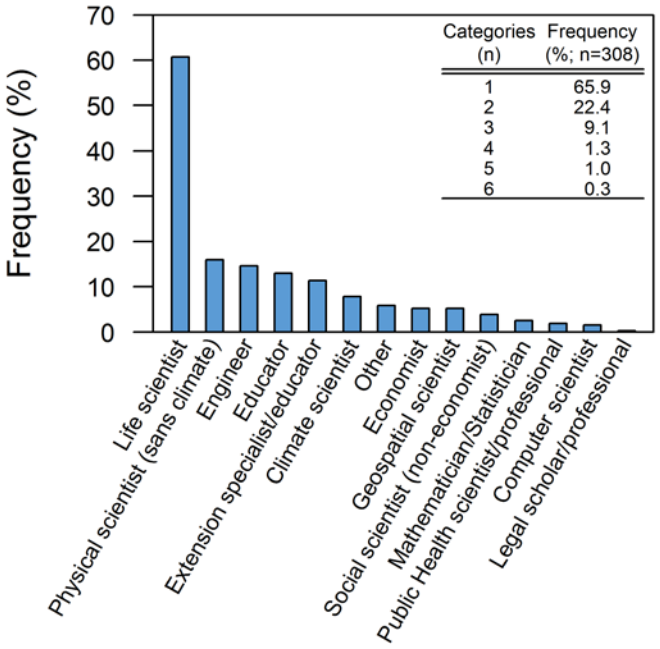

Figure 40. Competitive - PD scientist/professional
Corresponds to closed Q52: "Please specify the type of scientist/professional you are (check all that apply):"

Table 59. Competitive - PD scientist/professional open response codes
Corresponds to open portion of Q52 (n=19[a]): "Please specify the type of scientist/professional you are (check all that apply):"

Code	Frequency (n)
Agriculturist[b]	6
Business	1
Environmentalist	1
Range Scientist	2
Soil Scientist	6
Toxicologist	1
Miscellaneous[c]	3

[a] Respondents indicated >1 "other" codes, which is included in the frequency table resulting in an n greater than the n of respondents.
[b] Agriculturist includes aquaculturists, agronomists, crop scientists, and horticulturists.
[c] Miscellaneous includes community organizer, fisherman, and urban planner.

3.2.8 Project Director Success

A total of 11 factors with definitions were provided as contributors to project success (Q53). The PDs were asked to rank the top three most important factors to their project success. All 11 factors were identified as the top factor by at least two PDs. Overall, the top three factors were identified as 1) "mission," 2) "personnel," and 3) "technical tasks" tied with "personnel." The top three factors ranked as number one were (in descending frequency) "mission" (37.1%), "personnel" (24.7%), and "communication" (13.1%; Figure 41).

PDs were asked to score the importance of 34 project success areas out of a 1-5 (1="not at all important," 5="extremely important") point scale (Table 60). Overall, all project areas were rated as "moderately important" or higher with a mean Likert score range of 2.9-4.3. The highest (Likert mean=4.3 and highlighted in dark blue) ranked area was "publishing research results." The lowest score (Likert mean=2.9) was "improving policy making."

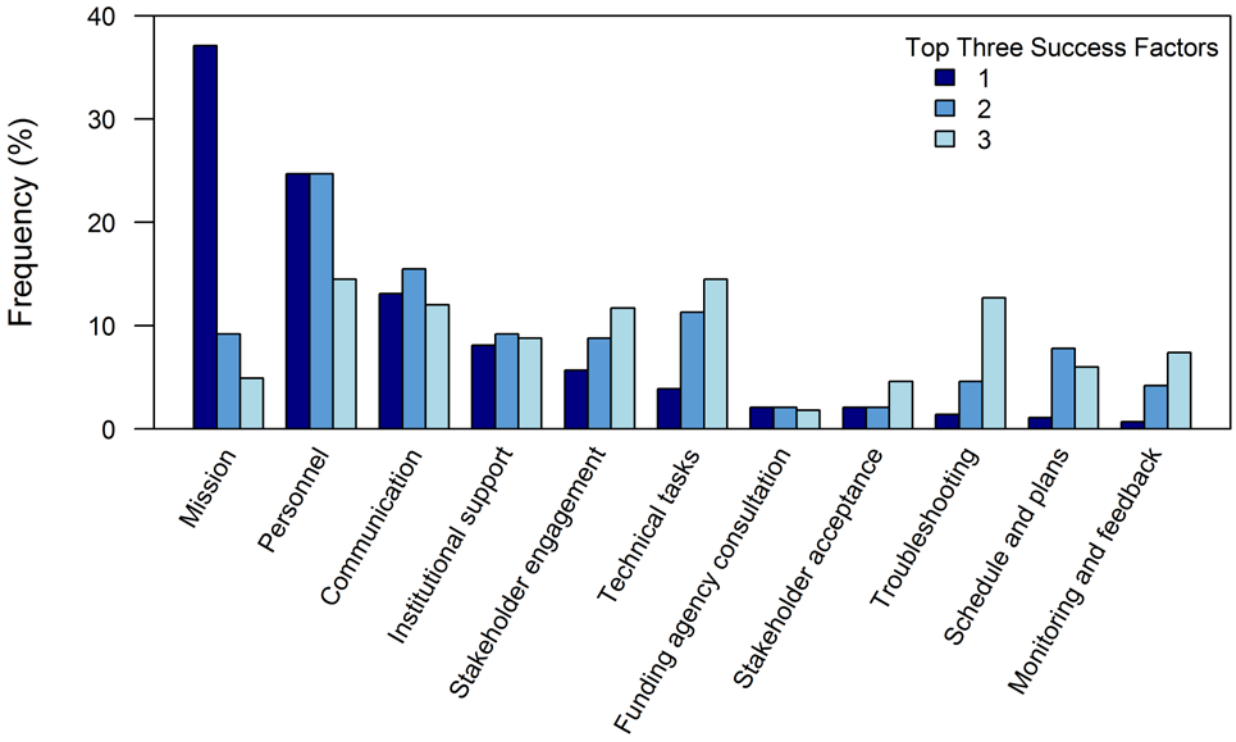

Figure 41. Competitive - Most important success factors to help achieve project success
Corresponds to closed Q53: "In your opinion, what are the three most important factors to help achieve project success?" Ordered by frequency of top success factor (n=283). Frequency calculated across ranking (e.g., number of PDs that selected "1" divided by n of respondents multiplied by 100).

Table 60. Competitive - Project area success advice

Corresponds to closed Q54: "If you were to provide advice to another PD, how important would the following areas be to the success of a project?"

Project area	Respondents (n)	Frequency (%)					Likert mean[a]
		Not at all important	Slightly important	Moderately important	Very important	Extremely important	
Ability/flexibility to troubleshoot	292	0	2.7	18.8	51.4	27.1	4.0
Communicating with collaborators	293	0.3	0.7	6.1	51.5	41.3	4.3
Completing all project goals/objectives	291	0	1.7	25.1	48.1	25.1	4.0
Creating standardized protocols	291	2.7	9.6	41.9	36.8	8.9	3.4
Defining a lab/team/professional mission	294	1.0	7.8	28.2	43.2	19.7	3.7
Defining data needs/objectives prior to implementation	293	1.0	3.1	17.7	48.8	29.4	4.0
Developing detailed data management plans	294	2.7	9.9	37.4	36.7	13.3	3.5
Developing new relationships/synergies with other organizations	293	2.4	11.3	38.6	36.2	11.6	3.4
Developing quality assurance plans	290	3.4	16.6	39.7	33.4	6.9	3.2
Developing relationship with stakeholders	290	1.7	7.6	26.9	36.9	26.9	3.8
Early stakeholder involvement	287	3.5	10.1	31.4	34.1	20.9	3.6
Engaging in social activities with collaborators/peers	287	3.5	10.1	31.4	34.1	20.9	3.6
Enhancing project team relationships	288	1.4	10.1	28.8	45.1	14.6	3.6
Enhancing/developing relationship with stakeholders	289	2.8	12.1	31.1	40.5	13.5	3.5
Funding agency satisfaction with outcomes/progress	288	0.3	5.6	22.6	45.8	25.7	3.9
Having a project manager	288	5.6	11.8	23.3	38.9	20.5	3.6
Having institutional support for and authority to acquire resources	286	0.3	5.9	22.4	43.7	27.6	3.9
Having interdisciplinary project teams	290	1.4	8.3	26.2	40.7	23.4	3.8
Having sense of urgency	288	4.5	13.2	33.3	34.0	14.9	3.4
Impacting stakeholder behavior	288	3.8	15.3	39.6	31.2	10.1	3.3
Improving policy making	287	9.4	24.0	35.9	26.1	4.5	2.9
Increasing your reputation/value to funding agency	290	2.4	13.4	30.3	39.7	14.1	3.5
Involving project stakeholders early on in project design	288	3.5	12.2	29.5	38.5	16.3	3.5
Leveraging funds	292	1.0	11.0	30.5	41.4	16.1	3.6
Monitoring and receiving feedback from stakeholders	286	2.8	11.2	31.1	42.3	12.6	3.5
Open line of communication with funding agencies	291	0.3	11.0	35.1	39.9	13.7	3.6
Operating within budget	291	0.7	3.1	15.1	43.6	37.5	4.1
Overcoming technological limitations	288	0.3	2.8	19.1	50.3	27.4	4.0
Publishing research results	290	2.1	4.5	9.0	38.3	46.2	4.2
Recruiting personnel	293	0.7	3.4	8.9	38.9	48.1	4.3
Satisfaction with outcomes/progress	293	0	1.4	9.9	64.2	24.6	4.1
Sharing research results with stakeholders	291	1.0	3.4	16.2	50.9	28.5	4.0
Training university students	293	3.1	7.2	15.0	43.7	31.1	3.9
Using adaptive management techniques	289	4.2	11.8	32.9	33.9	17.3	3.5
Other[b]	18	44.4	0	5.6	22.2	27.8	2.9

[a] Calculated from Likert scale 1-5 (1="Not at all important" to 5="Extremely important"); shading corresponds to lowest=light blue and highest=dark blue. [b] The specified other areas are not detailed in this report.

3.2.9 Journal Articles and Additional Comments

Journal article publications provided in Q56 and 57 were consolidated and summarized by NIFA Knowledge Area Topic in Table 61.

Additional comments provided by PDs included specific project details, how the projects were still ongoing therefore completing the survey seemed preemptive, how they were unsure of why they were considered part of the Climate Portfolio, comments about NIFA, and suggestions to NIFA. Feedback regarding the survey was not included in this report (Table 62).

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Table 61. Competitive - Journal assessment summary

Corresponds to Q56 "Please provide a citation list of products (e.g., papers, materials, presentations, extension, website, etc.) generated by this project to date using the upload option below" and Q57, "Please provide up to 5 products (e.g., papers, materials, model outcomes, presentations, extension, website, etc.) that you believe to be the most important products generated by this project to date." Summary presented by NIFA Knowledge Area Topic (n=64).

Knowledge Area Topic	Articles (n)	Number of authors (mean ± sd)	Journal Impact Factor[a] (mean ± sd)	Climate or Weather (%)			Publication Year (%)							
				Weather	Climate	Neither	2010	2011	2012	2013	2014	2015	2016	2017
Agricultural, Natural Resource, & Biological Engineering	5	5.40 ± 2.07	1.19 ± 0.48	80.0	20.0	0	0	0	0	0	0	0	60	40
Air	2	4.00 ± 1.41	1.82 ± 1.30	50.0	0	50.0	0	0	0	0	50.0	0	50.0	0
Animal Production	37	7.41 ± 3.45	2.08 ± 0.92	91.9	0	8.1	0	0	2.7	18.9	13.5	35.1	29.7	0
Animal Protection	3	4.00 ± 1.00	2.03 ± 0.19	0	0	100	0	0	0	0	0	66.7	33.3	0
Economics, Markets, & Policy	20	4.95 ± 3.38	4.91 ± 8.50	0	40.0	60.0	0	0	5.0	20.0	15.0	10.0	50.0	0
Food Safety	2	5.00 ± 4.24	2.1 ± 2.08	0	0	100	0	0	0	0	0	0	100	0
Forest & Range Resources	19	14.32 ± 16.57	3.44 ± 1.67	15.8	42.1	42.1	0	0	0	0	5.3	31.6	42.1	21.1
Human Health	6	4.50 ± 1.76	3.09 ± 1.63	0	0	100	0	0	0	0	0	16.7	66.7	16.7
Natural Resources, General	23	4.70 ± 1.66	3.75 ± 1.75	8.7	69.6	21.7	0	4.3	4.3	0	8.7	30.4	39.1	13.0
Non-food	5	4.00 ± 1.22	3.06 ± 3.20	0	0	100	0	0	0	0	0	40.0	60.0	0
Plant Production	72	5.35 ± 3.29	2.41 ± 1.67	26.4	23.6	50.0	8.3	8.3	9.7	9.7	22.2	18.1	22.2	1.4
Plant Protection	13	6.00 ± 6.20	2.6 ± 1.56	0	23.1	76.9	0	0	0	0	30.8	30.8	30.8	7.7
Soil	40	6.60 ± 9.77	4.27 ± 5.90	0	25.0	75.0	0	0	0	0	10	42.5	42.5	5.0
Water	9	4.11 ± 1.45	2.53 ± 1.37	11.1	33.3	55.6	0	0	0	0	0	22.2	66.7	11.1

[a]5-year mean

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Table 62. Competitive - Additional comments
Corresponds to open Q58: "Please use the space below for any additional comments about this survey or NIFA projects and funding."

Code	Counts	Description	Responses
Project detail	25	Detail regarding project	*"This was a student training grant for environmental science field research. Only one paper was published resulting from one of the many research activities undertaken by students and faculty during the 5 years of the grant. This paper was authored by [name] and [name] and is 'in press.'"* *"This was a planning grant…"* *"CAP projects are special."* *"This project was unique in that it did not involve many of the features of other NIFA projects. As an educational project the products are curricular materials that have been integrated into online courses that cannot be easily tabulated or sourced. However, the volume of such material produced by this project was substantial and it has had a significant impact on student learning."* *"This was my first federal grant and it was crucial for me developing my research program."* *"We did engage stakeholders in the initial design, but NIFA cut all of our stakeholder engagement budget out of the original proposal. Nonetheless we will do our best to reach out again to those key stakeholders once we have some translatable results. We're just not there yet."* *"Some of the questions were not relevant to this project and I could not answer. We did not publish any articles or produce tangible products."* *"Our project addresses needs of farmers in their first 10 years. A small segment of the project focuses on sustainable methods to address climate change, the balance is farm management education."* *"Note that the main goal of this specific project was not climate change adaptation and mitigation, although the conservation technology investigated - prairie strips - are expected to assist with both."* *"Through time, the iPiPE CAP will create a repository for agriculture pest observations. This will require changing the culture to one of sharing pest observations among agricultural stakeholders. These data should be very useful to evaluating the impact of climate change on agriculture as well as addressing local and regional pest problems."* *"I presume my project was selected for inclusion because of an agroecosystem component."* *"The purpose of this SBIR research grant was not to produce publications. This kind of metric makes no sense in this case."* *"This is an SBIR funded project and there is no special emphasis on publications. Because much of our research and development is specifically geared to the commercial sector and NIFA recognizes our need to protect our IP, publications regarding our research activities are not a priority, especially prior to the end of our active research phase which is designed to prove feasibility during Phase I. Simply put, there are no 'products' to share at this point in our research."* *"We are a private farm developing production techniques to keep us competitive, some of which will be considered proprietary."* *"This grant funded a partial meeting grant."* *"This project is an umbrella project for many subawards, some of which deal directly with the topic of this survey, others are more peripheral."* *"Our project is focusing on the recycling of used railroad ties."*

Code	Counts	Description	Responses
			"Since this was considered a seed grant ($150,000) it seemed that many of these questions were not applicable to this early stage of the work. Also one aspect that is always difficult is to assign products to one project and not multiple projects. This becomes difficult with the current project goal of creating a stronger multi-institutional working group." *"Although we trained our National Needs Fellows to become scientists, the focus of our project was on the training and not on the science."* *"We funded undergraduate research and high school science fair students. About one-third of the projects were related to Climate Change, but little, if any, information can be used to set Climate Change agenda."* *"The goal of this project was to develop enzyme biosensors with extended operational life based on combining high pressure, chemical modification and immobilization on nanofilms. We expect that some of these sensors will have an impact in food and agriculture."* *"In terms of our project, it is a bit of an anomaly in this water portfolio. We are not focused on generating new water science or new water curricula. We are focused on working as a force multiplier to existing water efforts by integrating/building capacity in the newest wave of systems thinking to water research, education, outreach, policy. To that end, my results may not fit as easily."* *"The # of students we will train is 600 because the aim of this project is to develop curriculum that will be taught to students at universities around the country."* *"…However, we have had to delay the start of the field research portion to 2017 for various reasons."* *"Also, the environmental differences between rice and bean cultivars (e.g., climate relevant) were not necessarily a component to the proposed project and so answers may not be directly relevant to assessing this dimension. While we are currently assessing bean and rice bran as dietary markers in Colorado children and adults, I do envision that validation of this project across the globe would take into consideration the climatic and food differences as important variables."*
Ongoing	15	Project still ongoing	*"I do not know how to answer questions about a project that is not finished. Answers about output on unfinished projects will lead to inaccurate assessment if they are interpreted as answers about completed projects. Should I guess about what we will have finished when everything is done and manuscripts are through the review process? Should I guess about what will have driven success or what will have caused problems?"* *"While I am deeply sympathetic to the aims of this survey, I feel like it was a total waste of time. My project is mid-way to completion, with a large field research component. As such, we don't have deliverables, policy recommendations, or other 'take homes' that are the focus of this survey. Further, we are in the throes of digging into our data so I certainly don't have advice for other PDs. I completed this survey because I have a tremendous amount of respect for Jerry Hatfield and got a ton of emails on it. Now that I have spent the time doing it, I see that it is not a good fit for where my project is (incomplete). It is actually a little demoralizing to be doing a lot of these reflections mid-way, as is makes you feel somewhat like a failure, which I know is not the intent whatsoever. It's really not a great fit for mid-point projects."* *"We are not able to publish any scientific papers as of now. We hope to publish three papers within a year once our survey is completed."* *"We have only finished two years of field work and are working on the manuscripts as well as our extension component of our research."*

Code	Counts	Description	Responses
			"We are early on in this project and have no publications or products to share." *"Early in the project. No outcomes yet."* *"We are only one year into this three year project. Several products are being prepared but are not quite complete at this time."* *"Our project has barely started so it does not seem that my answers will be very helpful--so far, we have only held one very successful Extension workshop--flyer attached."* *"We are just one year into the project funding period of 5 years. We have a number of preliminary findings, but we are not in a position to provide publications yet."* *"We have just completed our first field season on this project and are getting ready to begin present data at regional and national meetings."* *"Would be good to wait till further along in project to evaluate these."* *"Will be better able to address these questions further on in the project (might be good to skip projects in the first 2 years)?"* *"…and is in its early stages."* *"Although it has been funded for 1.5 years, the student did not begin until 1 year ago and the data are a bit behind in their collection. However, all data to date are excellent and I expect to publish at least 3 papers and have 2-3 presentations at conferences."* *"Also, as I understood it, this survey requests information for funding distributed last year, and the first project reports from subawards will be filed in March of 2017, so very little information is available about products from these two-three year projects."*
Question climate	15	Unsure why included in the portfolio or climate aspect tangential within project	*"It does not address climate change specifically except for the role that climate change may have in the appearance of new disease or pest challenges in livestock systems."* *"This is not a climate change project specifically."* *"This project was not related to climate issues."* *"I am not clear why I was given this survey. It appears to focus on climate mitigation and adaptation. Those were not the main objectives or our work."* *"I am not a climate scientist, so it is unclear why I was asked to fill in this survey."* *"This project impact on Climate Change is indirect."* *"Unfortunately, the goals of this 5-decade old project do not address climate change issues, as stated earlier in the survey they are to determine safe pesticide use protocols for specialty crops."* *"Our project was not part of the Climate Change portfolio, is a research project (not education or extension)…"* *"This project is not directly related to climate change, but is focused on facilitating biofuels from forestry materials, thus no climate scientist is directly involved."* *"Our program does not have a specific climate focus. Potentially in the future climate/temperature will come into effect."* *"A comment: I am not involved in a climate project nor am I a climate scientist but I was asked to fill out this survey."*

Code	Counts	Description	Responses
			"I believe that climate change is an important issue, but I don't think my project was funded through the Climate Change initiative. Thus, many questions were not relevant to the research objectives for which I currently receive NIFA funding." *"I would like to note that my project is not connected with the problem of climate change anyhow and no climate change specialist is involved in project's implementation."* *"While this work will have a direct impact on material wastes and bioenergy production and therefore potential impact on the environment, we don't directly address climate change in the proposal and we don't have a climate expert in the team."* *"In addition, the project does not explicitly address climate change. It is not clear to me why this project was selected to be part of this survey."*
NIFA comment	10	General comment about program or NIFA	*"There's too much USDA required annual paper-work."* *"Efforts to research and quantify the economic, social and environmental impacts of increasing irrigated agriculture in the East are critical to food security. This NIFA funding has been essential in moving the applied science on this subject forward."* *"NIFA funding is critical in advancing knowledge and more informed decision making as a result of the new knowledge. Also, the funding is large enough so several scientists can be involved from different scientific areas."* *"One of the important roles of NIFA, as opposed to industry, is to work on longer term projects so that societal problems can be addressed. As with many things in agriculture, impacts are often not seen until many years after the project is over, which is in large part because there is only one major growing season a year for most crops. Given the nature of the survey questions, it is unfortunate that the survey is being asked of current and recent grantees instead of or in addition to grantees of projects that ended 5 to 15 years ago. The main impacts that can occur in a few years are superficial metrics (publications, number of students trained, numbers of producers reached), but I think there are more valuable impact and outcome metrics (along with the recognition that all projects will / cannot create meaningful impacts) to the mission of NIFA and USDA."* *"I had a very bad experience uploading my project into the REEportal. I was so traumatized by the lack of assistance by the NIFA communication staff that I will never be involved with another NIFA funded project. The stress of the upload was not worth it."* *"This fellowship has provided me, as a young, female, scientist an invaluable training opportunity. Not only has this funded a new, novel research endeavor that will provide me with a new research focus with which to launch my career, but it has provided an opportunity for me to change disciplines. While I did not get as far as I would have liked in addressing the climate change questions, I will not stop pursuing these questions as I move forward."* *"The on-line annual reporting system is too complicated for the PDs to work on. It is very time consuming."* *"One challenge with multiple university teams is the indirect amount for the home institution becomes a major portion of the budget because indirect is collected on all of the subawards and on the home institution's award. If NIFA did not allow universities to collect indirect on subawards this would allow more money for research and would encourage collaboration among multiple universities."* *"Our project's outcomes were greatly enhanced by the positive relationship and interaction we had with our program leader."*

Code	Counts	Description	Responses
			"And thank you for making it possible to apply for SEED grant money. I probably would not have applied if I'd had to make a full proposal at the longer length."
NIFA suggestion	6	Suggestion about program or to NIFA	*"As a new PD, I would have appreciated more interactions with the NIFA Grant Officers. There was very little communication between NIFA and our team and few opportunities to do so."* *"Need some support for Phase III continued R+D since new products are not usually 'perfect' by the end of Phase II."* *"While developing the project, can NIFA suggest experts for collaboration in the lacking areas?* *"When unexpected problems such as technological or instrumentation or equipment happens, it would great when funding agency is flexible with duration of the funding and providing extension for genuine causes. NIFA limits funding duration to maximum of 5 years regardless of any technical or resource or other problems. It would be nice to have the flexibility when there is a genuine cause."* *"With the increasing pressures to divert funding to other programs, I would urge NIFA to fight for more dollars and use those funds to provide more support for the basic fundamental research, education, and teaching that is going on in IPM at land grant and partner institutions, including 1890s institutions in the Northeast." (n=2)*
PD factoid	4	Detail regarding PD	*"I direct the [center name], which funds research, extension, and education projects in the region. I spend three solid weeks each year visit every single PD in the region and their work is fundamental with regard to learning about the biology and ecology that underpins our agricultural, forest, and natural systems. Further, the transfer of this knowledge to growers, policy makers, professionals, researchers, students, land managers, and homeowners is the key to our ability to sustain ecosystems and economies." (n=2)* *"Please note that I am the previous co-PD on this project; the current PD may have answered some questions differently."* *"I am retiring, so have passed on some of the final elements of this project to [name] as the representative of the other coPIs on this project. She will be the best contact for final publications / reports."*
Miscellaneous	1	Miscellaneous project specific activities and/or interactions	*"This type of research and all research would be more impactful if we had a research culture of development and engagement, not just judgement."*
Not coded	6	Vague or irrelevant	*"N/A" (n=4)* *"Best wishes!"* *"Why do I have to waste my time with this?"*

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4 References

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Appendix A: USDA-NIFA Climate Portfolio Project Director Survey

NIFA Climate Change and Agroecosystems: Project Director Survey

You have been identified as a Project Director who received funding associated with the USDA-NIFA Climate Change and Agroecosystems Portfolio (Climate Portfolio). The purpose of this survey is to gather your perspectives on your NIFA funded project (indicated on the following page) in order to identify critical findings, lessons learned, and to evaluate the effectiveness of projects in promoting climate change and agroecosystem solutions. Additionally, by participating in this survey you are assisting in identifying future funding priorities for the Climate Portfolio.

Your participation in this survey is voluntary. Your answers will be kept confidential and will be released only as summaries where individual answers cannot be identified. The survey should take approximately 30 – 45 minutes to complete and consists of eight sections of varying lengths. A progress bar has been included for your convenience and the system saves your progress as you go if you need to return at a later date to finish the survey. Please read each question carefully.

For information regarding the survey, please contact Linda Prokopy (lprokopy@purdue.edu; 765-496-2221) or Jerry Hatfield (Jerry.Hatfield@ARS.USDA.GOV). Thank you in advance for your help!

Introduction
In this section, please respond to the following questions and confirm your status within the Climate Portfolio.

Question 1 (Q1). Were/Are you the Project Director (PD) or a co-PD on project account/accession number [ACCESSION NUMBER] entitled [PROPOSAL TITLE]?

- ❍ No; I have no relationship to this project
- ❍ No; however, I have a significant role in this project (please specify):_____
- ❍ Yes

Display: If respondent selected "No; I have no relationship to this project", text below displayed and the survey concluded after response submitted.

Please provide any information, if known, that may help us identify the current PDs.

Q2. Is this an on-going project?

- ❍ No
- ❍ Yes

Display: Q3-Q8 only displayed to capacity funded projects.

Q3. Were you required by your institution to apply for this type of grant (referred to by NIFA as a "Capacity Grant" and by many institutions as "Formula Funded" [e.g. Hatch, McIntire-Stennis, Evans-Allen])?

- ❍ No
- ❍ Yes

Q4. Direct funds received (i.e. funds that you as the PD personally received to dispense) through this project *were/will be* used in the following categories (check all that apply):

- ❑ Did not receive direct funds
- ❑ Experimental station/center
- ❑ Extension programming
- ❑ Post-doctoral research fellow(s)/associate(s)/assistant(s)
- ❑ Student(s)
- ❑ Supplies/materials/equipment
- ❑ Travel
- ❑ Other(s) (please specify): _____

Q5. Indirect funds received through this project *were/will be* used in the following categories (check all that apply):

- ❑ Don't know
- ❑ Did not receive indirect funds
- ❑ University administration
- ❑ Experimental station/center
- ❑ Extension programming
- ❑ Your salary
- ❑ Travel
- ❑ Other(s) (please specify): _____

Q6. Funds from other grants/sources *were/will be* necessary to complete the project goals?

- ❍ No
- ❍ Yes

Display: If respondent selected "Yes" to Q6, Q7 would display.

Q7. What approximate percentage of project goals *were/will be* completed with funding from other grants/sources?

- ❍ <25%
- ❍ 25-49%
- ❍ 50-74%
- ❍ 75-99%
- ❍ 100%

Q8. Please provide any additional comments regarding the Capacity Grant application or funding process in the space below:

Section 1: Project Summary
Please answer the following descriptive questions, including project type, scope, and team composition, regarding your project [PROPOSAL TITLE].

Q9. Please specify the project type:

- ❍ Education
- ❍ Extension
- ❍ Research
- ❍ Education and Extension
- ❍ Education and Research
- ❍ Extension and Research
- ❍ Education, Extension, and Research

Display: If respondent selected and response that included "research" for Q9, Q10 would display.

Q10. How would you classify this project's research (check all that apply)?

- ❑ Applied
- ❑ Basic/Fundamental
- ❑ Exploratory
- ❑ Field
- ❑ Interdisciplinary
- ❑ Laboratory
- ❑ Qualitative
- ❑ Quantitative
- ❑ Theoretical

Q11. Please indicate the geographical focus feature/area of the project (check all that apply):

- ❑ No geographical focus
- ❑ Coastal
- ❑ Farmland
- ❑ Forestland and/or woodland
- ❑ Government managed (e.g. state parks, national forests, etc.)
- ❑ Groundwater (e.g. aquifers, basins, wells, etc.)
- ❑ Pasture and/or grassland
- ❑ Rural
- ❑ Surface water (e.g. lakes, rivers, reservoirs, streams, etc.)
- ❑ Tribal or Indian Land
- ❑ Urban
- ❑ Urbanizing
- ❑ Wetland
- ❑ Other(s) (please specify): _____

Q12. Please indicate the geographical extent of your project (check all that apply):

- ❑ No geographical extent
- ❑ Small extent (less than an entire county)
- ❑ County
- ❑ Multi-county
- ❑ State/Territory
- ❑ Multi-state/Multi-territory
- ❑ National
- ❑ International
- ❑ Global
- ❑ Other(s) (please specify):_____

Display: If respondent selected any extent below "National" for Q12, Q13 would display.

Q13. Please identify the state(s)/territory(-ies) included in the project's geographical extent (check all that apply):

- ❑ Alabama
- ❑ Alaska
- ❑ Arizona
- ❑ Arkansas
- ❑ California
- ❑ Colorado
- ❑ Connecticut
- ❑ Delaware
- ❑ Florida
- ❑ Georgia
- ❑ Hawaii
- ❑ Idaho
- ❑ Illinois
- ❑ Indiana
- ❑ Iowa
- ❑ Kansas
- ❑ Kentucky
- ❑ Louisiana
- ❑ Maine
- ❑ Maryland
- ❑ Massachusetts
- ❑ Michigan
- ❑ Minnesota
- ❑ Mississippi
- ❑ Missouri
- ❑ Montana
- ❑ Nebraska
- ❑ Nevada
- ❑ New Hampshire
- ❑ New Jersey
- ❑ New Mexico
- ❑ New York
- ❑ North Carolina
- ❑ North Dakota
- ❑ Ohio
- ❑ Oklahoma
- ❑ Oregon
- ❑ Pennsylvania
- ❑ Rhode Island)
- ❑ South Carolina
- ❑ South Dakota
- ❑ Tennessee
- ❑ Texas
- ❑ Utah
- ❑ Vermont
- ❑ Virginia
- ❑ Washington
- ❑ West Virginia
- ❑ Wisconsin
- ❑ Wyoming
- ❑ American Samoa
- ❑ Guam
- ❑ Northern Mariana Islands
- ❑ Puerto Rico
- ❑ United States Virgin Islands

Q14. Excluding yourself as the PD, indicate the types of scientists/professionals included as part of the project team (i.e. funded by the project) (check all that apply):

- ❑ Climate scientist(s)
- ❑ Computer scientist(s)
- ❑ Economist(s)
- ❑ Educator(s) (K-12)
- ❑ Engineer(s)
- ❑ Extension specialist(s)/educator(s)
- ❑ Geospatial scientist(s)
- ❑ Legal scholar(s)/professional(s)
- ❑ Life scientist(s) (e.g. biologists, ecologists, botanists, zoologists, physiologists, biochemists and/or related subjects)
- ❑ Mathematician(s)/Statistician(s)
- ❑ Physical scientist(s) (excluding climate scientists) (e.g. chemists, astronomers, geologists, physicists and/or related subjects)
- ❑ Public Health scientist(s)/professional(s)
- ❑ Social scientist(s) (non-economists)
- ❑ Other(s) (please specify): _____

Q15. Including yourself, how many PDs *were/are* involved in this project (if no co-PDs respond "1")?

Skip: If response greater than "1" entered, answer Q16 and Q17. Response equal to "1" continue to Q18.

Q16. Please indicate where the co-PDs were located when this project was funded (check all that apply):

- ❑ Intra-university (single university)
- ❑ Interuniversity (multiple universities)
- ❑ Government
- ❑ Public/private business and/or organization (please specify): _____
- ❑ Other(s) (please specify): _____

Q17. Were any of the co-PDs from a Minority Serving Institution (MSI) such as a Historically Black College or University (HBCU), a Hispanic Serving Institution (HSI), or Tribal College or University when this project was funded?

- ❍ Don't know
- ❍ No
- ❍ Yes

Skip: If "Yes" selected, continue to Q19.

Q18. *Did/Will* the project interact (i.e. share resources, ideas, or data, meeting attendance, and/or collaborate) with a Minority Serving Institution (MSI) such as a Historically Black College or University (HBCU), a Hispanic Serving Institution (HSI), or Tribal College or University?

- ❍ Don't know
- ❍ No
- ❍ Yes

Q19. Have the project goal(s) changed over the course of the project?

- ❍ No
- ❍ Yes (please explain how and why): _____

Q20. *Did/Will* the project generate datasets?

- ❍ Don't know
- ❍ No
- ❍ Yes

Display: If "Yes" selected, Q21 was displayed.

Q21. *Were/Will* the datasets *made/be made* publicly available?

- ❍ Don't know
- ❍ No
- ❍ Yes

Q22. *Did/Will* the project access privileged datasets (i.e. restricted/proprietary data)?

- ❍ Don't know
- ❍ No
- ❍ Yes

Display: If "Yes" selected, Q23 was displayed.

Q23. ***Were/Will*** **the privileged datasets** ***made/be made*** **accessible to the public?**

- ❍ Don't know
- ❍ No
- ❍ Yes

Q24. ***Did/Will*** **the project use data created by other NIFA funded projects?**

- ❍ Don’t know
- ❍ No
- ❍ Yes

Display: Display Q25 to non-Hatch projects based on portfolio.

Q25. ***Did/Will*** **the project interact (i.e. share resources, ideas, or data, meeting attendance, and/or collaborate) with multi-state Hatch projects?**

- ❍ Don't know
- ❍ No
- ❍ Yes

Q26. ***Did/Will*** **the project interact (i.e. share resources, ideas, or data, meeting attendance, and/or collaborate) with other USDA-NIFA or USDA funded initiatives that were not multi-state Hatch projects (e.g., CAP projects, climate hubs, etc.)?**

- ❍ Don't know
- ❍ No
- ❍ Yes

Section 2: Project Success
One objective of this survey is to understand the attributes of a successful project. In this section, we are interested in your perspectives of project success. Please answer the following questions regarding this project in terms of its success.

Q27. Please tell us, in your opinion, how this project was successful to date:

Q28. Please tell us, in your opinion, how this project could have been more successful to date:

Q29. *Did/Will* you evaluate project success?

- ❍ No
- ❍ Yes

Skip: If "No" selected, skip to Q33.

Q30. When *was/will* the project's success *evaluated/be evaluated* (check all that apply)?

- ❑ Annually
- ❑ As objectives/tasks were completed
- ❑ End of project
- ❑ Intermittently (not scheduled around task completion)
- ❑ Other(s) (please specify): _____

Q31. When you *evaluated/evaluate* project success *were/will* any of the following project elements assessed?

Yes	No	
❍	❍	Completion of project objectives
❍	❍	Quality of project results
❍	❍	Impact of project results
❍	❍	Stakeholder need
❍	❍	Stakeholder satisfaction
❍	❍	Project team satisfaction with project
❍	❍	Other (please specify): _____

Q32. The following methods *were/will be* used to evaluate project success (check all that apply):

- ❑ Informal assessment
- ❑ Assessed number of citations
- ❑ Assessed number of publications
- ❑ Event/workshop evaluation(s)
- ❑ External evaluator(s)
- ❑ Project team meeting(s)
- ❑ Report(s)
- ❑ Stakeholder case study(-ies)
- ❑ Stakeholder focus group(s)
- ❑ Stakeholder interview(s)
- ❑ Stakeholder meeting(s)
- ❑ Survey(s)
- ❑ Other(s) (please specify): _____

Section 3: Project Stakeholders

We seek to understand who stakeholders are and how information is disseminated to stakeholders within Climate Portfolio projects. Project stakeholders are persons or groups that have an interest or concern in the project's topic(s), finding(s), and/or outcome(s). Please answer the following questions regarding this project's stakeholders.

Q33. *Were/Will* the following stakeholder groups *informed/be informed* of project knowledge or not:

Yes	No	
❍	❍	Business/Industry
❍	❍	Certified crop advisor(s)
❍	❍	College(s)/University(-ies)
❍	❍	Educator(s)
❍	❍	Extension
❍	❍	Farmer(s)/Producer(s)/Rancher(s)
❍	❍	Government (federal, state, or local) (excluding NIFA)
❍	❍	International government, group, and/or university
❍	❍	NIFA
❍	❍	Non-government organization
❍	❍	Public/community
❍	❍	Researcher(s)
❍	❍	Youth (below college age)
❍	❍	Other(s) (please specify): _____

Q34. What type(s) of project knowledge *was/will be* disseminated to stakeholders (check all that apply)?

- ❑ Baseline data/inventories
- ❑ Extension/outreach programs
- ❑ K-12 educational activities/curriculum
- ❑ Life cycle analysis
- ❑ Management practice(s)
- ❑ Method(s)/model(s)/technology(-ies)
- ❑ Monitoring data
- ❑ Result(s)
- ❑ Standardized methodology(-ies)
- ❑ Training
- ❑ University curriculum
- ❑ Other(s) (please specify): _____

Q35. The project team *disseminated/will disseminate project* knowledge to stakeholder groups through the following means (check all that apply):

- ❑ Broadcast news media
- ❑ Classroom(s) for college/university students
- ❑ Classroom(s) for K-12 students
- ❑ Conference(s)
- ❑ Decision support tool(s)/technology(-ies)
- ❑ Fact sheet(s)
- ❑ Field day(s)/tours(s)
- ❑ Lecture(s)/seminar(s) (non-conference)
- ❑ Magazine(s)
- ❑ Meeting(s) (non-conference)
- ❑ Newsletter(s)
- ❑ Podcast(s)/webinar(s)
- ❑ Print news media
- ❑ Publication(s) (peer-reviewed journal articles)
- ❑ Report(s)
- ❑ Social media (e.g. Facebook, Twitter, Instagram, etc.)
- ❑ Training(s)
- ❑ Video(s)
- ❑ Website(s)
- ❑ Workshop(s)
- ❑ Other(s) (please specify): _____

Display: If "Website(s)" selected, Q36 was displayed.

Q36. The website for this project is . . .

- ❍ Available/accessible to the public but not updated regularly
- ❍ Available/accessible to the public and updated regularly
- ❍ No longer available/accessible to the public
- ❍ Under construction

Q37. In your opinion, what is the most successful way to communicate with stakeholders? How, if at all, does this method change for different stakeholder groups?

Section 4: Project Outcomes
We seek to understand project outcomes generated from the Climate Portfolio. Please answer the following questions regarding the outcomes of this project.

Q38. Were funds used to seed this project (if yes, check all that apply)?

- ❑ Don't know
- ❑ No
- ❑ Yes; other NIFA funds
- ❑ Yes; other non-NIFA funds

Q39. Has this project led to funding for (an) additional project(s) (if yes, check all that apply)?

- ❑ Don't know
- ❑ No
- ❑ Yes; additional NIFA funds
- ❑ Yes; additional non-NIFA funds

Q40. Please indicate the following publication types and the number of each published from this NIFA project to date (if you do not specifically remember, please enter your best guess):

- ❑ Extension materials: _____
- ❑ Journal articles: _____
- ❑ Theses and dissertations: _____
- ❑ Other(s) (please specify type and number): _____

Q41. *Have/Will* the following outcomes *been/be* achieved or not?

Yes	No	
❍	❍	Disseminated knowledge on how agricultural, forest, and/or natural resource systems are able to adapt to climate variability
❍	❍	K-12 educational curricula developed
❍	❍	Empowered farmers and/or foresters to adapt and change by managing risks
❍	❍	Empowered farmers and/or foresters to adapt and change by reducing emissions
❍	❍	Extended this project into other geographical areas
❍	❍	Extension programs developed
❍	❍	Increased public discussion about agriculture's role in climate change adaptation and mitigation
❍	❍	Policy changed
❍	❍	Research/tool(s) commercialized
❍	❍	Science knowledge expanded
❍	❍	University student(s) trained
❍	❍	Other (please specify): _____

Display: If "Yes" was selected for "University student(s) trained", *Q42 and Q43 were displayed.*

Q42. You indicated university students *were/will be* trained through this project. How many students *were/will be* trained?

Q43. *Were/Will* the student(s) *from/will be* the same discipline as the primary PD?

- ❍ Don't know
- ❍ No
- ❍ Yes
- ❍ Some but not all

Section 5: Project Synthesis
We seek to understand project areas in order to facilitate a synthesis of the knowledge gaps in the Climate Portfolio. Please reflect on this project as a whole and answer the following questions.

Q44. In your opinion, how successful was this project in the following areas to date?

	Very unsuccessful	**Unsuccessful**	**Neither successful nor unsuccessful**	**Successful**	**Very successful**	*Don't know*	*Not applicable*
Ability/flexibility to troubleshoot	❍	❍	❍	❍	❍	❍	❍
Communicating with collaborators	❍	❍	❍	❍	❍	❍	❍
Completing all project goals/objectives	❍	❍	❍	❍	❍	❍	❍
Creating standardized protocols	❍	❍	❍	❍	❍	❍	❍
Defining data needs/objectives prior to implementation	❍	❍	❍	❍	❍	❍	❍
Defining project mission	❍	❍	❍	❍	❍	❍	❍
Developing new relationships/synergies with other organization	❍	❍	❍	❍	❍	❍	❍
Empowering stakeholders with science-based knowledge	❍	❍	❍	❍	❍	❍	❍
Engaging in social activities with collaborators/project team	❍	❍	❍	❍	❍	❍	❍
Enhancing extension capacity	❍	❍	❍	❍	❍	❍	❍
Enhancing project team relationship	❍	❍	❍	❍	❍	❍	❍
Enhancing/developing relationship with partner institutions	❍	❍	❍	❍	❍	❍	❍
Enhancing/developing relationship with stakeholders	❍	❍	❍	❍	❍	❍	❍
Funding agency satisfaction with outcomes/progress	❍	❍	❍	❍	❍	❍	❍
Generating research results	❍	❍	❍	❍	❍	❍	❍
Having an interdisciplinary project team	❍	❍	❍	❍	❍	❍	❍
Having institutional support for and authority to acquire resources	❍	❍	❍	❍	❍	❍	❍
Impacting stakeholder behavior	❍	❍	❍	❍	❍	❍	❍
Improving policy making	❍	❍	❍	❍	❍	❍	❍

	Very unsuccessful	Unsuccessful	Neither successful nor unsuccessful	Successful	Very successful	*Don't know*	*Not applicable*
Increasing public discussion about agriculture's role in climate change adaptation and mitigation	❍	❍	❍	❍	❍	❍	❍
Increasing your reputation/value to funding agency	❍	❍	❍	❍	❍	❍	❍
Involving project stakeholders early on in project design	❍	❍	❍	❍	❍	❍	❍
Leveraging other funds	❍	❍	❍	❍	❍	❍	❍
Monitoring and receiving feedback from stakeholders	❍	❍	❍	❍	❍	❍	❍
Opening/having a line of communication with funding agency	❍	❍	❍	❍	❍	❍	❍
Overcoming technological limitations	❍	❍	❍	❍	❍	❍	❍
Project team satisfaction with project outcomes/progress	❍	❍	❍	❍	❍	❍	❍
Publishing research results	❍	❍	❍	❍	❍	❍	❍
Recruiting personnel	❍	❍	❍	❍	❍	❍	❍
Training university students	❍	❍	❍	❍	❍	❍	❍
Other (please specify):	❍	❍	❍	❍	❍	❍	❍

Display: If "Neither successful nor unsuccessful", "Successful", or "Very Successful" was selected for "Developing new relationships/synergies with other organization", Q45 was displayed.

Q45. New synergies/relationships developed through this project influenced your ability to:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	*Don't know*
Improve decision maker adoption of project results	❍	❍	❍	❍	❍	❍
Improve partner agency adoption of project results	❍	❍	❍	❍	❍	❍
Improve stakeholder adoption of project results	❍	❍	❍	❍	❍	❍
Increase public discussion about agriculture's role in climate change adaptation and mitigation	❍	❍	❍	❍	❍	❍
Leverage additional funds	❍	❍	❍	❍	❍	❍
Other (please specify):	❍	❍	❍	❍	❍	❍

Q46. Based on project findings what knowledge gaps remain?

Q47. In your opinion, what is the largest contribution of your project?

Q48. If you could rewrite one element of your grant proposal, what would you change?

Section 6: Project Director Information
Please answer the following questions about you as the PD. If you are not the PD, please respond regarding the PD.

Q49. What year were you born?

Q50. What is your gender?

Q51. What was your job title when this project was funded (check all that apply)?

- ❑ Assistant Professor
- ❑ Associate Professor
- ❑ Chair
- ❑ Dean
- ❑ Extension Specialist/Educator
- ❑ Full Professor
- ❑ Post-doctoral research fellow/associate/assistant
- ❑ Program Director/Manager
- ❑ Research Associate/Assistant Professor
- ❑ Research Staff (i.e. Scientist, Specialist, Technician, etc.)
- ❑ Other (please specify): _____

Q52. Please specify the type of scientist/professional you are (check all that apply):

- ❑ Climate Scientist
- ❑ Computer scientist
- ❑ Economist
- ❑ Educator
- ❑ Engineer
- ❑ Extension specialist/educator
- ❑ Geospatial scientist
- ❑ Legal scholar/professional
- ❑ Life scientist (e.g. biologist, ecologist, botanist, zoologist, physiologist, biochemist or related subject) (9)
- ❑ Mathematician/Statistician
- ❑ Physical scientist (excluding climate scientist) (e.g. chemist, astronomer, geologist, physicist or related subject)
- ❑ Public Health scientist/professional
- ❑ Social scientist (non-economist)
- ❑ Other (please specify): _____

Section 7: Project Director Success

We are interested in informing NIFA about factors that facilitate project and professional success. In this section, please reflect on the role of a PD and answer the following questions.

Q53. In your opinion, what are the three most important factors to help achieve project success? Please order your top three success factors from most to least important by clicking and dragging the listed items into the box on the right.

Three most important success factors

Communication:
Provision of timely data and information to project team(s)

Funding agency consultation:
Communication/consultation with funding agency(-ies) throughout project(s) lifecycle

Institutional support:
Resources, authority, and power for implementation provided by home institution

Mission:
Clearly defined goals and direction

Monitoring and feedback:
Timely and comprehensive control of project status(es) and stakeholder feedback

Personnel:
Recruitment, selection, and training of competent personnel

Schedule and plans:
Detailed specification of implementation process

Stakeholder acceptance:
Achieving acceptance of the final product from funding agency(-ies) and all stakeholders

Stakeholder engagement:
Identification and engagement of all stakeholders

Technical tasks:
Ability of the required technology and expertise

Troubleshooting:
Ability to handle unexpected problems

Q54. If you were to provide advice to another PD, how important would the following areas be to the success of a project?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Ability/flexibility to troubleshoot	❍	❍	❍	❍	❍
Communicating with collaborators	❍	❍	❍	❍	❍
Completing all project goals/objectives	❍	❍	❍	❍	❍
Creating standardized protocols	❍	❍	❍	❍	❍
Defining a lab/team/professional mission	❍	❍	❍	❍	❍
Defining data needs/objectives prior to implementation	❍	❍	❍	❍	❍
Developing detailed data management plans	❍	❍	❍	❍	❍
Developing new relationships/synergies with other organizations	❍	❍	❍	❍	❍
Developing quality assurance plans	❍	❍	❍	❍	❍
Developing relationship with stakeholders	❍	❍	❍	❍	❍
Early stakeholder involvement	❍	❍	❍	❍	❍
Engaging in social activities with collaborators/peers	❍	❍	❍	❍	❍
Enhancing project team relationships	❍	❍	❍	❍	❍
Enhancing/developing relationship with stakeholders	❍	❍	❍	❍	❍
Funding agency satisfaction with outcomes/progress	❍	❍	❍	❍	❍
Having a project manager	❍	❍	❍	❍	❍
Having institutional support for and authority to acquire resources	❍	❍	❍	❍	❍
Having interdisciplinary project teams	❍	❍	❍	❍	❍
Having sense of urgency	❍	❍	❍	❍	❍
Impacting stakeholder behavior	❍	❍	❍	❍	❍
Improving policy making	❍	❍	❍	❍	❍
Increasing your reputation/value to funding agency	❍	❍	❍	❍	❍
Involving project stakeholders early on in project design	❍	❍	❍	❍	❍
Leveraging funds	❍	❍	❍	❍	❍
Monitoring and receiving feedback from stakeholders	❍	❍	❍	❍	❍
Open line of communication with funding agencies	❍	❍	❍	❍	❍
Operating within budget	❍	❍	❍	❍	❍
Overcoming technological limitations	❍	❍	❍	❍	❍
Publishing research results	❍	❍	❍	❍	❍
Recruiting personnel	❍	❍	❍	❍	❍
Satisfaction with outcomes/progress	❍	❍	❍	❍	❍
Sharing research results with stakeholders	❍	❍	❍	❍	❍
Training university students	❍	❍	❍	❍	❍
Using adaptive management techniques	❍	❍	❍	❍	❍
Other (please specify): _____	❍	❍	❍	❍	❍

Section 8: Climate Change and Agroecosystems Portfolio
One object of this study is to synthesize the current state of the portfolio and to identify knowledge gaps. Please provide the following information regarding the project Climate Scientist and project products, which may be used to conduct an impact analysis.

Q55. Please provide the name and contact information for the primary climate scientist on the project in the space provided below. An additional survey on climate specific topics will be sent to these specialists in January.
Name: _____
Email: _____
Phone number: _____

Please provide a citation list of products (e.g. papers, materials, presentations, extension, website, etc.) generated by this project to date using the upload option below.

Q56. If you would prefer to email the citation list, please select "Yes" below otherwise select "No" and you will be asked to upload a pdf.
- ❍ No
- ❍ Yes

Display: If "Yes" was selected, text below was displayed.

Please email Purdue University Research Associate [EMAIL ADDRESS] the citation list of products (e.g. papers, materials, presentations, extension, website, etc.) generated by this project to date.

Display: If "No" was selected, text below was displayed.

Citation list upload:
Drop files or click here to upload

Please provide up to 5 products (e.g. papers, materials, model outcomes, presentations, extension, website, etc.) that you believe to be the most important products generated by this project to date. If your list includes URLs, provide them in the text box below otherwise use the following file upload options.

Q57. If you would prefer to email the 5 products at a later date, please select "Yes" below otherwise select "No" and you will be asked to upload pdfs.
- ❍ No
- ❍ Yes

Display/Skip: If "Yes" was selected, text below was displayed then skipped to Q58.

Please email Purdue University Research Associate [EMAIL ADDRESS] up to 5 products (e.g. papers, materials, presentations, extension, website, etc.) generated by this project to date.

Display: If "No" was selected, text below was displayed.

Please paste your project product URL list below if applicable.

Unfortunately, this survey software will only allow one file upload at a time. Please use the following upload options for the 5 project products.

Project product upload 1:
Drop files or click here to upload

Project product upload 2:
Drop files or click here to upload

Project product upload 3:
Drop files or click here to upload

Project product upload 4:
Drop files or click here to upload

Project product upload 5:
Drop files or click here to upload

Q58. Please use the space below for any additional comments about this survey or NIFA projects and funding.

Thank you for completing this survey and providing your feedback to the assessment of the NIFA Climate Change and Agroecosystems Portfolio. Please click the >> button to submit your responses. We may contact you in the future for additional input and information. A summary report of the survey results will be emailed to you once it has been prepared.

Appendix B: Supplemental Tables

Appendix Table 1. Capacity - Project area success

Corresponds to closed Q44: "In your opinion, how successful was this project in the following areas to date?"

Project areas	Respondents (n)	Frequency (%)						
		Very unsuccessful	Unsuccessful	Neither	Successful	Very successful	Don't know	Not applicable
Ability/flexibility to troubleshoot	564	1.4	0.5	12.1	39.0	29.1	7.4	10.5
Communicating with collaborators	571	1.2	1.1	5.1	44.8	38.5	2.6	6.7
Completing all project goals/objectives	569	1.1	2.8	13.0	50.6	27.6	3.3	1.6
Creating standardized protocols	564	1.2	1.1	17.6	38.8	14.9	5.5	20.9
Defining data needs/objectives prior to implementation	566	1.1	0.9	9.4	50.4	26.1	4.8	7.4
Defining project mission	567	1.2	0.4	6.0	52.0	33.3	3.9	3.2
Developing new relationships/synergies with other organizations	568	1.2	2.8	17.3	37.3	28.5	4.4	8.5
Empowering stakeholders with science-based knowledge	569	1.4	2.8	17.2	43.4	23.7	6.7	4.7
Engaging in social activities with collaborators/project team	562	2.0	3.2	25.3	29.7	9.4	5.3	25.1
Enhancing extension capacity	564	1.4	4.3	20.4	34.2	9.6	8.2	22.0
Enhancing project team relationship	560	1.1	1.2	10.2	46.6	23.8	3.4	13.8
Enhancing/developing relationship with partner institutions	560	1.1	1.2	10.2	46.6	23.8	3.4	13.8
Enhancing/developing relationship with stakeholders	560	1.2	1.8	19.6	41.6	21.4	4.8	9.5
Funding agency satisfaction with outcomes/progress	561	0.9	1.4	12.7	37.6	22.3	19.1	6.1
Generating research results	562	1.2	1.1	5.5	40.2	47.2	2.0	2.8
Having an interdisciplinary project team	563	1.4	1.4	15.6	33.7	31.6	2.3	13.9
Having institutional support for and authority to acquire resources	562	4.1	8.0	23.0	38.3	14.2	5.5	6.9
Impacting stakeholder behavior	557	1.3	3.1	24.4	32.7	6.5	19.0	13.1
Improving policy making	555	1.4	6.1	29.5	17.5	4.0	21.4	20
Increasing public discussion about agriculture's role in climate change adaptation and mitigation	557	1.6	5.0	26.2	24.4	4.7	15.6	22.4
Increasing your reputation/value to funding agency	558	1.1	2.3	15.4	44.3	12.9	19.5	4.5
Involving project stakeholders early on in project design	559	1.6	5.7	24.3	34.2	12.7	5.7	15.7
Leveraging other funds	557	2.2	6.6	14.9	37.9	25.9	5.9	6.6
Monitoring and receiving feedback from stakeholders	554	1.3	4.9	26.5	34.5	10.3	7.8	14.8
Opening/having a line of communication with funding agency	558	1.8	7.2	31.2	32.6	6.8	10.4	10
Overcoming technological limitations	558	0.9	2.0	21.3	42.8	12.5	5.2	15.2
Project team satisfaction with project outcomes/progress	560	0.7	1.8	9.3	54.6	21.6	4.8	7.1
Publishing research results	563	1.4	2.1	13.1	42.3	33.4	3.7	3.9
Recruiting personnel	559	1.8	2.1	17.4	44.2	15.0	3.4	16.1
Training university students	560	1.4	0.7	3.6	43.6	42.5	2.3	5.9
Other	93	1.1	0	12.9	3.2	5.4	17.2	60.2

Appendix Table 2. Competitive - Project area success

Corresponds to closed Q44: "In your opinion, how successful was this project in the following areas to date?"

Project areas	Respondents (n)	Frequency (%)						
		Very unsuccessful	Unsuccessful	Neither	Successful	Very successful	Don't know	Not applicable
Ability/flexibility to troubleshoot	301	0.7	0	7.6	46.2	32.9	4.0	8.6
Communicating with collaborators	304	0.3	0.3	6.9	43.4	45.4	1.3	2.3
Completing all project goals/objectives	305	1.0	1.3	9.5	52.1	30.5	2.3	3.3
Creating standardized protocols	307	0.7	0	18.6	34.5	16.0	3.3	27.0
Defining data needs/objectives prior to implementation	303	1.0	0	7.3	51.8	27.4	4.3	8.3
Defining project mission	304	0.3	0	2.0	47.4	44.4	1.0	4.9
Developing new relationships/ synergies with other organizations	307	0.3	1.6	15.3	40.1	31.3	2.6	8.8
Empowering stakeholders with science-based knowledge	304	0.3	2.6	19.7	36.5	24.3	7.2	9.2
Engaging in social activities with collaborators/project team	305	1.0	4.6	23.6	35.1	12.5	4.6	18.7
Enhancing extension capacity	303	0.7	3.6	24.8	26.4	9.2	7.6	27.7
Enhancing project team relationship	305	1.0	0.7	6.2	51.8	32.1	3.3	4.9
Enhancing/developing relationship with partner institutions	305	1.0	0.7	6.2	51.8	32.1	3.3	4.9
Enhancing/developing relationship with stakeholders	304	0.3	2.6	16.8	42.4	20.4	6.9	10.5
Funding agency satisfaction with outcomes/progress	304	0.3	1.0	8.9	38.8	20.4	27.0	3.6
Generating research results	303	0.7	0.3	6.3	42.9	41.3	2.0	6.6
Having an interdisciplinary project team	306	0.7	1.6	8.5	35.6	43.8	1.3	8.5
Having institutional support for and authority to acquire resources	303	1.7	3.6	17.5	46.2	18.2	5.3	7.6
Impacting stakeholder behavior	304	0	2.3	24.3	29.3	6.9	21.4	15.8
Improving policy making	302	0.7	5.0	26.8	10.6	3.0	21.2	32.8
Increasing public discussion about agriculture's role in climate change adaptation and mitigation	302	0.3	4.3	21.2	25.2	4.0	11.9	33.1
Increasing your reputation/value to funding agency	302	0	0	8.9	49.3	13.9	25.8	2.0
Involving project stakeholders early on in project design	299	0	2.3	21.7	34.8	19.4	4.7	17.1
Leveraging other funds	300	0.3	3.7	18.7	34.7	27.3	7.0	8.3
Monitoring and receiving feedback from stakeholders	300	0.3	2.7	21.3	37.0	15.3	5.0	18.3
Opening/having a line of communication with funding agency	302	0.3	7.0	25.2	46.4	14.2	4.0	3.0
Overcoming technological limitations	302	0.3	1.7	16.9	49.0	18.9	2.6	10.6
Project team satisfaction with project outcomes/progress	301	0.3	1.7	7.0	57.5	29.2	2.7	1.7
Publishing research results	304	0.3	1.0	24.0	38.5	23.4	3.0	9.9
Recruiting personnel	302	0.7	2.3	15.6	46.4	20.2	2.0	12.9
Training university students	304	0.3	1.0	5.9	39.8	41.8	1.0	10.2
Other	45	0	2.2	0	4.4	11.1	2.2	80

Appendix Table 3. Capacity - Synergies

Corresponds to closed Q45: "New synergies/relationships developed through this project influenced your ability to:"

Synergy	Respondents (n)	Frequency (%)					
		Strongly disagree	Disagree	Neither	Agree	Strongly agree	Don't know
Improve decision maker adoption of project results	458	0.4	2.8	26.9	41.3	9	19.7
Improve partner agency adoption of project results	457	0.4	3.1	30.2	34.8	9	22.5
Improve stakeholder adoption of project results	458	0.4	2.2	27.1	41.7	11.1	17.5
Increase public discussion about agriculture's role in climate change adaptation and mitigation	456	1.8	6.1	29.2	28.5	7.7	26.8
Leverage additional funds	459	0.7	4.1	17.2	47.5	22	8.5
Other[a]	52	0	0	23.1	3.8	5.8	67.3

[a] The specified other synergies are not detailed in this report.

Appendix Table 4. Competitive - Synergies

Corresponds to closed Q45: "New synergies/relationships developed through this project influenced your ability to:"

Synergy	Respondents (n)	Frequency (%)					
		Strongly disagree	Disagree	Neither	Agree	Strongly agree	Don't know
Improve decision maker adoption of project results	263	0.4	2.3	20.5	43.3	10.3	23.2
Improve partner agency adoption of project results	264	0.8	2.3	24.2	35.6	10.2	26.9
Improve stakeholder adoption of project results	263	0.8	1.9	23.6	35.7	10.3	27.8
Increase public discussion about agriculture's role in climate change adaptation and mitigation	261	2.3	5.0	25.3	31.4	9.6	26.4
Leverage additional funds	261	0.4	3.4	15.3	47.9	19.2	13.8
Other[a]	26	0	0	23.1	7.7	7.7	61.5

[a] The specified other synergies are not detailed in this report.

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