An evaluation of the Triticeae Coordinated Agricultural Project (TCAP)

Final report of results from year 2011-2012

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Introduction

The Triticeae Coordinated Agricultural Project (TCAP), funded by the United States Department of Agriculture (USDA), is an effort to improve the quality of wheat and barley breeding and increase the number of plant breeders, especially from racially and ethnically diverse backgrounds. TCAP's educational component consists of providing education and research opportunities for graduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field.

An evaluation with multiple components is being conducted to assess the progress of TCAP, including yearly surveys and interviews. The aim is to assess faculty and graduate students' perceptions of plant breeding education, perceptions of TCAP programming, collaborative relationships and networks over time, and the partnerships with MSI institutions to promote the plant breeding field. This report provides a summary of the evaluation findings from the second year of programming in 2012.

Methods

Surveys. The evaluation team worked collaboratively with members of the TCAP educational committee to make revisions to the student and PI baseline surveys developed during the first year of the project. The surveys were administered online between late April to early June of 2012. A total of 5 of 15 MSI students, 24 of 32 fully- and partially-funded TCAP graduate students, 8 of 20 undergraduate students, 29 of 54 TCAP PIs, and 6 of 8 MSI faculty completed the surveys. Members of the TCAP educational committee were not administered the TCAP PI survey due to their close involvement in evaluation activities and the development of the survey. The student surveys assessed students' perceptions of plant breeding education, interest and motivation in the plant breeding field, perceptions of the TCAP educational programming, and collaborative networks with other students, faculty, and researchers within and outside of the TCAP project. Similarly the TCAP PI and MSI PI surveys assessed perceptions of plant breeding education and collaborative networks, but additionally assessed perceptions of TCAP educational components and relationships with PIs from TCAP and MSI institutions. While this synthesis report provides an overview of the survey data, Appendix A provides each of the detailed survey reports.

Interviews. Students and faculty were interviewed as part of the evaluation process(see Appendix B for each of the reports). Between December 2012 and February 2013, 8 of 27 TCAP-funded graduate students were interviewed.. Evaluators attempted to get a representative sample of graduate students to interview based on institution, race/ethnicity, and gender; however, after a low response rate to the initial interview invitations – interviews were opened up to all fully-funded students. An incentive of a $10 online gift card was given to all students who participated in the interviews. Most interviews were conducted over the phone and lasted about 15 to 35 minutes. Students were asked about their perceptions of the educational component of TCAP, the online learning community, and their relationships with other TCAP students and faculty.

In February 2013, 2 of 38 TCAP-funded undergraduate students were also interviewed. An additional undergraduate student who is not currently receiving TCAP funding, but is being mentored by a TCAP-funded graduate student, was also interviewed. All three students attend the same institution. Of these three students, there were two female students and one male student. Students were asked about their involvement and perception in the TCAP's educational component, relationships with others in the TCAP, and their future plans. Interviews were conducted over the phone and lasted about 15 to 20 minutes.

Between December 2012 and February 2013, 6 of 23 students from partnering MSIs were also interviewed. Of the six students who were interviewed, there were four female students and two male students. Two students were undergraduate, and the remaining students were graduate students. Two of the graduate students interviewed participated in the TCAP in the 2010-11 academic school year and have since received their Bachelor's degree and are currently enrolled in graduate school.

Similarly, between November 2012 and January 2013, 4 of 34 TCAP PIs, 7 of 7 MSI PIs, and 6 of 7 TCAP collaborators (i.e. TCAP PIs collaborating with MSI PIs) were interviewed. Evaluators selected TCAP PIs for the interviews based on their geographic location, gender, ethnicity, and school size. All interviews were conducted over the phone and lasted about 20 to 55 minutes. TCAP PIs were asked about their relationships and collaborations with other TCAP and MSI institutions, their involvement in and perceptions of the educational component of TCAP and their beliefs about recruitment efforts. As a note of caution, the TCAP PI perceptions may not be representative of the perceptions of all TCAP PIs given the small number of PIs interviewed. MSI PIs and TCAP collaborators were asked about their and their students' involvement with and perceptions of the educational component, their collaboration with each other and students, how the collaboration affected them, how they saw themselves working together in the future, and how they supported their students.

This synthesis report provides a summary of the interview data while Appendix B provides the various detailed reports about the interviews.

Summary of key findings

TCAP students and principle investigators (PIs)

Survey data

Graduate students were very involved, engaged, and interested in research. Although, they felt more confident in some plant breeding knowledge areas and skills than others, including genetics, causes of and resistance to biotic stress, managing data, and working cooperatively. The skills that students felt most confident in, the students also reported using the most. As for ratings of educational processes, students felt field experience, laboratory experience, and exposure to diverse research methods were most important. Furthermore, the majority of the graduate students felt motivated to pursue a career in plant breeding.

In terms of graduate students' networks, they reported most frequently interacting with other students at their institution, as well as their advisor. The majority of graduate students reported no interaction with MSI faculty or students. About half of the graduate students also reported not having any interactions with students and researchers outside of their institution.

There were some differences by gender. Male students tended to be more confident in some plant breeding knowledge and skills than female students, including experimental design, causes of and resistance to abiotic stress, causes and resistance to biotic stress, selection theory and techniques, designing experiments, and identifying new allelles to use for improvement. Male students also tended to use the skills of considering alternative hypothesis and participating in planning research more often than female students.

Most of the undergraduate TCAP students who completed the survey did not know very much about the goals of the TCAP. These students reported being part of the TCAP as research interns for varying amounts of time (between 1 to 9 months). Overall, these students generally enjoyed their research experience and reported wanting to gain a variety of skills and knowledge, such as field experience, research skills, independent development of research ideas, communication and interpersonal skills within a research setting, and more science knowledge. In the lab, these students most often performed skilled lab work duties. Half of the students reported that their research experience increased their awareness and desire to go to graduate school, with most indicating some interest to pursue a plant breeding career.

With respect to TCAP PIs, the survey indicated that TCAP PIs thought faculty mentoring of graduate students and research was extremely import while interactions with plant breeders at other institutions, interactions at the PAG meeting, online course (PBTN network), inquiry-based learning approaches, and teaching/learning tools, among others, were important. These faculty thought graduate student mentoring of undergraduates, skill workshops, developing relationships with faculty from MSI institutions, understanding challenges to recruiting and retaining underrepresented minority groups into plant breeding graduate programs were not as important.

Close to one-half of the TCAP PIs identified lack of interest and/or awareness of plant breeding as the top barrier to increasing the number of underrepresented minorities in plant breeding. Moreover, the PIs thought underrepresented minorities' perceptions of plant breeding and agriculture was a top barrier to their recruitment. Most reported not having strong relationship with MSI institutions or collaborating with MSI faculty. TCAP faculty identified lack of funding as the top barrier to collaborating with MSI faculty.

Comparison reports of the survey data

Comparison of graduate student survey results by year

While not statistically significant, graduate students in 2012 seemed to be more diverse than students in 2011. There were more Asian students and more students without U.S. citizenship in 2012 than in 2011. In terms of TCAP participation and networking, more students in 2012 participated in problem solving and communicated more frequently with other students at and outside of their institution than students in 2011.

Comparison of TCAP PI survey results by year

In 2011, 42 TCAP PIs completed the survey, while 29 did so in 2012. Twenty-five of these faculty completed the survey on both years. Thus comparison of the survey was based on these same 25 faculty members and survey items that were the same for both years. The survey data showed some changes between 2011 and 2012 for these TCAP PIs. More TCAP PIs viewed faculty mentoring of graduate students to be important in 2012 than did so in 2011 (an increase of twenty percentile points). Similarly, more PIs viewed inquiry-based learning approaches to be important in 2012 than 2011. Four items related to the importance of TCAP education components showed decreases in the percentage of TCAP PIs who viewed them to be important in year 2011 vs. 2012. These items were: graduate student mentoring of undergraduates, developing relationships with MSI faculty, skill workshops, and recruiting more American-born underrepresented minorities to plant breeding programs.

Cross-comparison of the 2012 TCAP PI and student survey results

We compared student ratings of confidence in knowledge areas and TCAP PI ratings of skill sets in plant breeding in the 2012 surveys. Similarly, we compared students' and PIs' perceptions about educational processes—the importance of certain processes in educating graduate students and the nature of their collaborative networking with others that PIs and students reported. These were items that could be compared based on the nature of the PI and student surveys.

Students appear to have less confidence in most areas that PIs consider to be very valuable knowledge areas for graduating MS or PhD students in plant breeding. It also appears that certain areas students report having confidence in are considered by the PIs to be less valuable. These findings are summarized in Appendix A, which shows percentage of surveyed PIs who consider given knowledge areas in plant breeding very valuable and the percentage of students who report being moderately confident or very confident in those areas.

While there was an overall agreement between the students and the PIs about the importance of processes needed to educate graduate students, there were also striking differences in the students' and PIs' perceptions of some of those processes. For instance, there was an almost 30 percentile point difference between the PIs and students with respect to the importance of laboratory experiences in educating graduate students, with 72% of students viewing this as an extremely important while only 43% of the PIs thought so. This suggests the need to align students' perceptions of what is important for their education and PIs views of what is needed to educate graduate students in plant breeding programs.

Comparison of the comparison reports

Data from the comparison reports indicated that most students seemed to have less confidence in most areas that PIs consider to be very valuable knowledge areas or skill sets for graduating MS or PhD students in plant breeding. TCAP students and faculty were overall in agreement about what educational processes were most important. While these trends continued in years 2012 and 2011, there was some movement in the percentages reported. In the plant breeding knowledge areas, four items (genetics, experimental design, teaching strategies, and factors in crop plant that impact productivity) showed change. While these may signal changes, it is important to keep in mind that

the 2012 student data includes new student cohorts who may have different perspectives and perceptions and therefore caution has to be taken in interpreting this data.

Interview data

Graduate students reported being actively involved in TCAP activities, particularly the online activities (webinars, modules, online forum) and mentoring, with a couple students even working together to coordinate the online webinars/modules. Many students mentioned particularly enjoying the association mapping course and reporting that they learned a lot. In addition, students who have been in the TCAP since its inception commonly mentioned improvement in the coordination of the online activities.

Some graduate students reported collaborating with other TCAP students, primarily because they have similar research projects. Students reported communicating through the Adobe Connect chat room or through emailing each other. Several students also mentioned meeting other students face-to-face at the annual PAG meeting and how that facilitated their collaborative efforts.

Graduate students were asked about their mentoring of undergraduates experiences. Overall, students felt that mentoring was a beneficial experience to share and affirm their plant breeding knowledge, as well as to guide mentees into the plant breeding field. A couple students felt mentoring was like a coaching or teaching experience. However, some students reported having mixed experiences with mentoring. Typically, graduate students felt their mentoring experiences were more positive when their mentee was interested in plant breeding and invested in the research. Several graduate students reported that it was difficult to gauge students' interest in plant breeding and that they were unsure what was expected from them as mentors and what to expect from their mentees. Furthermore, a couple graduate students felt mentoring was a big time commitment in terms of balancing the work they had to do and teaching and supervising the work of their mentees.

Not many graduate students reported having worked or interacted with under-represented minority students. Of the few who have had interactions with under-represented minority students, they felt it is no different from interacting with any other students.

Undergraduate students felt the TCAP was a "great opportunity" to gain research experience and receive research funding. All three students associated the TCAP with its research component of being a nation-wide effort of researchers improving barley and wheat breeding. Most primarily reported conducting data collection duties, including planting seeds, caring for plants daily, documenting plant line observations, weighing samples, and counting kernels. One student mentioned also conducting experiments with the plants and writing up the results. They are working primarily on helping with their graduate mentor's research project. Students reported enjoying their work in the lab and did not feel there was anything that they particularly did not like to do.

Additionally, undergraduate students reported working most closely with graduate students. They regarded graduate students as mentors and felt graduate students were very informative and helpful. They reported that graduate students helped them learn more about plant breeding by

providing them with current academic literature, explaining the steps of the research, and teaching them how to do lab work. They also felt that graduate students were helpful in advising them about graduate school. Their future plans included both interest in industry but also graduate programs (PhD and masters), most likely in plant breeding.

TCAP PIs were similarly asked about their and their student's involvement in the educational component of the TCAP and what they thought was working well or could be improved. The faculty interviews show that the TCAP PIs have very differing levels of involvement with and understanding of the educational components of TCAP. Despite this, however, they have very positive and hopeful perceptions about what it has and will be able to accomplish. In terms of their involvement with the educational component, they appeared willing to participate but wanted to make sure it was the most efficient use of their time. It also appears that the PI knowledge of the educational component has increased since last year along with their and their students' levels of involvement. They reported encouraging their students to participate and they felt that the students were indeed participating. PI involvement and interaction with MSIs and underrepresented minority students URMs is still low. They did report that their institutions were interested and involved in recruiting URMs and that they had had at least some URM students. PIs reported that they provide all of their students with individualized attention based on their needs and that therefore special accommodations for URMs were not necessary. When asked about collaborations, they responded that the main component in determining whether or not collaborations would continue is the quality of the research the collaboration produced.

Students and PIs from Minority Serving Institutions (MSIs)

Survey data

MSI students generally valued TCAP activities and felt educational processes were important to some extent. They generally enjoyed their research experience and were mostly involved in research at their own institution. The students reported wanting to gain a variety of skills and knowledge, such as field experience, research skills, independent development of research ideas, communication and interpersonal skills within a research setting, and more science knowledge. Most felt comfortable to some extent in approaching faculty members and students at partnering TCAP institution; however, none of the MSI students had spent time working at the TCAP institution at the time of the survey.

With respect to MSI PIs, they felt TCAP educational components were important. They also generally felt plant breeding knowledge and skills were valuable. They felt that the most important things TCAP can accomplish was attracting and encouraging more students to pursue plant breeding. However, MSI PIs pointed out some barriers including lack of interest, knowledge, and exposure to plant breeding. Relationships with TCAP institutions were rated as "very strong" and about half of the MSI PIs reported collaborating "a lot" with TCAP faculty. While collaborations were strong, MSI PIs felt funding was a key barrier. As for networking, MSI PIs reported most frequently interacting with students and other faculty at their institution

Comparison of MSI PI survey results by year

Comparison of the MSI PI data by year showed that MSI PIs' relationships with TCAP institutions have strengthened between 2011 and 2012. In 2011, only one of eight MSI PIs felt their relationship with TCAP institutions were "very strong," while all six MSI PIs completing the survey in 2012 felt the same way. Additionally, it appears that MSI PIs have increased their interaction with other students (besides their advisees) at their institution. Lastly, perceptions of the value of plant breeding skills appear to have decreased slightly. Making marker assisted selections and utilizing single nucleotide polymorphisms or genotyping by sequencing was rated less valuable in 2012 than in 2011.

Interview data

MSI student interviews

Students at MSI institutions primarily became involved in the TCAP through their advisors. Advisors offered students the opportunity to get involved and participate in TCAP-related research projects. Students also participated in some online activities, such as participating in webinars, listening to pre-recorded lectures, and browsing through posted presentations. However, these students generally associated with the TCAP research portion of wheat and barley breeding rather than the educational portion. Additionally, several of these students reported having the opportunity to complete a summer internship at the partnering TCAP institution which they felt was very positive, reporting learning and understanding more about plant breeding.

MSI students who participated in summer internships were more likely to have more frequent contact with TCAP faculty and students outside of their institution than students who did not have that experience. Students who completed a research summer internship at their partnering TCAP institution reported being able to maintain relationships with TCAP PIs and graduate students afterwards – mainly through email. These students tremendously appreciated the exposure they got through the TCAP program and recommended that the program be "broadcasted" more widely to MSI institutions.

MSI faculty and TCAP PI collaborators interview data

The interviews with the MSI faculty and their TCAP faculty collaborators show that the MSI outreach projects appear to be establishing positive collaborations. These collaborations show the potential to increase the number of underrepresented undergraduate students applying to plant sciences graduate programs. To date, two students from MSI institutions in the TCAP program have been accepted to plant science graduate programs with one student receiving a graduate assistantship directly through participation as a summer intern. There is also evidence that the faculty value the interactions and are willing to put in the time to make the collaborations successful. Face-to-face interaction; particularly through faculty site visits appears to enhance the collaborations. Other positive components are mutual understanding and interests, which are also enhanced by face-to-face interactions. Complimentary research interests are important for collaborations but most compelling is the nature of the relationship between the people. All faculty agreed that increasing the number of underrepresented minority students was important and they thought some collaboration would continue even after TCAP funding ended. They all reported they mentored their students in an individualized, hands-on fashion regardless of race or culture. MSI

faculty members did not consider the diversity of the receiving graduate institution as a factor in determining whether or not they recommended their undergraduate students to a particular graduate program. Faculty were uniformly positive about the educational component of TCAP.

Recommendations and suggestions

This synthesis report for 2011-2012 includes all of the reports prepared by the evaluation team in the two appendices. Summaries of the results and data gathering methods are presented above. The purpose of this 'Recommendations and Suggestions' section is to present recommendations synthesized across reports, which the evaluation team believes are the most relevant to the continued successful operation of the educational component of TCAP.

As can be seen in all of the reports in the appendices, the educational component of TCAP is proceeding well. The education team has shown flexibility in its approaches and has adapted its programming based on information obtained during the first year helping the offerings to better meet the needs of participants, such as providing a seminar series and having the graduate students more directly involved in planning and delivering educational sessions. The realization that changing educational cultures is a long term process has informed the pace of change. The suggestions that follow are provided in acknowledgement of the substantial accomplishments of the educational component to date and offer potential ideas for incremental change in an already successful endeavor.

One of the issues is the identification of who exactly is being impacted by the project. Initial notions of a small cohort group of students are being shown to be inadequate for the reality of the educational offerings. Many different types of students and faculty are being affected by the educational components. A primary audience was to have been graduate students fully funded by TCAP over a number of years. While those types of students exist, others are also benefitting e.g., students who are partially funded, students who are funded through different mechanisms, students from other programs, students from a variety of levels, etc. It is important to celebrate the extension of TCAP effects to a variety of participants. Additionally, it is critical to track the type of participant and the dosage of TCAP they receive so that differential effects will not be viewed negatively. Clarification of what the educational component will be held accountable for would be useful. Along this line it is particularly important to clarify and prioritize the outcomes expected from the MSI collaborations.

One of the major goals of the educational component is to recruit more and more diverse students into plant breeding. The findings to date show that the MSI research collaborations are being effective at accomplishing this goal. However, it may be possible to enhance the outcomes of these collaborations and perhaps to institute additional strategies to help meet this goal. The data indicate that more face-to-face interaction between the MSIs and TCAP institutions would be valuable. This appears to enhance the strength of the collaborations through better understanding of TCAP PIs of the context at the MSIs and of MSI students of the TCAP institutions. It also appears that induction of students into graduate level plant breeding programs and their completion of these programs is a very individualized process so time and resources to allow this to occur need to

be provided. Other strategies might be fruitful. One possibility is funding the MSI PIs and their students to actively recruit other students on their campuses - in order to change the existing perceptions of what a plant breeding career might entail and emphasizing the strong possibility of employment. Students at MSI institutions appear to be particularly susceptible to negative or nonexistent perceptions of plant breeding as a career. Another possibility is working directly with institution or departmental level recruiters to provide them with information to show the attractiveness of plant breeding as a career. These recruiters might work directly with the targeted MSI institutions as well as others.

It would be useful to increase the awareness and understanding of the educational component across the TCAP PIs. There are very positive perceptions of the educational component but PIs are not clear as to what is actually being done, their role or their students' roles. For example, in the mentoring of undergraduate components, the actual roles the undergraduates, graduate students and PIs should play are not clear. It is valuable to have the solutions be institutionally unique but at the same time general guidelines might be useful, such as do the undergraduate students have their own projects or assist with existing TCAP projects? If they have their own project, how related to TCAP should it be? How much time are the graduate students expected to spend mentoring the undergraduates? How long should undergraduates continue? Who selects the undergraduates? What are the criteria related to interest in future work in plant breeding? Etc. The mentoring seminar appears to provide good instruction on how to mentor but the parameters within which the mentoring occurs need to be more universally agreed upon. Another area where PI clarification would be beneficial is in what the PIs need to encourage their graduate and undergraduate students to participate in. Students tend to do what their supervisors expect them to do so making participation parameters clear to the PIs should help to support student engagement.

It appears that it would be helpful if there were more opportunity for all of the involved students to interact with each other, i.e., the MSI students, the other undergraduate students, the graduate students. There are different on line communities for the different students and the educational team works hard to facilitate engagement but the communities could be more vibrant and cross community interactions might help to facilitate this vibrancy. It appears to be important that face-to-face opportunities be provided to facilitate the community building. Students feel more comfortable interacting with and soliciting help from other students and faculty if they have actually met them. More opportunities for students and faculty to come together would most likely facilitate the depth of participation in the on line communities. In addition, the opportunity for the MSI students to visit the TCAP institutions appears to enhance the likelihood of them pursuing graduate study and graduate study in plant breeding. Another opportunity, albeit not face-to-face, would be to make sure that anyone who provides a seminar is open to and expects to receive questions for people who listened to the seminar. To promote this, the seminars might provide some sort of problem or issue for the participants to think about and provide feedback on either through some sort of blog or directly to the presenter. This would help to extend the impact of the seminar and increase community connections.

In terms of the evaluation going forward, it might be beneficial to reconsider just what should be included in the surveys, the number of surveys and the degree of overlap between the surveys and

interviews. This year we changed the surveys somewhat but perhaps more substantial changes should be implemented. Some surveys are administered to a small number of people, this may not be the most effective way to obtain information from them. Students appear to be uninterested in participating in interviews. We believe this is related to the lack of PI understanding of the educational component and their leadership in conveying to the students what is important but perhaps interviewing them should be dropped in favor of surveys. We also didn't conduct case study visits at MSI institutions this year and opted instead to interview all MSI PIs and collaborators. This provided a broader range of information but prevented the in-depth analysis on individual best practices. What strategy would be best for next year needs to be considered. It might also be possible to incorporate some more research oriented studies in the coming year. It would be most feasible to conduct further analyses with existing data such as examining the effect of institution type or looking at relationships among the variables within the surveys. Additional data might be collected to examine important issues such as the growth of cohesion within the TCAP institutions or how group development in an on line environment is distinct from development in face-to-face environments. The originally proposed research ideas do not appear to be as relevant to the evolving educational component.

In summary, the educational component is progressing well. It is providing strong programming and altering its offerings to better fit the needs and expectations of the participants.

Appendix A: Survey data

Results from the 2012 graduate student survey

An evaluation of the Triticeae Coordinated Agricultural Project (TCAP)

Results from the 2012 graduate student survey

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List of tables and figures

Introduction

The Triticeae Coordinated Agricultural Project (TCAP), funded by the United States Department of Agriculture (USDA), is an effort to improve the quality of wheat and barley breeding and increase the number of plant breeders, especially from racially and ethnically diverse backgrounds. TCAP's educational component consists of providing education and research opportunities for graduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field.

An evaluation with multiple components is being conducted to assess the progress of TCAP. One of the evaluation components is a yearly survey to assess graduate students' perceptions of plant breeding education, perceptions of TCAP programming, and collaborative relationships and networks over time. This report provides a summary of survey results from the second year of programming.

Methods

The evaluation team worked collaboratively with members of the TCAP educational committee to make revisions to the baseline survey. The 2012 TCAP Graduate Student Survey was administered online to full- and partially-funded TCAP graduate students in early June. The graduate student survey assessed perceptions of plant breeding education, motivation to pursue a plant breeding career, perceptions of the TCAP educational programming, and collaborative networks with other students, faculty, and researchers within and outside of the TCAP. Results for items with the highest and lowest ratings are highlighted in the "Key findings" section, while results are summarized more generally in the "Issues to consider" section.

Respondents' demographics

Of a total of 32 students, 24 students completed the graduate student survey for a response rate of 75%. There were slightly more male students (58%) than female students (42%) (Table 1). The majority of students (65%) were in their mid- to late-20s (Table 2). None of the students reported being of Hispanic or Latino origin (Table 3). Slightly over half of the students (55%) identified as White, while the remaining students identified as Asian (45%) (Table 4). Slightly over half of the students (57%) reported having citizenship in the U.S. (Table 5).

Key findings

Summarized by Mao Thao, BS, BA

The following summarizes key findings from the TCAP graduate student survey:

- Of the 10 plant breeding knowledge areas, genetics and causes of and resistance to biotic stress were areas that received the highest percentages of "very" confident ratings by students. Over one-third of the students (38%) felt "very" confident in the area of genetics and over one-quarter of the students (28%) felt "very" confident in causes of and resistance to biotic stress. Knowledge areas that students did not feel as confident in were teaching strategies and selection theory and techniques, where 66% and 46% respectively felt they were "not at all" or "somewhat" confident (Table 6). Students also listed several other knowledge areas that they felt were valuable, such as various plant science topics, statistics, and project management skills (Table 7). Additionally when asked to rank the top three knowledge areas, about one-quarter of the students chose experimental design (28%) as the top-ranking area and data management as the second-ranking area they felt most confident in (Table 8).
- As for the 19 plant breeding skills, almost half of the students felt "very" confident in managing data (48%) and working cooperatively (40%). Several other plant breeding skills were also highly rated by nearly one-third of the students: defining and solving problems (32%), making marker assisted selections (30%), considering alternative hypotheses (28%), and observing and interpreting results (28%). Several items were rated low where about one-quarter of students felt "not at all" confident in making genome wide selections (26%), utilizing single nucleotide polymorphisms or genotype by sequencing (25%), networking skills (25%), and resource management skills (24%) (Table 10). Two students felt there were additional skills that are valuable, such as selecting parents for crossing and biochemistry and NIR techniques (Table 10). Working cooperatively was ranked by about one-quarter of the students (28%) as the top skill that students feel most confident in, while defining and solving problems and leadership skills were ranked second by 20% of students (Table 11).
- Students were also asked to rate the importance of 13 educational processes on a scale of 1 to 5, with 1 being "not important at all" and 5 being "extremely important". Field experience (76%), laboratory experience (72%), and exposure to diverse research methods (68%) received the highest percentage of "extremely important" ratings. One student (4%) felt collaboration with graduate students from other institutions was "not important at all". Exposure to plant breeding students from different ethnic backgrounds received a rating of two by almost one-quarter of the students (24%) (Table 12). The highest ranking items as the most important educational process was one-on-one mentoring (24%) and experience writing grants (24%) (Table 13).
- Of the plant breeding skills listed, the majority of students reported using the skills: managing data (67%), working cooperatively (67%), and observing and interpreting results (63%) the most. Half of the students (48%) used the skill making genome wide selections "not at all" (Table 14). Working collaboratively was also ranked as the top skill that students used the most by almost one-third of the students (33%), while leadership skills was ranked as the second top skill by 16% of the students (Table 15).

- The majority of students (83%) generally feel motivated to pursue a career in plant breeding (Table 16).
- Conducting research and gathering, analyzing, and managing data were the two activities that students reported participating in the most – with slightly more than half of students saying they participate in these activities "very" often (54% and 52% respectively). Close to one-third of the students (29%) reported "not at all" participating in the online community, while about one-quarter of the students (17%) did not participate in mentoring an undergraduate student (Table 17).
- Students highly valued research. Planning research (96%); gathering, analyzing, and managing data (96%); problem solving (96%), and conducting research (92%) were rated as "very" valuable by almost all of the students. Students appeared not to value mentoring an undergraduate and the online community as much, with 38% of the students rating the online community as "a little" important and 32% of the students rating mentoring an undergraduate student as "not at all" or "a little" important (Table 18).
- Students generally had frequent interaction with students at their institution (both graduate and undergraduate students, and students in their lab) and their advisor. A high percentage of students reported "never" interacting with students (88%) and faculty (87%) from MSIs. Additionally, almost half of students reported "never" interacting with students from other institutions and researchers outside of their institution (both those at other institutions, outside of the U.S., and at businesses and/or private companies) (Table 19).
- Of the students who interacted with students and researchers outside of their institution, most interactions were about collaborations, job prospects, or for social purposes. Interactions with students at their institution were mostly about class assignments and collaborations (Table 20).

Comparisons by gender

The survey data were analyzed by gender. Items that resulted in statistically significant differences are reported; however, these results should be interpreted with caution as the sample sizes and cell counts are small (Table 21).

- Male students tend to rate their confidence in several plant breeding knowledge and skills more highly than female students, including experimental design, causes of and resistance to abiotic stress, causes of and resistance to biotic stress, selection theory and techniques, design experiments, and identify new alleles to use for improvement.
- Male students reported using the skill of considering alternative hypotheses more often than female students, 93% compared to 50% respectively.
- Male students also tend to participate in planning research more often, where all male students reported participating in this activity compared to only half of female students (50%).

Issues to consider

The following are some issues for consideration based on the survey results:

- Students are very involved, engaged, and interested in research. Research related items generally received high ratings from students, such as managing data and experience in the lab or field. It is important for the TCAP to continue to provide students with the resources they need to develop their research skills, pursue collaborative research opportunities, network to solve problems with their research, and have opportunities to share and talk about their research.
- Teaching strategies (inquiry-based learning approaches) was a knowledge area that many students did not feel confident in. It should be considered whether teaching strategies are relevant to students and provide opportunities for students to learn about this area.
- Most students felt confident in their mentoring skills and reported that they often use their mentoring skills. However, some students reported not mentoring an undergraduate student. Additionally, several students also reported never interacting with mentee, but it is unclear whether these students have a mentee. The TCAP should consider ways to increase the interaction between students and their mentees.
- Generally, students reported using the skills that they felt most confident in – such as managing data, working cooperatively, observing and interpreting results, and defining and solving problems. The only item that was particularly different was considering alternative hypotheses, where students reported high confidence in, but low use. The TCAP educational committee should consider whether it is important to ask about plant breeding skills in different ways.
- While there were some significant gender differences, it may be that female students are more modest in rating their confidence than male students rather than actually lacking confidence in their knowledge and abilities. The differences should be noted, yet the sample sizes are so small that these results do not have enough evidence to firmly demonstrate differences.
- Very few students interacted with MSI faculty and students. The TCAP should consider whether it is a priority for all TCAP graduate students to network and collaborate with MSI partners. If this is a priority for all graduate students (not just graduate students with MSI partners), develop strategies and opportunities for greater interaction between TCAP graduate students and MSI faculty and students.
- For future survey administrations and analyses, the TCAP educational committee should continue to track students' background characteristics (such as year in program) and share such information to further explore differences and interpret results.

Table 1: Respondents' sex.

What is your sex?	Second year students n	New students n	Total n	Total %
Male	5/8	9/16	14/24	58%
Female	3/8	7/16	10/24	42%

Table 2: Respondents' age.

What is your age?	Second year students n	New students n	Total n	Total %
18 to 20 years old	—	1/15	1/23	4%
21 to 23 years old	1/8	2/15	3/23	13%
24 to 26 years old	5/8	4/15	9/23	39%
27 to 29 years old	2/8	4/15	6/23	26%
30 to 32 years old	—	2/15	2/23	9%
33 years or older	—	2/15	2/23	9%

Table 3: Respondents' ethnicity.

Are you of Spanish, Hispanic, or Latino origin?	Second year students n	New students n	Total n	Total %
Yes	0/8	0/12	0/20	0%
No	8/8	12/12	20/20	20%

Table 4: Respondents' race.

Please specify your race:	Second year students n	New students n	Total n	Total %
American Indian or Alaskan Native	—	—	—	—
Asian	1/7	8/13	9/20	45%
Black or African American	—	—	—	—
Native Hawaiian or Pacific Islander	—	—	—	—
White	5/7	5/13	11/20	55%
Mixed race	—	—	—	—

Table 5: Respondents' citizenship status.

Are you a U.S. citizen?	Second year students n	New students n	Total n	Total %
Yes	7/8	6/15	13/23	57%
No	1/8	9/15	10/23	43%

Table 6: Students' confidence in plant breeding knowledge areas.

How confident did you feel in the following knowledge areas:	N	Not at all		Somewhat		Moderately		Very	
		n	%	n	%	n	%	n	%
Genetics (mendelian, quantitative, population and molecular)	24	—	—	6	25%	9	38%	9	38%
Causes of and resistance to biotic stress	25	3	12%	5	20%	10	40%	7	28%
Data management (collection, analysis, database)	25	1	4%	2	8%	16	64%	6	24%
Factors in crop plants that impact productivity	25	3	12%	3	12%	13	52%	6	24%
Methods for breeding in selfing and outcrossing systems	23	2	9%	5	22%	11	48%	5	22%
Selection theory and techniques	24	1	4%	10	42%	8	33%	5	21%
Causes of and resistance to abiotic stress	25	3	12%	7	28%	10	40%	5	20%
Plant breeding strategies (e.g. traditional, molecular, physiological)	24	2	8%	5	21%	13	54%	4	17%
Experimental design	25	—	—	6	24%	15	60%	4	16%
Teaching strategies (Inquiry-based learning approaches)	21	3	14%	11	52%	6	29%	1	5%

Table 7: Other valuable plant breeding knowledge areas identified by students.

Are there any other knowledge areas in plant breeding that you feel are valuable to you?
Disease resistance
Genetic analysis like association mapping
Linear and mixed linear model in statistics
Plant pathology; interaction between pathogens and host
Selection of parents for crossing
Team management, project management, work environment, health and safety practices

Table 8: Students' ranking of the plant breeding knowledge areas they feel most confident in (*N* = 25).

What are the top three knowledge areas that you felt most confident in?	#1 Rank		#2 Rank		#3 Rank	
	n	%	n	%	n	%
Experimental design	7	28%	5	20%	2	8%
Genetics (mendelian, quantitative, population and molecular)	6	24%	3	12%	4	16%
Factors in crop plants that impact productivity	4	16%	—	—	4	16%
Data management (collection, analysis, database)	2	8%	7	28%	1	4%
Causes of and resistance to abiotic stress	2	8%	3	12%	2	8%
Causes of and resistance to biotic stress	2	8%	2	8%	5	20%
Plant breeding strategies (e.g. traditional, molecular, physiological)	1	4%	3	12%	5	20%
Other	1	4%	—	—	2	8%
Methods for breeding in selfing and outcrossing systems	—	—	1	4%	3	12%
Selection theory and techniques	—	—	1	4%	1	4%
Teaching strategies (Inquiry-based learning approaches)	—	—	—	—	1	4%

Table 9: Students' confidence in plant breeding skills.

How confident did you feel in the following skill areas:	N	Not at all 1		Somewhat 2		Moderately 3		Very 4	
		n	%	n	%	n	%	n	%
Manage data	25	—	—	3	12%	10	40%	12	48%
Work cooperatively	24	—	—	3	13%	6	25%	15	40%
Define and solve problems	25	1	4%	3	12%	13	52%	8	32%
Make marker assisted selections	23	2	9%	7	30%	7	30%	7	30%
Consider alternative hypotheses	25	—	—	3	12%	15	60%	7	28%
Observe and interpret results	25	—	—	4	16%	14	56%	7	28%
Molecular techniques	24	2	8%	3	13%	14	58%	5	21%
Design experiments	25	1	4%	6	24%	13	52%	5	20%
Make phenotypic selections	25	2	8%	7	28%	11	44%	5	20%
Networking skills	24	6	25%	14	58%	4	17%	4	17%
Communicate your scientific ideas	25	—	—	5	20%	16	64%	4	16%
Statistical analysis	25	1	4%	5	20%	15	60%	4	16%
Choose parents and make crosses	24	4	17%	7	29%	10	42%	3	13%
Mentoring skills	23	2	9%	3	13%	15	65%	3	12%
Leadership skills	24	1	4%	3	13%	18	75%	2	8%
Resource management	25	6	24%	—	—	17	68%	2	8%
Identify new alleles to use for improvement	24	3	13%	7	29%	12	50%	2	8%
Utilize single nucleotide polymorphisms (SNPs) or genotype by sequencing (GBS)	24	5	25%	8	33%	9	38%	1	4%
Make genome wide selections	23	6	26%	8	35%	8	35%	1	4%

Table 10: Other valuable plant breeding knowledge areas identified by students.

Are there any other plant breeding skills that you feel are valuable to you?
Again, selection of parents for use in crossing
Biochemistry, NIR techniques

Table 11: Students' ranking of the plant breeding skills they feel most confident in (*N* = 25).

What are the top three skills that you felt most confident in?	#1 Rank		#2 Rank		#3 Rank	
	n	%	n	%	n	%
Work cooperatively	7	28%	1	4%	4	16%
Design experiments	4	16%	1	4%	1	4%
Molecular techniques	3	12%	1	4%	3	12%
Make marker assisted selections	2	8%	2	8%	3	12%
Define and solve problems	1	4%	5	20%	1	4%
Manage data	1	4%	5	20%	1	4%
Leadership skills	1	4%	3	12%	—	—
Make phenotypic selections	1	4%	2	8%	—	—
Networking skills	1	4%	1	4%	2	8%
Communicate your scientific ideas	1	4%	1	4%	—	—
Other	1	4%	—	—	1	4%
Mentoring skills	1	4%	—	—	—	—
Resource management skills	1	4%	—	—	—	—
Identify new alleles to use for improvement	—	—	2	8%	—	—
Choose parents and make crosses	—	—	2	8%	—	—
Statistical analysis	—	—	1	4%	4	16%
Observe and interpret results	—	—	—	—	2	8%
Utilize single nucleotide polymorphisms (SNPs) or genotype by sequencing (GBS)	—	—	—	—	1	4%
Consider alternative hypotheses	—	—	—	—	—	—
Make genome wide selections	—	—	—	—	—	—

Table 12: Students' perceptions on the importance of educational processes (*N* = 25).

How important do you believe the following are in the process of educating graduate students?	Not important at all 1		2		3		4		Extremely important 5	
	n	%	n	%	n	%	n	%	n	%
Field experience	—	—	—	—	3	12%	3	12%	19	76%
Laboratory experience	—	—	—	—	2	8%	5	20%	18	72%
Exposure to diverse research methods and tools	—	—	—	—	2	8%	6	24%	17	68%
One-on-one mentoring	—	—	1	4%	6	24%	9	36%	9	65%
Experience presenting results (meetings, papers)	—	—	—	—	2	8%	8	32%	15	60%
Independent development of research designs	—	—	—	—	4	16%	8	32%	13	52%
Independent development of hypotheses	—	—	—	—	5	20%	7	28%	13	52%
Collaboration with other graduate students in this institution (in this lab or other labs)	—	—	1	4%	4	16%	9	36%	11	44%
Collaboration with faculty other than the advisor	—	—	—	—	5	20%	10	40%	10	40%
Experience writing grants	—	—	—	—	6	24%	9	36%	10	40%
Exposure to plant breeding students from different ethnic backgrounds	—	—	6	24%	7	28%	4	16%	8	32%
Teaching experience[a]	—	—	4	17%	8	33%	5	21%	7	29%
Collaboration with graduate students from OTHER institutions	1	4%	2	8%	8	32%	9	36%	5	20%

[a] N = 24

Table 13: Students' ranking of the most important educational processes (*N* = 25).

How important do you believe the following are in the process of educating graduate students?	#1 Rank		#2 Rank		#3 Rank[a]	
	n	%	n	%	n	%
One-on-one mentoring	6	24%	3	12%	2	8%
Exposure to diverse research methods and tools	6	24%	2	8%	2	8%
Independent development of hypotheses	3	12%	3	12%	1	4%
Collaboration with other graduate students in this institution (in this lab or other labs)	3	12%	1	4%	3	13%
Field experience	2	8%	2	8%	4	17%
Collaboration with faculty other than the advisor	1	4%	4	16%	—	—
Independent development of research designs	1	4%	2	8%	4	17%
Experience writing grants	1	4%	1	4%	—	—
Collaboration with graduate students from OTHER institutions	1	4%	—	—	—	—
Exposure to plant breeding students from different ethnic backgrounds	1	4%	—	—	—	—
Laboratory experience	—	—	3	12%	2	8%
Experience presenting results (meetings, papers)	—	—	2	8%	5	21%
Teaching experience	—	—	1	4%	1	4%

[a] N = 24

Table 14: Students' use of plant breeding skills.

How often do you use the following skills in plant breeding?		Not at all 1		Somewhat 2		Moderately 3		Very 4	
	N	n	%	n	%	n	%	n	%
Manage data	24	1	4%	1	4%	6	25%	16	67%
Work cooperatively	24	1	4%	2	8%	5	21%	16	67%
Observe and interpret results	24	1	4%	2	8%	6	25%	15	63%
Define and solve problems	24	1	4%	1	4%	11	46%	11	46%
Molecular techniques	23	2	9%	6	26%	5	22%	10	44%
Make phenotypic selections	23	5	22%	4	17%	4	17%	10	44%
Statistical analysis	24	1	4%	4	17%	9	38%	10	42%
Make marker assisted selections	23	6	26%	4	17%	4	17%	9	39%
Design experiments	24	1	4%	4	17%	11	46%	8	33%
Choose parents and make crosses	23	7	30%	4	17%	5	22%	7	30%
Communicate your scientific ideas	24	1	4%	4	17%	12	50%	7	29%
Networking skills	24	2	8%	5	21%	10	42%	7	29%
Mentoring skills	24	2	8%	8	33%	7	29%	7	29%
Identify new alleles to use for improvement	23	6	26%	6	26%	5	22%	6	26%
Utilize single nucleotide polymorphisms (SNPs) or genotype by sequencing (GBS)	23	9	39%	4	17%	4	17%	6	26%
Consider alternative hypotheses	24	1	4%	5	21%	12	50%	6	25%
Leadership skills	24	1	4%	6	25%	11	46%	6	25%
Resource management skills	24	1	4%	7	29%	10	42%	6	25%
Make genome wide selections	23	11	48%	5	22%	4	17%	3	13%

Table 15: Students' ranking of the plant breeding skills they use the most (*N* = 25).

What are the top three skills that you use the most?	#1 Rank		#2 Rank		#3 Rank	
	n	%	n	%	n	%
Work cooperatively	8	32%	2	8%	3	12%
Manage data	4	16%	1	4%	5	20%
Define and solve problems	3	12%	2	8%	3	12%
Make marker assisted selections	2	8%	2	8%	1	4%
Molecular techniques	2	8%	2	8%	—	—
Design experiments	2	8%	1	4%	1	4%
Observe and interpret results	1	4%	3	12%	—	—
Identify new alleles to use for improvement	1	4%	1	4%	—	—
Other	1	4%	—	—	2	8%
Mentoring skills	1	4%	—	—	1	4%
Leadership skills	—	—	4	16%	—	—
Statistical analysis	—	—	3	12%	3	12%
Resource management skills	—	—	1	8%	—	—
Communicate your scientific ideas	—	—	1	4%	1	4%
Make phenotypic selections	—	—	1	4%	1	4%
Utilize single nucleotide polymorphisms (SNPs) or genotype by sequencing (GBS)	—	—	1	4%	1	4%
Networking skills	—	—	—	—	2	8%
Choose parents and make crosses	—	—	—	—	1	4%
Consider alternative hypotheses	—	—	—	—	—	—
Make genome wide selections	—	—	—	—	—	—

Table 16: Students' motivation in the plant breeding field (*N* = 23).

	Not at all motivated 1		2		3		4		Extremely motivated 5	
	n	%	n	%	n	%	n	%	n	%
How motivated do you feel to pursue a career in plant breeding?	1	4%	—	—	3	13%	9	39%	10	44%

Table 17: Frequency of students' participation in activities.

How often you participate in the following activities:		Not at all 1		A little 2		Moderately 3		Very 4	
	N	n	%	n	%	n	%	n	%
Conducting research	24	1	4%	1	4%	9	38%	13	54%
Gathering, analyzing, and managing data	25	—	—	1	4%	11	44%	13	52%
Working in the field	24	2	8%	2	8%	10	42%	10	42%
Problem solving	25	—	—	1	4%	14	56%	10	40%
Planning research	22	1	5%	4	18%	10	46%	7	32%
Mentoring an undergraduate student	25	6	24%	8	32%	3	12%	8	32%
Being mentored by your advisor	24	3	13%	3	13%	12	50%	6	25%
Inquiry-based learning approaches	21	2	8%	8	38%	8	32%	3	14%
Participating in the online community	24	7	29%	7	29%	9	38%	1	4%

Table 18: Students' perceptions of the value of activities.

How valuable are the activities to your understanding of how to be the best plant breeder possible:	N	Not at all 1		A little 2		Moderately 3		Very 4	
		n	%	n	%	n	%	n	%
Planning research	24	—	—	—	—	1	4%	23	96%
Gathering, analyzing, and managing data	25	—	—	—	—	1	4%	24	96%
Problem solving	25	—	—	—	—	1	4%	24	96%
Conducting research	24	—	—	—	—	2	8%	22	92%
Working in the field	24	—	—	—	—	6	25%	18	75%
Inquiry-based learning approaches	22	1	5%	—	—	10	46%	11	50%
Being mentored by your advisor	23	—	—	2	9%	12	52%	9	39%
Mentoring an undergraduate student	25	1	4%	7	28%	11	44%	6	24%
Participating in the online community	24	—	—	9	38%	12	50%	3	13%

Table 19: Students' collaborative networking with others.

How often do you interact with the following types of people?	N	Never		Once a year or less		Once every three months		Once a month or less		Once a week or less		More than once a week	
		n	%	n	%	n	%	n	%	n	%	n	%
My mentee	16	3	19%	1	6%	—	—	—	—	2	13%	10	63%
Other undergraduates at my institution	16	2	13%	3	19%	2	13%	3	19%	1	6%	5	31%
Students in my lab	22	3	14%	—	—	—	—	—	—	2	9%	17	77%
Other graduate students at my institution	19	2	11%	—	—	—	—	3	16%	3	16%	11	58%
Students from other institutions in the U.S.	21	6	29%	1	5%	4	19%	7	33%	3	14%	—	—
Students from minority serving institutions (MSIs)	16	14	88%	1	6%	—	—	—	—	—	—	1	6%
Students from institutions outside the U.S.	20	8	40%	1	5%	2	10%	4	20%	3	15%	2	10%
My advisor	22	2	9%	—	—	—	—	—	—	8	36%	12	55%
Researchers at my institution	21	1	5%	1	5%	4	18%	3	14%	6	29%	6	29%
Researchers at MSIs	15	13	87%	1	7%	1	7%	—	—	—	—	—	—
Researchers at other institutions in the U.S.	18	8	44%	1	6%	2	11%	6	33%	—	—	1	6%
Researchers outside of the U.S.	19	9	47%	4	21%	3	16%	2	11%	—	—	1	5%
Researchers from businesses and/or private companies	19	8	42%	2	11%	3	16%	5	26%	1	5%	—	—

Table 20: Topics of interaction between students and others[a].

What is the most prevalent topic of your interaction was about?	N	Class assignments/ Classes in general		Trouble shooting research		Collaborations		Social		Mentoring/ Being mentored		Interpreting research results	
		n	%	n	%	n	%	n	%	n	%	n	%
My mentee	14	1	7%	2	14%	5	36%	—	—	3	21%	—	—
Other undergraduates at my institution	14	8	57%	—	—	1	7%	3	21%	—	—	—	—
Students in my lab	18	2	11%	3	17%	9	50%	3	17%	—	—	—	—
Other graduate students at my institution	16	4	25%	2	13%	5	31%	5	31%	—	—	—	—
Students from other institutions in the U.S.	16	—	—	2	13%	4	25%	6	38%	—	—	—	—
Students from minority serving institutions (MSIs)	2	—	—	—	—	—	—	—	—	1	50%	—	—
Students from institutions outside the U.S.	11	—	—	2	18%	1	9%	5	45%	—	—	—	—
My advisor	19	—	—	4	21%	5	26%	—	—	5	26%	3	16%
Researchers at my institution	19	1	5%	6	32%	4	21%	—	—	3	16%	1	5%
Researchers at MSIs	2	—	—	—	—	—	—	—	—	—	—	—	—
Researchers at other institutions in the U.S.	11	—	—	1	9%	7	64%	—	—	—	—	1	9%
Researchers outside of the U.S.	10	—	—	—	—	4	40%	2	20%	—	—	—	—
Researchers from businesses and/or private companies	11	—	—	—	—	1	9%	3	27%	—	—	—	—

Table 20: Topics of interaction between students and others (*continued…*).

What is the most prevalent topic of your interaction was about?	N	Theory of genetics or breeding		Job prospects and professional networking		Other	
		n	%	n	%	n	%
My mentee	14	—	—	1	7%	2	14%
Other undergraduates at my institution	14	—	—	—	—	2	14%
Students in my lab	18	—	—	—	—	1	6%
Other graduate students at my institution	16	—	—	—	—	—	—
Students from other institutions in the U.S.	15	—	—	1	7%	3	20%
Students from minority serving institutions (MSIs)	2	—	—	—	—	1	50%
Students from institutions outside the U.S.	11	—	—	1	9%	2	18%
My advisor	19	—	—	1	5%	1	5%
Researchers at my institution	19	2	11%	—	—	2	11%
Researchers at MSIs	2	—	—	—	—	2	100%
Researchers at other institutions in the U.S.	11	—	—	1	9%	1	9%
Researchers outside of the U.S.	10	—	—	1	10%	3	30%
Researchers from businesses and/or private companies	11	1	9%	4	36%	2	18%

Table 21: 2012 trends by gender[a].

Survey items	Male	Female
How confident do you feel in the following knowledge areas:	*"Moderately" or "Very"*	
Experimental design**	14/14 (100%)	5/10 (50%)
Causes of and resistance to abiotic stress**	12/14 (86%)	3/10 (30%)
Causes of and resistance to biotic stress**	13/14 (93%)	3/10 (30%)
Selection theory and techniques*	10/13 (77%)	3/10 (30%)
How confident did you feel in the following skill areas:	*"Moderately" or "Very"*	
Design experiments**	13/14 (93%)	4/10 (40%)
Identify new alleles to use for improvement*	10/13 (77%)	3/10 (30%)
How often do you use the following skills in plant breeding?	*"Moderately" or "Very"*	
Consider alternative hypotheses*	12/13 (93%)	5/10 (50%)
How often do you participate in the following activities:	*"Moderately" or "Very"*	
Planning research**	12/12 (100%)	5/10 (50%)

[a] A total of 122 chi-square tests were completed to examine differences by gender. All data and chi-square significance test results should be interpreted with caution due to the low sample size and low cell counts (*$p < .05$, **$p < .01$, ***$p < .001$).

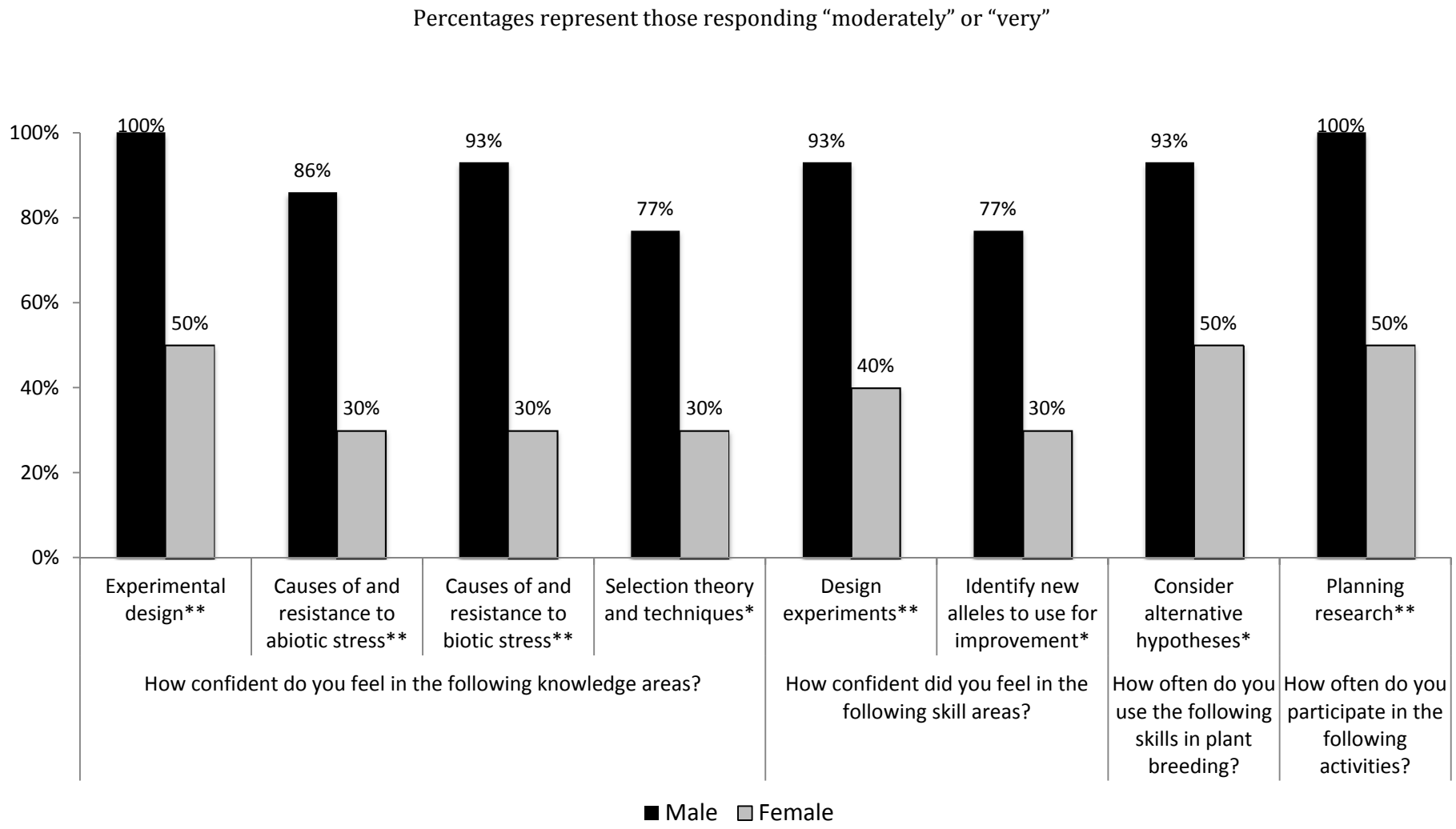

Figure 1. Comparison of significant items by gender.

Results from the 2012 undergraduate student survey

An evaluation of the Triticeae Coordinated Agricultural Project (TCAP)

Results from the 2012 Undergraduate Student Survey

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Introduction

The Triticeae Coordinated Agricultural Project (TCAP), funded by the United States Department of Agriculture (USDA), is an effort to improve the quality of wheat and barley breeding and increase the number of plant breeders, especially from racially and ethnically diverse backgrounds. TCAP's educational component consists of providing education and research opportunities for graduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field.

An evaluation with multiple components is being conducted to assess the progress of TCAP. One of the evaluation components is a yearly survey to assess undergraduate students' perceptions of their participation in TCAP. This report summarizes the survey responses from those undergraduates who participated in TCAP as research interns in the 2011-2012 academic year.

Methods

The evaluation team worked collaboratively with members of the TCAP educational committee to develop the survey. A survey think-aloud was completed with an undergraduate student the Plant Sciences Department at Montana State University. Both the faculty member and student were not part of TCAP.

Surveys were administered online to undergraduate students in late April to early May 2012. The survey assessed students' mentoring experience, research experience, and interest to pursue graduate studies in plant breeding. Undergraduate students include both those attending TCAP institutions, as well as those attending minority serving institutions (MSIs). Data tables are provided in Appendix A. Results are report separately for TCAP and MSI students, as well as for all students. Due to the low response rate and small sample size, only frequencies are reported.

Demographics of survey respondents

Of a total of 20 TCAP students, 8 students completed the survey, while 5 of 15 MSI students completed the survey.

TCAP students

There were equivalent numbers of females (4/8) and males (4/8) among TCAP students who completed the survey (Table 1). Students ranged in age between 18 and 23 years old (Table 2). Most students identified as White (7/8) and no students identified being of Hispanic ethnicity (Tables 3 & 4). Most students (5/7) reported majoring in Applied Plant Sciences (Table 5).

MSI students

All, but one MSI student was female (Table 1). Students ranged in age between 20 to 23 years old (Table 2). Three of four MSI students identified as Black or African American, while one student identified as White (Table 4). Two of four MSI students reported being of Hispanic descent (Table 3). Of the five MSI students, only three students reported their major – which was Biology (Table 5).

Key findings

Summarized by Mao Thao, BS, BA

The following summarizes key findings by topic area. As stated earlier, data tables are provided in Appendix A.

TCAP participation & educational processes

- Of the 13 students completing the survey, most students (4/5 MSI students and 7/8 TCAP students) know "a little" about the goals of TCAP (Table 6).
- Half of the students have participated in a research project developed by others (6/12, three MSI and 3 TCAP students) and a mentoring experience (6/12, four MSI and two TCAP students), while only a few students (3/12, one MSI and two TCAP students) have participated in an independently developed research project (Table 7).
- The activity that students reported participating in the most is participating in research in a laboratory setting with 9 of 13 students (all five MSI and four TCAP students) responding with "very often". The activity with the least participation is participating in a research experience at another institution, where 10 of 13 students (three MSI and seven TCAP students) reported participating "not at all". Many students (9/13, two MSI and seven TCAP students) also reported low participation in a community of researchers online (Table 8).
- Overall, most students generally saw value in the listed TCAP activities. Being mentored was rated as "very valuable" by 9 of 12 students, all five MSI and four TCAP students. The activity that several students viewed as least valuable was participating in a community of researchers online, in which 5 of 10 students (one MSI and four TCAP students) rated as "not at all" or "somewhat" valuable (Table 9).
- Most students felt the educational processes were at least "somewhat" important. Almost all students (11/13, four MSI and seven TCAP students) felt laboratory experience was "extremely important". The lowest rated items where several students rated as "a little important" was collaboration with other students at other institutions (Table 10).

Mentoring experience

- Almost all students (10/12, four MSI and six TCAP students) reported that there is someone involved in their research experience that they consider as a mentor. Five of nine students (two MSI and three TCAP students) reported having more than one mentor (Table 11).
- All MSI students reported that their primary mentor was a faculty member, while only one of six TCAP students reported similarly. Four TCAP students reported having a graduate student as their primary mentor, and one student reported that their primary mentor had some other role (Table 12).
- Students reported many things that they liked about their mentoring experience. Most comments were about having a personable and knowledgeable mentor. Students also were very appreciative of the helpful guidance that their mentor provides them personally and professionally (Table 13).

- Only a couple students provided feedback about what could make their mentoring experience better. One students felt clarifying expectations would be helpful, while another student wanted more resources to better understand plant breeding (Table 14).

Research experience

- Students' participation as a research intern ranged between one to nine months, with most students (5/11, two MSI and three TCAP students) having been a research intern for three to four months (Table 15).
- Students reported wanting to gain a variety of skills, knowledge, and experiences from their research experience, including laboratory and field experience, research skills, independent development of research ideas, communication and interpersonal skills within a research setting, and more science knowledge. Several students commented that they wanted to further their education and future (Table 16).
- As research interns, students reported conducting skilled lab work duties the most with 8 of 12 students (four MSI and four TCAP students) reporting they do this "very often". The research activity that most students (7/12, one MSI and six TCAP students) reported not doing often at all was teaching someone else how to perform skilled lab work (Table 17).
- MSI students were asked additional questions about their research experience given the partnership and collaborative work between their institution and a TCAP institution.
    - When asked to what extent MSI students felt comfortable approaching faculty members and students at their partner TCAP institution, three of four students reported feeling at least "moderately" comfortable doing so (Table 18).
    - None of the MSI students reported having spent time working at their collaborators' institution. Given this, a set of questions about students' perceptions of their collaborators was not asked (Table 19).
- There were many things that students' liked about their research experience. Many students liked the opportunity to learn, do research, and get hands-on experience. One student commented that she/he liked being mentored by a faculty member and graduate student (Table 20).
- Students had several suggestions for improving their research experience, including collaborating with other people, labs, and universities; doing more lab work, lab techniques, and data analysis; exploring additional research topics; communicating more with professors on the project; and having more time to do their work (Table 21).

Interest in graduate school and plant breeding

- All 13 students reported being at least "somewhat" interested in graduate school, with 6 of 13 (three MSI and three TCAP students) being "extremely interested" (Table 22).
- About half of the students (5/11, two MSI and three TCAP students) felt their research experience has impacted their interest in graduate school (Table 23). They felt their research experience increased their awareness and desire to go to graduate school. One student reported that it made her want to go to graduate school rather than dental school (Table 24).
- Seven of ten students (three MSI and four TCAP students) felt their research experience has contributed at least "a little" to their ability to succeed in graduate school (Table 25).

- MSI students were asked whether they would consider going to their partner TCAP institution for graduate school. Three students felt they would consider attending their partner TCAP institution (Table 26). Reasons for considering partner TCAP institutions include having a program of interest, furthering current research interests, and getting experience at a different institution (Table 27).
- When asked about the top two potential barriers to graduate school, most students said money or funding/finances as the first barrier and finding a job/career as the second barrier (Table 28). Students reported needing a variety of financial support if they were to pursue graduate school (Table 29).
- Before participating in their research experience, most students did not think about or knew very little about plant breeding as a career. Only a couple students reported having high interest in plant breeding before they began their research experience (Table 30).
- Most students (11/13) reported being at least "somewhat" motivated to pursue a plant breeding career (Table 31).
- Most students (10/13, four MSI and six TCAP students) reported that their perceptions about plant breeding have changed since starting their research experience (Table 32). Students commented that they have learned more about plant breeding – both as a research area and career option. One student commented that plant breeding is "not as interesting" as she/he thought it was (Table 33).

Issues to consider

The following are some issues for consideration based on the survey results:

- The survey response rates for the two groups of undergraduate students were very low. In future survey administrations, consider notifying principle investigators of the timing of the survey and recruit their partnership in emphasizing the importance of TCAP and TCAP evaluation activities. Additionally, consider offering incentives to students who complete the survey such as a drawing for a monetary gift card or a small TCAP keepsake.
- Consider and promote opportunities for undergraduate students to independently develop research designs and projects. Very few students have had this opportunity before participating in TCAP and most students felt this was important.
- Continue to promote and build mentoring opportunities for undergraduate students. Students reported positive perceptions about their mentoring experience and being mentored was highly rated as valuable by most students and. Most students also regarded someone involved in their research experience as mentor; however, there were a couple students who did not feel there was anyone involved in their research experience that they would consider a mentor. Furthermore, consider whether it is important for students to be mentored by both faculty members and graduate students. MSI students tended to have a faculty member as their primary mentor, while TCAP students tended to have graduate students as their primary mentor.
- Continue to promote collaboration. Undergraduate students did not seem to have a lot of opportunities to collaborate with others at or outside of their institution. This is particularly important for MSI students as they have yet to spend time working at their partner TCAP institution – likely due to the limited breaks throughout the academic year. As summer break approaches, ensure that there are opportunities and funding for MSI students to spend time at

their partner TCAP institution working with and getting to know faculty and graduate student collaborators.

- Continue to provide students with a variety of research and learning opportunities. Students generally had positive comments about their research experience and enjoyed learning new skills and knowledge. Consider students' feedback for what they hope to gain from their research experience and what could help improve their experience.
- Continue to promote graduate school and the plant breeding field. Many students reported that their research experience has increased their awareness and interest in pursuing graduate school and considering plant breeding as a career.

Appendix A: Data Tables

Table 1: Respondents' gender.

What is your sex?	Female	Male
MSI students	4/5	1/5
TCAP students	4/8	4/8
Total	8/13	5/13

Table 2: Respondents' age.

What is your age?	MSI students	TCAP students	Total
17 of younger	—	—	—
18 to 19 years old	—	2/8	2/13
20 to 21 years old	1/5	5/8	6/13
22 to 23 years old	4/5	1/8	5/13
24 to 25 years old	—	—	—
26 years old or older	—	—	—

Table 3: Respondents' ethnicity.

Are you of Spanish, Hispanic, or Latino/Latina origin?	Yes	No
MSI students	2/4	2/4
TCAP students	—	7/8
Total	2/12	8/12

Table 4: Respondents' race.

What is your racial background?	MSI students	TCAP students	Total
American Indian or Alaskan Native	—	—	—
Asian	—	1/8	1/12
Black or African American	3/4	—	3/4
Native Hawaiian or Pacific Islander	—	—	—
White	1/4	7/8	8/12
Mixed race	—	—	—

Table 5: Respondents' major.

What is your major?	MSI students	TCAP students	Total
Applied Plant Science	—	5/7	5/10
Animal Science	—	1/7	1/10
Biology	3/3	—	3/10
Biotechnology	—	1/7	1/10

Table 6: Respondents' knowledge of TCAP goals.

How much do you know about the goals of the TCAP?	Nothing at all	A little	A lot
MSI students	—	4/5	1/5
TCAP students	1/8	7/8	—
Total	1/13	11/13	1/13

Table 7: Respondents' previous participation in research and mentoring.

Before joining TCAP, have you ever participated in any of these types of activities:	MSI students		TCAP students		Total	
	Yes	No	Yes	No	Yes	No
A research project developed by others	3/4	1/4	3/8	5/8	6/12	6/12
A research project that was developed independently by you	1/4	3/4	2/8	6/8	3/12	9/12
A mentoring experience	4/4	—	2/8	6/8	6/12	6/12

Table 8: Respondents' participation in TCAP activities.

How often do you participate in the following TCAP activities?	Not at all often	Somewhat often	Moderately often	Very often
Planning research				
MSI students	1/5	1/5	3/5	—
TCAP students	4/8	3/8	1/8	—
Total	5/13	4/13	4/13	—
Conducting research				
MSI students	—	—	1/5	4/5
TCAP students	1/8	3/8	2/8	2/8
Total	1/13	3/13	3/13	6/13
Being mentored				
MSI students	—	—	1/5	4/5
TCAP students	1/8	2/8	3/8	2/8
Total	1/13	2/13	4/13	6/13
Participating in a community of researchers on campus				
MSI students	—	3/5	1/5	1/5
TCAP students	2/8	1/8	2/8	3/8
Total	2/13	4/13	3/13	4/13
Participating in a community of researchers online				
MSI students	2/5	3/5	—	—
TCAP students	7/8	—	1/8	—
Total	9/13	3/13	1/13	—

Table 8: Respondents' participation in TCAP activities *(Continued…)*.

How often do you participate in the following TCAP activities?	Not at all often	Somewhat often	Moderately often	Very often
Gathering, analyzing, and managing data				
MSI students	—	—	2/5	3/5
TCAP students	1/8	2/8	3/8	2/8
Total	1/13	2/13	5/13	5/13
Problem solving				
MSI students	—	—	3/5	2/5
TCAP students	2/8	4/8	—	2/8
Total	2/13	4/13	3/13	4/13
Participating in a research experience at your institution				
MSI students	—	—	1/5	4/5
TCAP students	2/8	1/8	1/8	4/8
Total	2/13	1/13	2/13	8/13
Participating in a research experience at another institution				
MSI students	3/5	1/5	—	1/5
TCAP students	7/8	—	1/8	—
Total	10/13	1/13	1/13	1/13
Reporting research results				
MSI students	—	—	2/5	3/5
TCAP students	5/8	1/8	1/8	1/8
Total	5/13	1/13	3/13	4/13
Application of course concepts through hands-on experiences				
MSI students	—	—	2/5	3/5
TCAP students	1/8	4/8	—	3/8
Total	1/13	4/13	2/13	6/13
Participating in research in a laboratory setting				
MSI students	—	—	—	5/5
TCAP students	1/8	1/8	2/8	4/8
Total	1/13	1/13	2/13	9/13
Participating in research in a field setting				
MSI students	2/5	1/5	—	2/5
TCAP students	3/8	4/8	1/8	—
Total	5/13	5/13	1/13	2/13

Table 9: Respondents' value of TCAP activities.

How valuable are the following TCAP activities to you in your education?	Not at all valuable	Somewhat valuable	Moderately valuable	Very valuable
Planning research				
MSI students	—	—	—	5/5
TCAP students	—	—	6/7	1/7
Total	—	—	6/12	6/12
Conducting research				
MSI students	—	—	—	5/5
TCAP students	—	—	4/7	3/7
Total	—	—	4/12	8/12
Being mentored				
MSI students	—	—	—	5/5
TCAP students	—	—	3/7	4/7
Total	—	—	3/12	9/12
Participating in a community of researchers on campus				
MSI students	—	—	—	5/5
TCAP students	—	2/6	1/6	3/6
Total	—	2/11	1/11	8/11
Participating in a community of researchers online				
MSI students	—	1/5	1/5	3/5
TCAP students	3/5	1/5	1/5	—
Total	3/10	2/10	2/10	3/10
Gathering, analyzing, and managing data				
MSI students	—	—	1/5	4/5
TCAP students	—	2/7	3/7	2/7
Total	—	2/12	4/12	6/12
Problem solving				
MSI students	—	—	1/5	4/5
TCAP students	—	1/7	2/7	4/7
Total	—	1/12	3/12	8/12
Participating in a research experience at your institution				
MSI students	—	—	—	5/5
TCAP students	—	—	4/7	3/7
Total	—	—	4/12	8/12

Table 9: Respondents' value of TCAP activities *(Continued…)*.

How valuable are the following TCAP activities to you in your education?	Not at all valuable	Somewhat valuable	Moderately valuable	Very valuable
Participating in a research experience at another institution				
MSI students	—	—	2/5	3/5
TCAP students	1/5	—	3/5	1/5
Total	1/10	—	5/10	4/10
Reporting research results				
MSI students	—	—	—	5/5
TCAP students	—	1/6	4/6	1/6
Total	—	1/11	4/11	6/11
Application of course concepts through hands-on experiences				
MSI students	—	—	—	5/5
TCAP students	—	1/6	4/6	1/6
Total	—	1/11	4/11	6/11
Participating in research in a laboratory setting				
MSI students	—	—	1/5	4/5
TCAP students	—	1/7	2/7	4/7
Total	—	1/12	3/12	8/12
Participating in research in a field setting				
MSI students	—	—	1/5	4/5
TCAP students	—	—	3/5	2/5
Total	—	—	4/10	6/10

Table 10: Respondents' perception of educational processes.

How important do you believe these processes are in your education?	Not important at all	A little important	Somewhat important	Moderately important	Extremely important
One-on-one mentoring					
MSI students	—	—	—	1/5	4/5
TCAP students	—	—	1/8	4/8	3/8
Total	—	—	1/13	5/13	7/13
Collaboration with faculty other than your advisor					
MSI students	—	—	—	2/5	3/5
TCAP students	—	—	3/8	5/8	—
Total	—	—	3/13	7/13	3/13
Collaboration with other students at your institution					
MSI students	—	—	1/5	1/5	3/5
TCAP students	—	1/8	1/8	5/8	1/8
Total	—	1/13	2/13	6/13	4/13
Collaboration with other students at other institutions					
MSI students	—	1/5	—	1/5	3/5
TCAP students	—	2/8	2/8	2/8	2/8
Total	—	3/13	2/13	3/13	5/13
Independent development of hypotheses					
MSI students	—	—	—	1/5	4/5
TCAP students	—	—	1/8	5/8	2/8
Total	—	—	1/13	6/13	6/13
Independent development of research designs					
MSI students	—	—	—	—	5/5
TCAP students	—	1/8	—	3/8	4/8
Total	—	1/13	—	3/13	9/13
Field experience					
MSI students	—	—	—	1/5	4/5
TCAP students	—	—	—	3/8	5/8
Total	—	—	—	4/13	9/13

Table 10: Respondents' perception of educational processes *(Continued…)*.

How important do you believe these processes are in your education?	Not important at all	A little important	Somewhat important	Moderately important	Extremely important
Laboratory experience					
MSI students	—	—	—	1/5	4/5
TCAP students	—	—	—	1/8	7/8
Total	—	—	—	2/13	11/13
Exposure to diverse research methods and tools					
MSI students	—	—	—	1/5	4/5
TCAP students	—	—	1/8	4/8	3/8
Total	—	—	—	5/13	7/13
Experience writing grants					
MSI students	—	—	—	1/5	4/5
TCAP students	—	—	2/8	3/8	3/8
Total	—	—	2/13	4/13	7/13
Experience presenting results (e.g. meetings, papers)					
MSI students	—	—	—	1/5	4/5
TCAP students	—	—	3/8	2/8	3/8
Total	—	—	3/13	3/13	7/13
Working with students from different ethnic backgrounds					
MSI students	—	—	—	1/5	4/5
TCAP students	—	—	5/8	1/8	2/8
Total	—	—	5/13	2/13	6/13

Table 11: Respondents' mentoring experiences

	MSI students		TCAP students		Total	
	Yes	No	Yes	No	Yes	No
Is there anyone involved in your research experience that you would consider a mentor?	4/5	1/5	6/7	1/7	10/12	2/12
Are you being mentored by more than one person?	2/4	2/4	3/5	2/5	5/9	4/9

Table 12: Respondents' mentor's role.

What is your primary mentor's role?	MSI students	TCAP students	Total
Faculty member	4/4	1/6	5/10
A laboratory technician	—	—	—
Graduate student	—	4/6	4/10
Some other role	—	1/6	1/10

Table 13: Respondents' perceptions of the most liked aspect of their mentoring experience.

What do you like the most about your mentoring experience?
MSI students
He advises me in taking decision and has always been of great help.
I like the fact that it is easy to communicate with my mentor. Since it is easy to communicate with my mentor I feel secure asking questions when I do not know how to do something, have ideas about the research, or even need clarity on the research. Every question is viewed as a learning experience to my mentor. This creates a great learning environment.
My mentor is very personable with me. Not only do we exchange emails but phone calls and meet regularly to talk not only science but life in general.
TCAP students
Access to knowledge concerning the best paths to take in research and how to conduct such methods. Also advise on courses and beginning a career in general.
I am learning a lot.
My mentor is really knowledgeable about what my options are. I like working through problems with my mentor and learning the trade.

Table 14: Respondents' thoughts on improving their mentoring experience.

What could make your mentoring experience better?
MSI students
Not applicable. (2 students)
TCAP students
I think having his expectations explained would really help me understand what he wants.
My mentoring experience might be better if my mentor could suggest some papers I might read to better understand the concepts she is trying to teach me.
Nothing.

Table 15: Length of respondents' research experience.

Number of months[a]	MSI students[b]	TCAP students	Total
1 to 2 months	—	1/7	1/11
3 to 4 months	2/4	3/7	5/11
5 to 6 months	1/4	1/7	2/11
7 to 8 months	—	2/7	2/11
9 months[c]	1/4	—	1/11

[a] Number of months were calculated using the month and year students reported starting their research experience to the month of May 2012.
[b] One student reported starting their research experience in June 2010 and was excluded in the count.
[c] As August was the earliest month that undergraduates could have joined TCAP, the maximum number of months is nine months.

Table 16: Respondents' thoughts on what they want to gain from their research experience.

What do you hope to gain from your research experience?
MSI students
Hands on experience, knowledge and an opportunity to further my education in this area.
I hope to be a more well-rounded scientist. Learning techniques and habits that could be beneficial in any field.
I hope to gain experience needed to prepare for a life in research.
Lab experience.
TCAP students
Experience developing independent research plans and exercising creativity with those plans.
Experience in lab and field research.
I didn't get very much from my research because we did not have enough time
Interest in a new subject matter, learn more about something, get laboratory experience.
Laboratory experience and expert in technical practice, such as PCR.
More experience, better skills interacting with people in a research environment and more knowledge of the science surrounding my chosen field

Table 17: Respondents' participation in research activities.

In your research experience, how often do you do the following?	Not at all often	Somewhat often	Moderately often	Very often
Conduct miscellaneous basic lab duties (e.g. wash glassware, weigh samples, tend to plants, enter data, etc.)				
MSI students	—	—	1/5	4/5
TCAP students	1/7	3/7	2/7	1/7
Total	1/12	3/12	3/12	5/12
Conduct skilled lab work duties (e.g. DNA isolation, PCR, immunoassays, etc.)				
MSI students	—	—	1/5	4/5
TCAP students	1/7	1/7	1/7	4/7
Total	1/12	1/12	2/12	8/12
Work with another undergraduate in learning to do research				
MSI students	—	1/5	—	4/5
TCAP students	6/7	1/7	—	—
Total	6/12	2/12	—	4/12
Work with a graduate student				
MSI students	2/5	2/5	1/5	—
TCAP students	2/7	1/7	—	4/7
Total	4/12	3/12	1/12	4/12
Teach someone else how to performed skilled lab work tasks				
MSI students	1/5	—	1/5	3/5
TCAP students	6/7	1/7	—	—
Total	7/12	1/12	1/12	3/12
Prepare a report with research results				
MSI students	—	2/5	1/5	2/5
TCAP students	6/7	—	1/7	—
Total	6/12	2/12	2/12	2/12
Present at a scientific conference				
MSI students	—	2/5	1/5	2/5
TCAP students	6/7	—	1/7	—
Total	6/12	2/12	2/12	2/12

Table 17: Respondents' participation in TCAP activities *(Continued…)*.

How often do you participate in the following TCAP activities?	Not at all often	Somewhat often	Moderately often	Very often
Present at a student symposium				
MSI students	—	1/5	2/5	2/5
TCAP students	6/7	—	1/7	—
Total	6/12	1/12	3/12	2/12
Be involved in writing a manuscript for publication				
MSI students	1/5	4/5	—	—
TCAP students	5/7	1/7	1/7	—
Total	6/12	5/12	1/12	—

Table 18: MSI respondents' perceptions of collaborators.

To what extent do you feel comfortable approaching the following types of collaborators at the other institution?	Not at all	Somewhat	Moderately	Very
Faculty members	1/4	—	1/4	2/4
Students	—	1/4	2/4	1/4

Table 19: Extent of which MSI respondents have travelled to work with collaborators.

	Yes	No
Have you spent time working with collaborators at their campus?[a]	—	4/4

[a] As none of the MSI students have spent time working at their collaborators' campus, a set of questions about their perceptions of faculty members and students at the other institution was not asked.

Table 20: Respondents' perception of the most liked aspect of their research experience.

What do you like most about your research experience?
MSI students
I have gained a lot of hands on experience.
I like the fact that I know exactly how what I do is important to the overall research.
Learning new techniques.
The project I am currently working on.
TCAP students
I am learning so much!
I like my work with in the lab and learning how to interpret data.
Independence and the excitement of doing something novel.
Learn about the scientific mechanism such as DNA isolation; get to know more people and learn new things.
Nice to be able to actually do research and see what's it's like to be a scientist.
The ability to learn from a faculty mentor as well as a graduate student mentor.

Table 21: Respondents' perceptions on improving their research experience.

What could make your research experience better?
MSI students
Collaborating with other labs.
Collaborating with other universities.
N/A
Working with a new person.
TCAP students
Explore more into different research and get in touch with professor.
I wish I were doing more lab work and data analysis.
I'd like to be exposed to more lab techniques.
Maybe having more time or better time management.
Nothing.

Table 22: Respondents' interest in graduate school.

To what extent are you interested in graduate school?	Not at all interested	A little interested	Somewhat interested	Moderately interested	Extremely interested
MSI students	—	—	1/5	1/5	3/5
TCAP students	—	—	2/8	3/8	3/8
Total	—	—	3/13	4/13	6/13

Table 23: Respondents' perceptions of whether their research experience has impacted their interest in graduate school.

Has your research experience impacted your interest in pursuing graduate school?	Yes	No	I don't know
MSI students	2/4	—	2/4
TCAP students	3/7	2/7	2/7
Total	5/11	2/11	4/11

Table 24: Ways respondents' have been impacted by their research experience to pursue graduate school.

In what ways has your research experience impacted your interest in pursing graduate school?
MSI students
I started my research experience as an undergrad and it made me decide to go to grad school instead of dental school.
My research experience has made me aware of the graduate school route.
TCAP students
I know more that I want to go.
It showed me it was a viable option and that grad school increased my available options

Table 25: Respondents' perception of how their research experience has contributed to their ability to succeed in graduate school.

To what extent has your research experience contributed to your ability to succeed in graduate school?	Not at all	A little	A lot	I don't know
MSI students	—	—	3/4	1/4
TCAP students	—	3/6	1/6	2/6
Total	—	3/10	4/10	3/10

Table 26: MSI respondents' thoughts on attending their collaborators' institution for graduate studies.

	Yes	No	I don't know
Would you consider pursuing graduate studies at the other institution that is collaborating with your on your research project?	3/5	—	2/5

Table 27: Reasons why MSI respondents would attend their collaborator's institution.

Why would you consider pursuing graduate studies at this other institution?
I believe it will be an opportunity to broaden my horizon; furthermore they have the type of program; I am interested in participating in.
I feel as if I could further my knowledge of the research I am currently doing which in return could prepare me for a career.
To get a taste of life at another institution. I have been at my institution for the last 7 years.

Table 28: Respondents' report of the top two barriers to graduate school.

What are the top two barriers that might stop you from going to graduate school?			
MSI students		TCAP students	
First barrier	Second barrier	First barrier	Second barrier
Finances	Finding a career upon completion	Inspiration to study	Tuition fees
Funding	International status	Money	
Money	Time	Money	Class requirements
		Money	Getting a job
		Money	Job offer post undergraduate degree
		Time	Money
		Wanting to travel	Financial

Table 29: Respondents' report of needed supports for graduate school.

What kinds of support would you need if you were to pursue graduate school?
MSI students
Financial.
Graduate assistance. Guarantee that my international status will not affect me.
Grants, Scholarships, Assistantships, Fellowships, Career placement.
Monetary.
TCAP students
A scholarship would be nice it would help out a lot.
Financial support.
I feel like some sort of monetary support would be the most helpful.
Monetary.
None really. It is a decision I need to make.
Scholarship and the recommendation of professor. Also, the interest in study graduate school is important.

Table 30: Respondents' perceptions of a plant breeding career before participating in their research experience.

Before participating in your research experience, what did you think about a career in plant breeding?
MSI students
I actually never thought about a career in plant breeding prior to my research.
I didn't know much about plant breeding before my research.
I liked the idea because of my past experience of how plant bred crops help my country.
Never thought of it.
TCAP students
I had very little Idea about what plant breeding would be like.
I never ever considered it. I thought it would be an awful job.
I wanted a career in plant breeding before this project
I was highly interesting in plant breeding, and thought the TCAP experience would be a great way to learn more about plant breeding.
I was not considering it.
It is a worldwide and multicultural career. Somewhat is boring while the result has to wait for years.

Table 31: Respondents' motivation to pursue a plant breeding career.

To what extent are you motivated to pursue a career in plant breeding?	Not at all motivated	A little motivated	Somewhat motivated	Moderately motivated	Extremely motivated
MSI students	—	1/5	2/5	1/5	1/5
TCAP students	1/8	—	3/8	3/8	1/8
Total	1/13	1/13	5/13	4/13	2/13

Table 32: Respondents' change of perceptions about plant breeding.

Have your perception about plant breeding changed since you started your research experience?	Yes	No	I don't know
MSI students	4/5	1/5	—
TCAP students	6/8	1/8	1/8
Total	10/13	2/13	1/13

Table 33: Ways respondents' perceptions about plant breeding has changed since participating in their research experience.

In what ways did your perceptions of plant breeding change?
MSI students
I can see it as a career now. A career in which I am changing the world.
I didn't know what it was before doing research.
I was very enlightened, I think it is a very good idea
TCAP students
I didn't think breeding was so heavily based in molecular biology techniques.
I got to know what working in plant genetics could be like. What I learned was that it is a dynamic science that it is an adaptable science.
I thought it would be an ethical challenge, but I was confusing transgenics with plant breeding, when they are really two very different things. My perception has changed SO much since I've started working there.
It brings me more in-depth to look at the plant breeding. The mechanism and all take me to another level for the understanding in plant breeding.
Plant breeding is very repetitive in research methods and not as interesting as I previously thought.

Results from the 2012 PI survey

An evaluation of the Triticeae Coordinated Agricultural Project (TCAP)

Results from the 2012 PI survey

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Minneapolis, MN

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Introduction

The Triticeae Coordinated Agricultural Project (TCAP), funded by the United States Department of Agriculture (USDA), is an effort to improve the quality of wheat and barley breeding and increase the number of plant breeders, especially from racially and ethnically diverse backgrounds. TCAP's educational component consists of providing education and research opportunities for graduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field.

To assess TCAP faculty' perceptions about the educational components of the TCAP project, knowledge areas and skill sets in plant breeding they value the most, their collaborative networks and interactions with faculty from MSI and other research institutions, as well as their perceptions of plant breeding education, 54 principal investigators (PIs) funded by the TCAP project were surveyed online in June 2012, with 29 completing the survey, a response rate of 54%.

Methods

The evaluation team worked collaboratively with members of the TCAP educational committee to develop the survey. A survey think-aloud was completed with an undergraduate student the Plant Sciences Department at Montana State University. Both the faculty member and student were not part of TCAP.

Surveys were administered online to undergraduate students in late April to early May 2012. The survey assessed students' mentoring experience, research experience, and interest to pursue graduate studies in plant breeding. Undergraduate students include both those attending TCAP institutions, as well as those attending minority serving institutions (MSIs). Data tables are provided in Appendix A. Results are report separately for TCAP and MSI students, as well as for all students. Due to the low response rate and small sample size, only frequencies are reported.

Demographics of survey respondents

The demographic background of the 29 PIs who participated in this survey is shown in Tables 1-4. The participants included 27 males and 1 female (Table 1). The age of the participants ranged from 30 to 69 years old (Table 2). 3% (1 individual Table 3) was of Hispanic or Latino origin and most identified themselves as White (82%). 15% identified themselves as Asian and one individual (4%) as having mixed race. None of the participants were of American Indian/Alaskan Native, Black/African American or Native Hawaiian/Pacific Islander.

Key findings from the Survey

- When PIs were asked "how important" were 17 components of the education portion of TCAP, their responses appeared to be clustered into one of three groups (Table 5): items with a high percentage (75% and 80%) response rate of "extremely important," items with a medium

percentage (21% - 36%) response rate of "extremely important," and items with a low percentage (less than 15%) response rate of "extremely important." Two items constituted the high percentage group: faculty mentoring of graduate students and research. Majority of PIs reported these two items to be the most important component of the education portions of TCAP (82% and 75%, respectively). Items in the medium percentile group included interactions with plant breeders at other institutions, interactions at the PAG meeting, online course (PBTN network), inquiry-based learning approaches, and teaching/learning tools, among others (Table 5). Items in the low percentile group included graduate student mentoring of undergraduates, skill workshops, developing relationships with faculty from MSI institutions, understanding challenges to recruiting and retaining underrepresented minority groups into plant breeding graduate programs, among others. These groups are shown in Table 5.

- When asked, in an open-ended survey item, "what are the two most important things you see the education component of TCAP accomplishing?" the highest number of PIs (16) suggested training students to be the most important factor (Table 6), while 13 PIs reported creating networking opportunities for students as the second most important thing (Table 6).

- Close to one-half of the PIs identified lack of interest and/or awareness of plant breeding (41%) as the top barrier to increasing the number of underrepresented minorities in plant breeding (Table 7). 15% of the PIs thought underrepresented minorities' perceptions of plant breeding and agriculture was a top barrier to their recruitment, the second highest barrier identified by the PIs.

- When asked about their relationship with minority serving institutions (MSIs), the highest number of PIs (46%) reported their relationship was "not strong at all" while 4% (one individual) reported having "very strong" relationship with the MSIs (Table 8).

- Similarly, 72% of the PIs reported having no collaborations with MSI faculty and 3% (one PI) reported collaborating with MSI faculty a lot.

- As shown in Table 10, lack of funding was identified by about one-quarter of the PIs (22%) as the top barrier to collaborating with MSI faculty while a close 19% identified lack of networking opportunities with MSI faculty as the top barrier. Fewest PIs (1%), on the other hand, indicated lack of resources (e.g., technology, higher teaching load at MSI, etc) as a likely barrier to collaboration with MSI faculty.

- Of the items listed as plant breeding knowledge areas (Table 11), knowledge of genetics and plant breeding strategies were identified as the most valuable (96% and 93%, respectfully), followed closely by experimental design and data management skills (89% and 86%, respectfully). None of the items were rated as not valuable at all while two topics (causes of and resistance to biotic stress and data management skills) were seen as somewhat valuable by the fewest number of PIs (4%).

- In terms of plant breeding skills (Table 14), almost all of the PIs (93%) reported observing and interpreting results as well as problem-solving as the most valuable areas while making

phenotypic selections was seen by the fewest number of PIs (7%) as something valuable. None of the items were rated as "not valuable at all" by the PIs.

- All most all of the PIs (93%) thought one-on-one mentoring to be the most important item of the educational components of TCAP (Table 17) while close to three-quarters (75%) thought experiencing presenting results (in meetings, papers, etc) was extremely important. Collaboration with graduate students from other institutions was viewed as important by the fewest number of PIs (4%, one PI).

- When asked about their collaborative networking with others, close to one-half of the PIs (52-56%) indicated never interacting with researchers from their own institutions or from industry while the most interactions were with their advisees (79% more than once a week) (Table 18). Most of their interactions with their advisees were about trouble shooting research (48%) or collaborating (24%).

Full summary of the survey data is shown in Tables 5 through 19.

TCAP: Frequency Tables for PI Data

July 14, 2012

Table 1: PIs' gender (*N* = 28)

What is your sex?	**n**	**%**
Male	27	97%
Female	1	3%

Table 12: PIs' age (*N* = 28).

What is your age?	**n**	**%**
18 to 29 years old	—	—
30 to 39 years old	2	7%
40 to 49 years old	9	32%
50 to 59 years old	11	39%
60 to 69 years old	6	21%
70 years old or older	—	—

Table 3: PIs' ethnicity (*N* = 28).

Are you of Spanish, Hispanic, or Latino origin?	**n**	**%**
Yes	1	3%
No	27	97%

Table 4: PIs' race (*N* = 27).

Please specify your race:	**n**	**%**
American Indian or Alaskan Native	—	—
Asian	4	15%
Black or African American	—	—
Native Hawaiian or Pacific Islander	—	—
White	22	81%
Mixed race	1	4%

Table 5 : PIs' views of the importance of the TCAP education components (*N* = 28). Data is organized in descending order, with items viewed as "extremely important" in the last column on the top. [Note: **N* = 27; ***N* = 25; MSI = Minority Serving Institutions]

How important are the following components of the education portion of TCAP	**Not important at all 1**		**2**		**3**		**4**		**Extremely Important 5**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	n	**%**
Faculty mentoring of graduate students	—	—	—	—	1	4%	4	14%	23	82%
Research	—	—	—	—	3	11%	4	14%	21	75%
Interaction with plant breeders at other institutions or in the industry	1	4%	—	—	4	14%	13	46%	10	36%
Group interactions at Plant and Animal Genome Meeting (PAG)	1	4%	2	7%	2	7%	14	50%	9	32%
Online course (Plant Breeders Training Network (PBTN))	3	11%	1	4%	5	18%	11	39%	8	29%
Inquiry-based learning approaches**	2	8%	1	4%	3	12%	12	48%	7	28%
Teaching/learning tools*	1	3%	1	3%	3	10%	15	52%	7	26%
TCAP seminar series	1	4%	2	7%	7	26%	10	37%	7	26%
Skills workshops (Canopy spectral reflectance (CSR), Triticeae data base (T3) training, and others)*	1	4%	2	7%	7	24%	11	41%	6	22%
Recruiting more American-born, underrepresented groups to plant breeding programs*	1	4%	4	15%	4	15%	12	44%	6	22%
Increasing the number of plant breeders from culturally diverse backgrounds	1	4%	1	4%	8	29%	12	43%	6	21%
Graduate student mentoring of undergraduates	—	—	3	11%	3	11%	18	64%	4	14%
International travel/workshop (International Maize and Wheat Improvement Center (CYMMIT))	2	7%	1	4%	10	36%	14	50%	1	4%
Participation in National Association of Plant Breedes (NAPB)*	2	7%	3	11%	7	26%	14	52%	1	4%
Plant breeding educational film*	2	7%	3	11%	7	26%	14	52%	1	4%
Collaboration between MSI students and TCAP students	2	7%	3	11%	10	36%	12	43%	1	4%
Relationship development with faculty from MSIs	1	4%	4	14%	11	39%	11	39%	1	4%
Understanding challenges to recruiting and retaining underrepresented groups in pant breeding graduate programs*	2	7%	3	11%	7	26%	14	52%	1	4%

Table 6: Frequency of areas PIs identified as the most important things of the TCAP education component (N = 26)*

What are the two most important things you see the education component of TCAP accomplishing?				
Emerging Themes	**Response One**		**Response Two**	
	n	%	n	%
Training students (mainly graduate student training)	11	42%	6	23%
Creating networking opportunities for students	6	23%	7	28%
Research	3	12%	—	—
Online education (web-based seminars; facilitated collaborative problem-solving)	2	8%	—	—
Public outreach	—	—	2	8%
Student recruitment	1	4%	1	4%
Faculty mentoring	1	4%	1	4%
Increasing cultural diversity	1	4%	—	—
Undergraduate development/exposure to plant breeding	1	4%	3	12%
Training across institutions/external learning resources	—	—	2	8%
Seminars	—	—	1	4%
Contributing to food security	—	—	1	4%
Supporting larger research objectives	—	—	1	4%
Students learning from students	—	—	1	4%

**This item was an open-ended questionnaire with two parts. Themes are from the participant responses*

Table 7: Top two factors PIs identified as barriers to increasing number of underrepresented groups in their field* (data is organized in descending order, with factors elicits highest number of responses on the top)

What are the top two barriers you see to increasing the numbers of underrepresented groups in the plant breeding field?				
Emerging Themes	**Response One (*N* = 27)**		**Response Two (*N*= 25)**	
	n	%	n	%
lack of interest/awareness	11	41%	11	44%
No qualified candidates/Quality of students	2	7%	3	12%
Perception of plant breeding and agriculture	4	15%	—	—
Barriers due to location	2	7%	2	8%
The low number of underrepresented groups in plant breeding	1	4%	3	12%
Funding, Salary	2	7%	—	—
Lack of Jobs in the field/Drawn to other fields	—	—	3	12%
network with MSI not well established	1	4%	1	4%
Transition from high school to college	1	4%	—	—
Expectations (high expectation for marginal performance)	—	—	1	4%

**This item was an open-ended questionnaire with two parts. Themes are from the participant responses.*

Table 8: Strength of TCAP PIs relationships with MSI institutions (*N* = 28)
(5-item scale, with 1 = 'Not strong at all' and '5 = Very strong')

	Not strong at all 1		**2**		**3**		**4**		**Very strong 5**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	n	**%**
How strong did you feel your relationships are with minority serving institutions (MSIs)?	13	46%	7	25%	4	14%	3	11%	1	4%

Table 9: PIs' collaboration with non-TCAP MSI faculty (*N* = 29; *scale: 1 = Not at all, 2 = Sometimes, 3 = A lot)*

	Not at all		**Somewhat**		**A lot**	
	n	**%**	**n**	**%**	**n**	**%**
How often do you collaborate, i.e. work on a research project, with faculty of MSIs not involved in TCAP?	21	72%	7	24%	1	3%

Table 10
Top two barriers to collaborating on research projects with MSI faculty as identified by TCAP faculty*

What do you believe are the two most important barriers to collaborating on research projects with faculty of MSIs?				
Emerging Themes	**Response One (*N* = 27)**		**Response Two (*N*= 24)**	
	n	%	n	%
Lack of mutual goals/fit	4	15%	10	42%
Lack of funding	6	22%	3	13%
Lack of MSI faculty interest	2	7%	4	11%
Lack of communication with MSI faculty and institutions	4	15%	1	4%
Lack of networking opportunities with MSI faculty	5	19%	—	—
Time, mechanism, logistics	3	11%	2	8%
Lack of resources, research time, and technology at MSI institutions (e.g., higher teaching load in MSI institutions)	1	4%	2	8%
Barriers due to location (e.g. distant location)	—	—	3	13%
Lack of information about MSI faculty doing agricultural research (not knowing individual MSI faculty)	1	4%	—	—
Others (e.g., low reward for working with TCAP faculty, low expertise, lack of facilities)	1	4%	3	13%

Table 11: PIs' views of the value of certain knowledge areas (*N* = 28; scale: *1 = Not at all, 2 = Somewhat, 3 = Moderately, 4 = Very*).

How valuable are the following knowledge areas for a graduating MS or PhD student in plant breeding?	**Not at all**		**Somewhat**		**Moderately**		**Very**	
	n	**%**	**N**	**%**	**n**	**%**	**n**	**%**
Genetics (mendelian, quantitative, population and molecular)	—	—	—	—	1	4%	27	96%
Plant breeding strategies (e.g. traditional, molecular, physiological)	—	—	—	—	2	7%	26	93%
Experimental design	—	—	—	—	3	11%	25	89%
Data management (collection, analysis, database)	—	—	1	4%	3	11%	24	86%
Selection theory and techniques	—	—	—	—	6	21%	22	79%
Methods for breeding in selfing and outcrossing systems	—	—	—	—	9	32%	19	68%
Factors in crop plants that impact productivity	—	—	2	7%	11	39%	15	54%
Causes of and resistance to biotic stress	—	—	1	4%	16	57%	11	39%
Causes of and resistance to abiotic stress	—	—	2	7%	18	64%	8	29%
Teaching strategies (Inquiry-based learning approaches)	—	—	7	25%	16	57%	5	18%

Table 12: Emerging themes from PIs' views of knowledge areas considered to be valuable (*N* = 11).

Are there any other knowledge areas that you think are valuable for graduating MS or PhD students in plant breeding?	**n**	**%**
Statistical analysis	3	27%
Bioinformatics	2	18%
Resources Allocation	2	18%
Leadership skills	1	9%
Field training, practical knowledge	1	9%

Table 13: PIs' ranking of the most valuable knowledge areas.

What are the three most valuable knowledge areas for a graduating MS or PhD student in plant breeding?	#1 Rank (N = 28)		#2 Rank (N = 28)		#3 Rank (N = 28)	
	n	%	n	%	n	%
Plant breeding strategies (e.g. traditional, molecular, physiological)	10	36%	10	36%	4	14%
Data management (collection, analysis, database)	5	18%	5	18%	5	18%
Genetics (Mendelian, quantitative, population and molecular)	1	4%	8	29%	3	11%
Experimental design	5	18%	1	4%	2	7%
Methods for breeding in selfing and outcrossing systems	—	—	2	7%	5	18%
Causes of and resistance to biotic stress	5	18%	—	—	1	4%
Selection theory and techniques	1	4%	1	4%	4	14%
Factors in crop plants that impact productivity	—	—	1	4%	4	14%
Causes of and resistance to abiotic stress	1	4%	—	—	—	—
Teaching strategies (Inquiry-based learning approaches)	—	—	—	—	—	—
Other	—	—	—	—	—	—

Table 14: PIs' views of the value of skill sets in plant breeding (*N* = 28; scale: *1 = Not at all, 2 = Somewhat, 3 = Moderately, 4 = Very*).

How valuable are the following skills for a graduating MS or PhD student in plant breeding?	Not at all		Somewhat		Moderately		Very	
	n	%	N	%	n	%	n	%
Define and solve problems	—	—	—	—	2	7%	26	93%
Observe and interpret results	—	—	—	—	2	7%	26	93%
Make genome wide selections	—	—	—	—	4	14%	24	86%
Work cooperatively	—	—	3	11%	2	7%	23	82%
Design experiments	—	—	—	—	5	18%	23	82%
Manage data	—	—	—	—	5	18%	23	82%
Communicate your scientific ideas	—	—	—	—	5	18%	23	82%
Networking skills	—	—	1	4%	7	25%	20	71%
Resource Management skills	—	—	2	7%	6	21%	20	71%
Statistical analysis	—	—	—	—	9	32%	19	67%
Choose parents and make crosses	—	—	—	—	10	36%	18	64%
Consider alternative hypotheses	—	—	—	—	12	43%	16	57%
Make phenotypic selections	—	—	2	7%	11	39%	15	54%
single nucleotide polymorphisms (SNPs) or genotype by sequencing (GBS)	—	—	—	—	16	57%	12	43%
Identify new alleles to use for improvement	—	—	3	11%	15	54%	10	36%
Molecular techniques	—	—	4	14%	16	57%	8	29%
Make marker assisted selections	—	—	4	14%	16	57%	8	29%

Table 15 : Emerging themes from PIs' commentary on valuable knowledge areas (*N* = 4).

Are there any other knowledge areas that you think are valuable for graduating MS or PhD students in plant breeding?	**n**	**%***
Mechanical reasoning/physical health	1	—
Mechanical skills/grant writing/physical skills	1	—
Technology transfer	1	—
Synthesis and application of all knowledge and skills required for critical thinking/hands on learning experiences	1	—

*Because of the small *N*, percentages were not calculated.

Table 16: PIs' ranking of the three most valuable skill sets in plant breeding (*N* = 28).

What are the three most valuable skills for a graduating MS or PhD student in plant breeding?	**#1 Rank**		**#2 Rank**		**#3 Rank**	
	n	**%**	**n**	**%**	**n**	**%**
Define and solve problems	9	31%	1	4%	2	7%
Design experiments	5	18%	4	14%	2	7%
Observe and interpret results	2	7%	3	11%	5	18%
Choose parents and make crosses	3	11%	4	14%	1	4%
Manage data	2	7%	4	14%	1	4%
Make phenotypic selections	—	—	3	11%	4	14%
Work cooperatively	3	11%	2	7%	1	4%
Statistical analysis	1	4%	1	4%	5	18%
Communicate your scientific ideas	—	—	4	14%	2	7%
Resource management skills	1	4%	1	4%	1	4%
Leadership skills	1	4%	1	4%	1	4%
Molecular techniques	1	4%	—	—	—	—
Networking Skills	—	—	—	—	1	4%
Utilize single nucleotide polymorphisms (SNPs) or genotype by sequencing (GBS)	—	—	—	—	1	4%
Make genome wide selections	—	—	—	—	1	4%
Other	—	—	—	—	—	—

Table 17: PIs' views of the importance of the TCAP education components (*N* = 28).

How important do you believe the following are in the process of educating graduate students	**Not important at all 1**		**2**		**3**		**4**		**Extremely Important 5**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	n	**%**
One-on-one mentoring	—	—	—	—	—	—	2	7%	26	93%
Experience presenting results (meetings, papers)	—	—	—	—	—	—	7	25%	21	75%
Field experience	—	—	—	—	1	4%	7	25%	20	71%
Independent development of research designs	—	—	—	—	2	7%	13	46%	13	46%
Exposure to diverse research methods and tools	—	—	1	4%	1	4%	13	46%	13	46%
Collaboration with other graduate students in this institution (in this lab or other labs)	—	—	1	4%	2	5%7	13	46%	12	43%
Independent development of hypotheses	—	—	—	—	3	11%	13	46%	12	43%
Laboratory experience	—	—	—	—	4	14%	12	43%	12	43%
Collaboration with faculty other than the advisor	—	—	—	—	3	11%	17	61%	8	29%
Experience writing grants	—	—	—	—	2	7%	18	64%	8	29%
Exposure to plant breeding students from different ethnic backgrounds*	—	—	1	4%	10	37%	13	48%	3	11%
Collaboration with graduate students from OTHER institutions	1	4%	2	7%	9	31%	14	50%	2	7%
Teaching experience	—	—	2	7%	8	29%	16	57%	2	7%

**N = 27*

Table 18: PIs' collaborative networking with others

How often have you interacted with the following types of people?	N	Never		Once a year or less		Once every three months		Once a month or less		Once a week or less		More than once a week	
		n	%	n	%	n	%	n	%	n	%	n	%
My advisee/s	28	1	4%	—	—	—	—	—	—	5	18%	22	79%
Other researchers at U.S. institutions (not TCAP or MSI researchers)	28	—	—	—	—	2	7%	3	11%	2	7%	21	75%
Other students at my institution	29	—	—	2	7%	5	17%	10	35%	4	14%	8	28%
Other researchers outside of the U.S.	28	—	—	1	4%	6	21%	9	32%	7	25%	5	18%
TCAP students from other institutions	29	—	—	4	14%	7	24%	6	21%	9	31%	3	10%
Students from minority serving institutions (MSIs)	29	1	3%	4	14%	10	35%	10	35%	2	7%	2	7%
Researchers at my institution	27	15	56%	7	24%	2	7%	2	7%	—	—	1	4%
TCAP researchers at other institutions	27	4	15%	9	33%	6	21%	3	11%	4	15%	1	4%
Researchers at MSIs	27	3	11%	8	30%	8	30%	4	15%	3	11%	1	4%
Researchers from businesses and/or private companies	29	15	52%	6	21%	3	10%	3	10%	1	3%	1	3%
Non-TCAP students from non-MSIs in the U.S.	21	1	5%	—	—	3	14%	8	38%	9	43%	—	—
Non-TCAP students from institutions outside the U.S.	29	7	24%	8	28%	7	24%	7	24%	—	—	—	—

Table 19: Topics of interaction between PIs and others.

What the most prevalent topic of your interaction was about?	*N*	Class assignments/Classes in general		Trouble shooting research		Collaborations		Social		Mentoring/ Being mentored		Interpreting research results		Theory of genetics or breeding		Job prospects & professional networking		Other	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Other students at my institution	26	—	—	—	—	22	85%	1	4%	2	8%	1	4%	—	—	—	—	—	—
Other researchers outside of the U.S.	26	—	—	1	4%	21	81%	1	4%	—	—	3	12%	—	—	—	—	—	—
Other researchers at U.S. institutions (not TCAP or MSI researchers)	26	—	—	2	6%	24	71%	1	3%	—	—	2	6%	2	6%	1	3%	2	6%
Non-TCAP students from non-MSIs in the U.S.	26	4	15%	2	8%	7	27%	1	4%	3	12%	2	8%	4	15%	1	4%	2	8%
My advisee/s	25	—	—	12	48%	6	24%	—	—	3	12%	4	16%	—	—	—	—	—	—
TCAP students from other institutions	24	—	—	1	4%	19	79%	—	—	—	—	1	4%	1	4%	—	—	2	8%
Students from minority serving institutions (MSIs)	24	—	—	—	—	16	67%	2	8%	—	—	2	8%	—	—	2	8%	2	8%
Researchers at MSIs	21	—	—	4	19%	12	57%	—	—	2	10%	—	—	1	5%	2	10%	—	—
TCAP researchers at other institutions	20	—	—	4	20%	8	40%	—	—	1	5%	2	10%	2	10%	1	5%	2	10%
Researchers at my institution	19	—	—	—	—	4	40%	—	—	1	10%	2	20%	—	—	2	20%	1	10%
Non-TCAP students from institutions outside the U.S.	18	—	—	2	11%	7	39%	—	—	—	—	4	22%	3	17%	1	6%	1	6%
Researchers from businesses and/or private companies	13	—	—	—	—	8	62%	1	8%	—	—	1	8%	—	—	1	8%	2	15%

Results from the 2012 MSI PI survey

An evaluation of the Triticeae Coordinated Agricultural Project (TCAP)

Results from the 2012 MSI PI survey

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Introduction

The Triticeae Coordinated Agricultural Project (TCAP), funded by the United States Department of Agriculture (USDA), is an effort to improve the quality of wheat and barley breeding and increase the number of plant breeders, especially from racially and ethnically diverse backgrounds. TCAP's educational component consists of providing education and research opportunities for graduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field.

An evaluation with multiple components is being conducted to assess the progress of TCAP. One of the evaluation components is a yearly survey to assess the perceptions of plant breeding education, perceptions of TCAP programming, and collaborative relationships and networks over time of principal investigators from minority serving institution partners (MSI PIs). This report provides a summary of survey results from the second year of programming.

Methods

The evaluation team worked collaboratively with members of the TCAP educational committee to make revisions to the baseline survey. The 2012 TCAP MSI PI Survey was administered online to in early June. The survey assessed perceptions of MSI and TCAP PI relationships, barriers to recruiting underrepresented students into plant breeding, plant breeding education for graduate students, the TCAP educational programming, and collaborative networks with other students, faculty, and researchers within and outside of the TCAP. Results for items with the highest and lowest ratings are highlighted in the "Key findings" section, while results are summarized more generally in the "Issues to consider" section.

Respondents' demographics

There are a total of eight MSI PIs within TCAP, including four males and four females (Table 1). Six MSI PIs reported being between 40 to 59 years old (Table 2). None of the eight MSI PIs reported being of Hispanic or Latino origin (Table 3). Half of the MSI PIs identified as Asian (4 of 8), while the other half of the MSI PIs (4 of 8) identified as Black or African American (Table 4). Of these eight PIs, six PIs completed this year's survey. Demographics for these six PIs are not reported to ensure the confidentiality of their responses.

Key findings

Summarized by Mao Thao, BS, BA

Results should be interpreted with caution as the sample size is very small. Additionally, there were many items with missing data. It is unclear why respondents skipped some items, but it appears that respondents did go through the entire survey. The following are key findings from the MSI PI survey. Percentages are not reported due to the small number of MSI PIs.

- On a 5-point rating scale, with one being "not important at all" and 5 being "extremely important", 5/5 MSI PIs rated four items as "extremely important" educational components of TCAP including research, relationship development with faculty from TCAP institutions, increasing the number of plant breeders from culturally diverse backgrounds, and understanding challenges. No items were rated lower than a rating of five (Table 5).
- MSI PIs generally felt that the most important things TCAP can accomplish was attracting and increasing more students to pursue plant breeding. A couple respondents also felt it was important to get students involved with research (Table 6).
- MSI PIs felt that the lack of interest, knowledge, and exposure of plant breeding were key barriers to increasing the number of underrepresented groups in plant breeding. Funding was also mentioned as a barrier (Table 7).
- All six MSI PIs felt their relationships with TCAP institutions were "very strong" (Table 8). Half of the MSI PIs (3/6) reported that they collaborate with TCAP faculty "a lot" (Table 9).
- Funding was cited as a key barrier to collaborative research with faculty from TCAP institutions by four of the six MSI PIs. Other cited barriers include difference in research interests and time and distance constraints (Table 10).
- While MSI PIs may not have graduate students, the survey asked them about their opinions on educating students in graduate plant breeding programs.
    - Overall, all six MSI PIs felt the 10 knowledge areas listed were at least "moderately" valuable, with the exception of teaching strategies that received a rating of "somewhat" valuable by one respondent. Plant breeding strategies was the one item that received a "very" valuable rating by all respondents (Table 11). A couple MSI PIs also cited grant writing techniques and the integration of breeding in biotechnology as other valuable knowledge areas for plant breeding graduate students (Table 12). Half of the MSI PIs (n = 3) ranked plant breeding strategies as the most valuable knowledge area for a graduate student, while the other half of the MSI PIs (n = 3) ranked data management as the most valuable knowledge area (Table 13).
    - Of the 19 plant breeding skills listed, all six MSI PIs felt designing experiments and observing and interpreting results were the "very" valuable skills for graduate students in plant breeding. All other items received ratings of at least "moderately" valuable (Table 14). Designing experiments was ranked as the top most valuable skill for a graduate student by two of six MSI PIs, as well as defining and solving problems that was also ranked as the most valuable skill by two other MSI PIs (Table 16).
    - One-on-one mentoring and exposure to diverse research methods and tools were rated as "extremely important" educational components by all six MSI PIs out of 13 listed

processes. All other educational components did not receive lower ratings than "extremely important;" however, not all of the MSI PIs responded to each item (Table 17).

- MSI PIs most frequently interacted with their advisee/s, other students at their institution, and other researchers at their institution (Table 18). Interactions with researchers at their institutions typically focused on collaborations, while interactions with their advisee and other students revolved around various topics, including collaborations, interpreting research results, class assignments/classes in general, trouble shooting research, and mentoring (Table 19).

Issues to consider

The following are some issues for consideration based on the survey results:

- As many MSI PIs skipped some items, it is difficult to interpret perceptions. For future surveys, it should be considered whether it is relevant to ask about the value of plant breeding knowledge and skills for graduate students, especially if some MSI PIs do not have graduate students.
- MSI PIs seem to highly value research, as well as their relationships and collaborations with TCAP institutions. The TCAP should continue to find ways to offer collaborative research and networking opportunities, as well as funding for MSI and TCAP faculty to continue to work together.
- MSI PIs also highly value increasing the number of plant breeders of diverse backgrounds; however, many cited that lack of knowledge about plant breeding was a barrier. The TCAP should consider and develop strategies for all PIs to work together in promoting and increasing awareness of the opportunities plant breeding has to offer among undergraduate students.
- Few MSI PIs appear to frequently interact with students from TCAP institutions. The TCAP should consider whether this is a priority of the project and develop strategies for providing opportunities for MSI PIs and TCAP students to interact and network.

Table 1: MSI PIs' gender.

What is your sex?	n/N
Male	4/8
Female	4/8

[a] Percentages are not reported given the low number of respondents (N's).

Table 2: MSI PIs' age.

What is your age?	n/N
18 to 29 years old	—
30 to 39 years old	—
40 to 49 years old	3
50 to 59 years old	3
60 to 69 years old	—
70 years old or older	—

[a] Percentages are not reported given the low number of respondents (N's).

Table 3: MSI PIs' ethnicity.

Are you of Spanish, Hispanic, or Latino origin?	n/N
Yes	—
No	8

[a] Percentages are not reported given the low number of respondents (N's).

Table 4: MSI PIs' race.

Please specify your race:	n/N
American Indian or Alaskan Native	—
Asian	4
Black or African American	4
Native Hawaiian or Pacific Islander	—
White	—
Mixed race	—

[a] Percentages are not reported given the low number of respondents (N's).

Table 5: Respondents' perceptions of the importance of TCAP educational components.

How important are the following components of the education portion of TCAP?	Not important at all 1	2	3	4	Extremely Important 5
Research	—	—	—	—	5/5
Relationship development with faculty from TCAP institutions	—	—	—	—	5/5
Increasing the number of plant breeders from culturally diverse backgrounds	—	—	—	—	5/5
Understanding challenges to recruiting and retaining underrepresented groups in pant breeding graduate programs	—	—	—	—	5/5
Teaching/learning tools	—	—	—	—	4/4
Interaction with plant breeders at other institutions or in the industry	—	—	—	—	4/4
TCAP seminar series	—	—	—	—	4/4
Faculty mentoring of graduate students	—	—	—	—	3/3
Inquiry-based learning approaches	—	—	—	—	3/3
Collaboration between MSI students and TCAP students	—	—	—	—	3/3
Recruiting more American-born, underrepresented groups to plant breeding programs	—	—	—	—	3/3
Online course (Plant Breeders Training Network (PBTN))	—	—	—	—	2/2
Group interactions at Plant and Animal Genome Meeting (PAG)	—	—	—	—	2/2
Participation in National Association of Plant Breeders (NAPB)	—	—	—	—	2/2
Skills workshops (Canopy spectral reflectance (CSR), Triticeae data base (T3) training, and others)	—	—	—	—	1/1
Graduate student mentoring of undergraduates	—	—	—	—	1/1
International travel/workshop (International Maize and Wheat Improvement Center (CYMMIT))	—	—	—	—	1/1
Plant breeding educational film	—	—	—	—	1/1

Table 6: The top two areas respondents identified as the most important things TCAP can accomplish.

What are the two most important things you see the education component of TCAP accomplishing?	
First response	**Second response**
Attract more students to plant breeding	Expose plant breeding as a viable (if not better) career option
Awareness	Involving MSI
Expose more MSI Students to Plant Breeding	Bring Plant Breeding in the forefront of the cyber era
New Research Methods	Learning/Education
Recruiting more American-born, underrepresented groups to plant breeding programs	Relationship development with faculty from TCAP institutions
Student involves with research	Collaboration among programs

Table 7: The top two barriers to increasing the number of underrepresented groups in the plant breeding field.

What are the top two barriers you see to increasing the numbers of underrepresented groups in the plant breeding field?	
First response	**Second response**
Funding	What student want
Historical issues	Lack of Knowledge about agriculture
Ignorance and plant breeding not being considered a viable career option	Lack of exposure to the field
Increasing MSI participation	Increasing MSI funding
Most students preferred to work on medical field after graduate since the salary is higher and more respect by public is received	Some HBCU school has no plant breeding major
Need more scholarship	Awareness

Table 8: Respondents' perceptions of the strength of their relationship with TCAP institutions.

	Not strong at all 1	**2**	**3**	**4**	**Very strong 5**
How strong do you feel your relationships are with TCAP institutions?	—	—	—	—	6/6

Table 9: Respondents' collaboration with TCAP PIs.

	Not at all	**Somewhat**	**A lot**
How often do you collaborate, i.e. work on a research project, with faculty from TCAP institutions?	1/6	2/6	3/6

Table 10: The top two barriers to collaborating on research projects with TCAP.

What do you believe are the two most important barriers to collaborating on research faculty from TCAP institutions?	
First response	**Second response**
Communication	Funding
Faculty at Liberal art school have heavy teaching load and don't have enough time to concentrate on research.	Faculty at Liberal art school especial small colleges don't have enough facility to support faculty research on plant breeding.
Funding	Finding an intersect of research interests/priorities
Funding	Funding
Funding	Human Resources
Proximity	Time

Table 11: Respondents' perceptions of the value of plant breeding knowledge areas.

How valuable are the following knowledge areas for a graduating MS or PhD student in plant breeding?	Not at all 1	Somewhat 2	Moderately 3	Very 4
Plant breeding strategies (e.g. traditional, molecular, physiological)	—	—	—	6/6
Data management (collection, analysis, database)	—	—	1/6	5/6
Causes of and resistance to biotic stress	—	—	1/6	5/6
Genetics (mendelian, quantitative, population and molecular)	—	—	1/6	5/6
Selection theory and techniques	—	—	1/6	5/6
Factors in crop plants that impact productivity	—	—	1/6	5/6
Methods for breeding in selfing and outcrossing systems	—	—	2/6	4/6
Experimental design	—	—	1/5	4/5
Causes of and resistance to abiotic stress	—	—	3/6	3/6
Teaching strategies (Inquiry-based learning approaches)	—	1/6	2/6	3/6

Table 12: Other valuable plant breeding knowledge areas.

Are there any other knowledge area that you think are valuable for graduating MS or PhD students in plant breeding?
Grant writing techniques
No
Yes, especially the integration of breeding in biotechnology

Table 13: Respondents' ranking of the most valuable plant breeding knowledge areas.

What are the three most valuable knowledge areas for a graduating MS or PhD student in plant breeding?	#1 Rank	#2 Rank	#3 Rank
Plant breeding strategies (e.g. traditional, molecular, physiological)	3/6	1/6	—
Experimental design	3/6	—	—
Data management (collection, analysis, database)	—	2/6	1/6
Genetics (mendelian, quantitative, population and molecular)	—	1/6	3/6
Causes of and resistance to biotic stress	—	1/6	—
Factors in crop plants that impact productivity	—	1/6	—
Selection theory and techniques	—	—	1/6
Teaching strategies (Inquiry-based learning approaches)	—	—	1/6
Causes of and resistance to abiotic stress	—	—	—
Methods for breeding in selfing and outcrossing systems	—	—	—
Other	—	—	—

Table 14: Respondents' perceptions of the value of plant breeding skills.

How valuable are the following skills for a graduating MS or PhD student in plant breeding?	Not at all 1	Somewhat 2	Moderately 3	Very 4
Design experiments	—	—	—	6/6
Observe and interpret results	—	—	—	6/6
Work cooperatively	—	—	1/6	5/6
Define and solve problems	—	—	1/6	5/6
Communicate your scientific ideas	—	—	1/6	5/6
Statistical analysis	—	—	1/6	5/6
Choose parents and make crosses	—	—	1/6	5/6
Manage data	—	—	2/6	4/6
Identify new alleles to use for improvement	—	—	2/6	4/6
Make genome wide selections	—	—	2/6	4/6
Mentoring skills	—	—	2/6	4/6
Make phenotypic selections	—	—	3/6	3/6
Networking skills	—	—	3/6	3/6
Molecular techniques	—	—	4/6	2/6
Make marker assisted selections	—	—	4/6	2/6
Resource management skills	—	—	4/6	2/6
Consider alternative hypotheses	—	—	5/6	1/6
Utilize single nucleotide polymorphisms (SNPs) or genotype by sequencing (GBS)	—	—	5/6	1/6
Leadership skills	—	—	5/6	1/6

Table 15: Other valuable plant breeding skills.

Are there any other plant breeding skills that you feel are valuable for graduating MS or PhD students in plant breeding?
Yes, use DNA array and protein array to identify new genes

Table 16: Respondents' ranking of the most valuable plant breeding skills.

What are the three most valuable skills for a graduating MS or PhD student in plant breeding?	#1 Rank	#2 Rank	#3 Rank
Design experiments	2/6	—	1/6
Define and solve problems	2/6	—	—
Statistical analysis	1/6	—	1/6
Work cooperatively	1/6	—	—
Observe and interpret results	—	1/6	1/6
Make marker assisted selections	—	1/6	1/6
Communicate your scientific ideas	—	1/6	—
Identify new alleles to use for improvement	—	1/6	—
Make phenotypic selections	—	1/6	—
Networking skills	—	1/6	—
Make genome wide selections	—	—	1/6
Leadership skills	—	—	1/6
Manage data	—	—	—
Consider alternative hypotheses	—	—	—
Molecular techniques	—	—	—
Utilize single nucleotide polymorphisms (SNPs) or genotype by sequencing (GBS)	—	—	—
Choose parents and make crosses	—	—	—
Mentoring skills	—	—	—
Resource management skills	—	—	—
Other	—	—	—

Table 17: Respondents' perceptions of the importance of plant breeding educational processes.

How important do you believe the following are in the process of educating graduate students?	Not important at all 1	2	3	4	Extremely Important 5
One-on-one mentoring	—	—	—	—	6/6
Exposure to diverse research methods and tools	—	—	—	—	6/6
Laboratory experience	—	—	—	—	5/5
Experience presenting results (meetings, papers)	—	—	—	—	5/5
Independent development of research designs	—	—	—	—	4/4
Field experience	—	—	—	—	4/4
Teaching experience	—	—	—	—	3/3
Independent development of hypotheses	—	—	—	—	3/3
Exposure to plant breeding students from different ethnic backgrounds	—	—	—	—	3/3
Experience writing grants	—	—	—	—	2/2
Collaboration with faculty other than the advisor	—	—	—	—	1/1
Collaboration with other graduate students in this institution (in this lab or other labs)	—	—	—	—	1/1
Collaboration with graduate students from OTHER institutions	—	—	—	—	1/1

Table 18: Respondents' collaborative networking with others.

How often have you interacted with the following types of people?	Never	Once a year or less	Once every three months	Once a month or less	Once a week or less	More than once a week
My advisee/s	—	—	—	—	2/5	3/5
Other students at my institution	—	—	—	1/5	2/5	2/5
Students from TCAP institutions	1/3	1/3	—	1/3	—	—
Students from other minority serving institutions (MSIs)	1/4	2/4	—	1/4	—	—
Non TCAP and non MSI students in the U.S.	—	1/4	1/4	—	1/4	1/4
Non TCAP and non MSI students from institutions outside the U.S.	2/4	1/4	—	1/4	—	—
Researchers at my institution	—	—	1/5	1/5	2/5	1/5
Researchers at TCAP institutions	—	—	2/6	2/6	2/6	—
Researchers at other MSIs	—	2/3		1/3	—	—
Other researchers at U.S. institutions (not TCAP or MSI researchers)	—	1/4	1/4	2/4	—	—
Other researchers outside of the U.S.	—	3/3	—	—	—	—
Researchers from businesses and/or private companies	1/3	1/3	1/3	—	—	—

Table 19: Topics of interaction between respondents and others.

What the most prevalent topic of your interaction was about?	Class assignments/ Classes in general	Trouble shooting research	Collaborations	Social	Mentoring/ Being mentored	Interpreting research results	Theory of genetics or breeding	Job prospects & professional networking	Other
My advisee/s	–	1/5	1/5	–	1/5	2/5	–	–	–
Other students at my institution	1/5	1/5	2/5	–	1/5	–	–	–	–
Students from TCAP institutions	–	–	2/2	–		–	–	–	–
Students from other minority serving institutions (MSIs)	–	–	1/3	–	1/3	–	–	–	1/3
Non TCAP and non MSI students in the U.S.	1/3	–		–	1/3	–	–	–	1/3
Non TCAP and non MSI students from institutions outside the U.S.	–	–	1/2	–	1/2	–	–	–	–
Researchers at my institution	–	–	4/5	–	–	–	–	–	1/5
Researchers at TCAP institutions	–	–	6/6	–	–	–	–	–	–
Researchers at other MSIs	–	–	1/2	1/2	–	–	–	–	–
Other researchers at U.S. institutions (not TCAP or MSI researchers)	–	1/4	1/4	–	–	2/4	–	–	–
Other researchers outside of the U.S.	–	1/3	1/3	–	–	1/3	–	–	–
Researchers from businesses and/or private companies	–	–	1/2	1/2	–	–	–	–	–

Comparisons of the graduate student, TCAP PI, and MSI PI survey results by year

An evaluation of the Triticeae Coordinated Agricultural Project (TCAP)

Comparisons of the graduate student, TCAP PI, and MSI PI survey results by year

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Introduction

The Triticeae Coordinated Agricultural Project (TCAP), funded by the United States Department of Agriculture (USDA), is an effort to improve the quality of wheat and barley breeding and increase the number of plant breeders, especially from racially and ethnically diverse backgrounds. TCAP's educational component consists of providing education and research opportunities for graduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field.

An evaluation with multiple components is being conducted to assess the progress of TCAP. One of the evaluation components is a yearly survey to assess graduate students' perceptions of plant breeding education, perceptions of TCAP programming, and collaborative relationships and networks over time. This report provides a comparison of the separate graduate student survey, MSI PI survey, and TCAP PI survey by year.

Methods

The evaluation team worked collaboratively with members of the TCAP educational committee to develop three surveys in 2011: the graduate student survey, the TCAP PI survey, and the MSI PI survey. They also worked collaboratively to revise all three surveys in 2012. The surveys were administered online assessed perceptions of plant breeding education, interest and motivation in the plant breeding field, perceptions of the TCAP educational programming, and collaborative networks with other students, faculty, and researchers within and outside of the TCAP.

Given the small sample sizes of graduate students, crosstabs by year with chi-square significance testing was completed, but it should be interpreted with caution. Items that resulted in statistically significant differences are reported; however, some cells in the crosstabs have low counts. Matched analyses or more advanced statistical analyses were not completed given the number of students who completed the survey in both 2011 and 2012 (n = 8). A total of 123 chi-square tests were run, including chi-square tests of the five demographics by year and 118 survey items by year. However, with such small samples, it is important to note that the chi-square tests are not reliable.

No significance testing between years was completed for the MSI PI survey results due to the small number of MSI PIs involved in the TCAP; however, some large differences between years are highlighted. Additionally, demographics between years are not reported as it may breach confidentiality of responses and identify non-respondents.

Analyses for TCAP PI survey results

Similar to the graduate student survey comparison analysis, crosstabs by year with chi-square significance testing was completed for the TCAP PI data. Percentile changes in 2012 vs. 2011 is reported in Table 4 - 8, along with chi-square and p-values.

There were 29 respondents for the 2012 survey and 42 respondents for the 2011. Demographic analysis suggested there were no statistical differences between the respondents in 2011 and 2012 (Table 4, $p > 0.05$ on all the demographic items listed). However, given the differences between the

number of participants in each year, we were concerned about the possibility of response bias in the survey data. In order to avoid response bias, we analyzed only responses from the same participants (matched analysis). 4 of the 29 respondents in 2012 were new PIs who did not participate in the 2011 survey. As such, their responses were not included in the comparison analysis. These resulted 25 "matched sample" for both years. The PIs in the matched sample were mainly male (96%), of not Hispanic origin (91%), and mainly white (77-78%). PIs of Asian background roughly made up 20% of the sample.

Comparison of the graduate student survey results by year

Summarized by Mao Thao, BS, BA

There were not any significant differences in demographics by year among graduate students. However, students completing this year's survey seemed to be more diverse in terms of race and citizenship. This year, there were more students who identified as Asian – 8/13 (62%) compared to 2/10 (20%) of students from last year. Additionally, there were more students who reported not having U.S. citizenship than last year – 9/15 (65%) compared to 3/12 (25%) respectively (Table 1).

The following items resulted in significant differences between years (Table 2):

- More students in 2012 reported participating in problem solving than students in 2011, 96% compared to 67% respectively.
- Students in 2012 reported communicating more frequently with students at and outside of their institution than students in 2011. However, students in 2011 reported more frequent interaction with students from MSIs, researchers outside of the U.S., and from businesses and/or private companies.

Comparisons of the MSI PI survey results by year

Summarized by Mao Thao, BS, BA

- After about a year and half into the program, MSI PIs have strengthened their relationship with TCAP institutions. At the baseline survey, only one of eight MSI PIs felt their relationship with TCAP institutions were "very strong", while in this year's survey all six MSI PIs who completed the survey reported similarly.
- Perceptions on the value of plant breeding skills may have decreased slightly. Six of seven MSI PIs felt making marker assisted selections was "very" valuable at baseline, while only two of six felt the item was "very" valuable this year. Additionally, more MSI PIs (3/7) felt utilizing single nucleotide polymorphisms or genotype by sequencing was "very" valuable at baseline, while in this year's survey – only one of six reported similarly.
- MSI PI increased their interaction with other students at their institution. This year, four of five PIs reported interacting with other students at their institution either "Once a week or less" or "More than once a week". In 2011, only one of seven MSI PIs reported the same.

Comparisons of the TCAP PI survey results by year

Summarized by Abdi Warfa, MS, PhD Candidate

The PI survey yearly comparison is divided into subsections that pertain to specific areas. The highlights of the comparison follows

Comparison of TCAP PIs' views of the importance of the TCAP education components

One of the survey items in years 2011 and 2012 solicited TCAP PI's views of the importance of several TCAP education components. Of 17 items that were similar both years in the survey, 7 items showed changes of more than 5 percentile points among the same 25 faculty members (Figure 1) while 10 items showed changes of 4% or less. Table 5 shows the net change (Δ) from 2011 to 2012 as well as statistical analysis of whether the observed changes were significant (chi-squared statistic).

- 84% of the 25 PIs viewed faculty mentoring of graduate students to be extremely important in 2012 vs. 64% who did so in 2011, an increase of twenty percentile points (20%).
- There was an increase of 12% in the number of PIs who viewed inquiry-based learning approaches to be important in 2012 when compared to 2011 (Table 5). Similarly, 8% more PIs viewed group interactions at the Plant and Animal Genome (PAG) meeting to be important in 2012 vs. 2011 (32% vs. 24%, respectfully).
- Four items showed decrease in the percentage of TCAP PIs who viewed them to be important in year 2011 vs. 2012, respectively (Figure 1): graduate student mentoring of undergraduates (16% vs. 28%, Δ = - 12%), developing relationships with MSI faculty (4% vs. 16%, Δ = - 12%), skill workshops (40% vs. 24%, Δ = - 16%), and recruiting more American-born underrepresented minorities to plant breeding programs (32% vs. 16%, Δ = - 16%).
- A significant test was performed to determine whether the percent increases or decreases in 2012 were statistically different from those of the baseline data collected in year-2011. None of the observed changes were statistically significant at the .05 critical alpha level (Table 5).

Comparison of TCAP PIs' relationship and collaborations with MSI institutions and faculty

- There was a 6% decrease in 2012 in the percent of PIs who reported having "no strong relationship" with MSI institutions (Table 6) when compared to the data in 2011. This decrease was not statistically significant at the $p = 0.05$ alpha level.
- Collaborative relationship between TCAP PIs and non-TCAP MSI faculty has not changed in 2012 when compared to 2011, with the majority of TCAP PIs reporting having no collaborative relationship "at all" with non-TCAP MSIs in both years (72% and 76% respectively).

Comparison in knowledge, skill areas, and processes viewed to be valuable for graduating MS and PhD students

- In 2012, there was an increase of 12% in the number of PIs who viewed “factors in crop plants that impact productivity” to be very valuable knowledge area, and 8% increase in the number who viewed “genetics” to be very valuable (Table 7). These percent increases were not statistically significant ($p > 0.05$). In terms of skill sets, there was a 20% increase in the number of PIs who viewed “communication your scientific ideas” as very valuable skill while 8% more PIs viewed “manage data” and “make phenotypic selection” to be very valuable (Table 8).

- Two knowledge areas, experimental design and data management, showed 8% decrease in terms of the number of PIs who viewed them to be very valuable while three items (causes and resistance to biotic stress, causes and resistance to abiotic stress, and selection theory and techniques) showed a decrease of 16%. Only the change in the selection theory and techniques was statistically significant ($\chi^2 = 6.658$, $p < 0.05$, Table 7).

- It is worth noting that while there was and 8% increase in 2012 in the number of PIs who believed "manage data" to be valuable skill set for graduating MS and PhD students, the was a decrease of exactly 8% in the number of PIs who viewed "data management" as an important knowledge area for educating MS and PhD students (Tables 7 and 8). There was a decrease in the number of PIs who viewed "designing experiments" to be a valuable skill set and important knowledge area (12% and 8% decrease respectfully).

- The percentage of PIs who viewed “consider alternative hypothesis” to be very valuable skill similarly decreased by 16%.

- When asked about the importance of certain processes for educating graduate students, there appears to be an increase of 16% in the number of PIs who viewed "one-on-one mentoring" to be very important, and 8% increase in the number who viewed "field experience," "laboratory experience," and "presenting results" as very important (Table 8). The decreases were in; independent development of hypotheses ($\Delta = -12\%$), and the independent development of research designs ($\Delta = -8\%$, Table 8). These changes were not statistically significant.

Comparison of networking and social interactions

Items asking TCAP PI about how often they interact with certain people and what those interactions were about appeared to remain similar in both years or result small sample differences to carry out meaningful analysis, thus, such analysis has not been carried out

Issues to consider for graduate and MSI surveys

The following are some issues for consideration based on the comparison of the survey results by year:

- Matched analyses were not completed for the graduate student survey results due to the small number of students who completed both the 2011 and 2012 survey. For future analyses of survey data by year, strategies to increase the response rate of graduate students should be considered such as incentives.
- While there were some noticeable differences in the data between years, it is important to understand that the significance tests and interpretation of differences are flawed due to the small, unmatched sample. The TCAP educational committee should take note of the differences; however, interpreting the differences within its limits should carefully be considered before implementing any programming changes.
- This year, graduate students seem to have more frequent interaction with other students both at their institution and outside of their institution than students from last year, with the exception of students from MSIs. Perhaps, many students are new to the TCAP and have not had the opportunity to interact with MSI students or their institution may not have an MSI partner. As MSI collaborations are a key component of the educational portion of TCAP, it is important to consider strategies to provide students with opportunities to interact and network with MSI students.
- Fewer students interacted with researchers outside of the U.S. and from businesses and/or private companies in 2012 than in 2011. It is unclear why this is without additional background characteristics of students, however, if it is a priority – strategies for promoting and increasing the interaction between students and these researchers should be considered.
- Relationships between MSI PIs and TCAP PIs appear to have strengthened between years. It is important for the TCAP to continue to support these relationships and collaborations.

Issues to consider from the TCAP PI surveys

The following are some issues for consideration based on the comparison of the survey results by year:

- The year-to-year comparison showed certain areas in which there was a positive change and areas that resulted change in the other direction. For instance, faculty mentoring of graduate students appears to be an important knowledge areas, a process important for educating graduate students, and an area the TCAP PIs viewed is an extremely important component of the TCAP education. Areas that resulted changes in faculty views should be analyzed carefully and further actions considered.
- While none of the changes observed in comparing the TCAP PI survey of 2012 and 2011 were statistically significant, there may be practical importance in considering the data. For instance, relationships and collaborations between MSI and TCAP PIs appears to be weak, the value associated with developing relationships with underrepresented minority groups and their recruitment appears to have decreased in 2012 when compared to 2012. While statistically not significant changes, their practical importance should be carefully analyzed.

Table 1: Comparison of student demographics by year.

Demographics[a]	2011		2012	
	n	%	n	%
What is your sex?				
Male	6/11	50%	9/16	56%
Female	5/11	50%	7/16	44%
Age[b]				
18 to 20 years old	—	—	1/15	7%
21 to 23 years old	1/8	13%	2/15	13%
24 to 26 years old	5/8	63%	4/15	27%
27 to 29 years old	2/8	25%	4/15	27%
30 to 32 years old	—	—	2/15	13%
33 years old or older	—	—	2/15	13%
Are you of Spanish, Hispanic, or Latino/Latina origin?				
Yes	—	—	—	—
No	11/11	100%	12/12	100%
Race				
American Indian or Alaskan Native	—	—	—	—
Asian	2/10	20%	8/13	62%
Black or African American	—	—	—	—
Native Hawaiian or Pacific Islander	—	—	—	—
White	8/10	80%	5/13	38%
Mixed race	—	—	—	—
Are you a U.S. citizen?				
Yes	9/12	75%	6/15	40%
No	3/12	25%	9/15	60%

[a] Chi-square significant tests were completed for all five demographics by year; however, none of the tests resulted in significant findings.

[b] Age categories were revised to be smaller increments in the 2012 survey. The age data shown here is from the eight students who completed both the baseline survey in 2011 and this year's 2012 survey.

Table 2: Graduate student trends by year[a].

Survey items	2011	2012
How often do you participate in the following activities?	*"Moderately" or "Very"*	
Problem solving*	8/12 (67%)	24/25 (96%)
How often do you interact with the following types of people?		
Other undergraduates at my institution* (Besides mentee)		
Never	7/9 (78%)	2/16 (13%)
Once a year or less	1/9 (11%)	3/16 (19%)
Once very three months or less	1/9 (11%)	2/16 (13%)
Once a month or less	0/9 (0%)	3/16 (19%)
Once a week or less	0/9 (0%)	1/16 (6%)
More than once a week	0/9 (0%)	5/16 (31%)
Students in my lab**		
Never	3/10 (30%)	3/22 (14%)
Once a year or less	4/10 (40%)	0/22 (0%)
Once very three months or less	1/10 (10%)	0/22 (0%)
Once a month or less	1/10 (10%)	0/22 (0%)
Once a week or less	1/10 (10%)	2/22 (9%)
More than once a week	0/10 (0%)	17/22 (77%)
Other graduate students at my institution***		
Never	6/10 (60%)	2/19 (11%)
Once a year or less	4/10 (40%)	0/19 (0%)
Once very three months or less	0/10 (0%)	0/19 (0%)
Once a month or less	0/10 (0%)	3/19 (16%)
Once a week or less	0/10 (0%)	3/19 (16%)
More than once a week	0/10 (0%)	11/19 (58%)
Students from other institutions in the US*		
Never	4/10 (40%)	6/21 (29%)
Once a year or less	4/10 (40%)	1/21 (5%)
Once very three months or less	2/10 (20%)	4/21 (19%)
Once a month or less	0/10 (0%)	7/21 (33%)
Once a week or less	0/10 (0%)	3/21 (14%)
More than once a week	0/10 (0%)	0/21 (0%)
Students from minority serving institutions (MSIs)*		
Never	2/8 (25%)	14/16 (88%)
Once a year or less	0/8 (0%)	1/16 (6%)
Once very three months or less	1/8 (13%)	0/16 (0%)
Once a month or less	1/8 (13%)	0/16 (0%)
Once a week or less	2/8 (25%)	0/16 (0%)
More than once a week	2/8 (25%)	0/16 (0%)
Researchers outside of the US***		
Never	0/11 (0%)	9/19 (47%)
Once a year or less	0/11 (0%)	4/19 (21%)
Once very three months or less	0/11 (0%)	3/19 (16%)
Once a month or less	0/11 (0%)	2/19 (11%)
Once a week or less	5/11 (46%)	0/19 (0%)
More than once a week	6/11 (55%)	1/19 (5%)
Researchers from business and/or private companies*		
Never	0/11 (0%)	8/19 (42%)
Once a year or less	0/11 (0%)	2/19 (11%)
Once very three months or less	2/11 (18%)	3/19 (16%)
Once a month or less	4/11 (36%)	5/19 (26%)
Once a week or less	3/11 (27%)	1/19 (5%)
More than once a week	2/11 (18%)	0/19 (0%)

[a] A total of 123 chi-square tests were completed to examine differences by year. All data and chi-square significance test results should be interpreted with caution due to the low sample size and low cell counts. *$p < .05$, **$p < .01$, ***$p < .001$

Table 3: MSI PI trends by year[a].

Survey items	2011	2012
	"Very strong"	
How strong do you feel your relationships are with TCAP institutions?	1/8	6/6
How valuable are the following skills for a graduating MS or PhD student in plant breeding?	*"Very"*	
Make marker assisted selections	6/7	2/6
Utilize single nucleotide polymorphisms or genotype by sequencing	3/7	1/6
How often do you interact with the following types of people?	*"Once a week or less" or "More than once a week"*	
Other students at my institution (Besides advisee)	1/7	4/5

[a] Significance testing was not completed on these items.

Table 4. Demographics by year

	2011		2012	
Demographics	**n**	**%**	**n**	**%**
What is your sex?				
Male	35/39	90%	27/28	96%
Female	4/39	10%	1/28	4%
Are you of Spanish, Hispanic, or Latino/Latina origin?				
Yes	4/37	11%	1/27	4%
No	33/37	89%	25/27	93%
Race				
American Indian or Alaskan Native	2/37	5%	—	—
Asian	6/37	16%	4/27	15%
Black or African American	—	—	—	—
Native Hawaiian or Pacific Islander	—	—	—	—
White	28/37	76%	22/27	81%
Mixed race	1/37	3%	1/27	4%

[a] Differences in age between years is not reported due to revisions to the age categories in the 2012 survey. However, most PIs (about 75%) were between the ages of 40 and 59 years in both 2011 and 2012.

Table 5. Trends by year in components of TCAP education viewed to be "extremely important" by TCAP PIs (data is arranged in descending order with respect to observed net change)

Components of TCAP education viewed as "extremely important" by TCAP PIs	2011		2012		Δ	χ^2	*p*-value*
	n	%	n	%			
Faculty mentoring of graduate students	16/25	64%	21/25	84%	20%	3.516	0.06
Inquiry-based learning approaches**	3/25	12%	6/25	24%	12%	2.367	0.12
Group interactions at PAG meeting	6/25	24%	8/25	32%	8%	0.493	0.48
International travel/workshop	1/25	4%	1/25	4%	0%	—	—
Collaboration between MSI and TCAP students	1/25	4%	1/25	4%	0%	—	—
Understanding challenges to recruiting URMs	5/25	20%	5/25	20%	0%	—	—
Teaching/learning tools	8/25	32%	7/25	28%	-4%	—	—
Research	19/25	76%	18/25	72%	-4%	—	—
Online course(PBTN network)	9/25	36%	8/25	32%	-4%	—	—
Interaction with plant breeders at other inst.	10/25	40%	9/25	36%	-4%	—	—
Participation at NAPB meeting	2/25	8%	1/25	4%	-4%	—	—
Plant breeding educational film	2/25	8%	1/25	4%	-4%	—	—
Increasing number of URM groups in plant breeding	5/25	20%	4/25	16%	-4%	—	—
Graduate student mentoring of undergrads	7/25	28%	4/25	16%	-12%	1.240	0.26
Relationship development with MSI faculty**	4/25	16%	1/25	4%	-12%	1.860	0.17
Skill workshops	10/25	40%	6/24	24%	-16%	2.042	0.15
Recruiting more American-born, underrepresented groups to plant breeding programs	8/25	32%	4/25	16%	-16%	2.252	0.13

**The null hypothesis tested here is that percent changes observed in 2012 are the same as those of the 2011 baseline data; the alternative hypothesis is that the percentages have changed. A p-value ≤ 0.05 suggests significant test. However, caution should be exercised as some of the cell counts are too small to make any meaningful conclusions about the data.*

*** Caution should be used when interpreting the findings on these items due to the low cell count in either the 2011 or 2012 data.*

Table 6. Trends in TCAP PI-MSI relations and collaborations by year

	2011		2012		Δ	χ^2	*p*-value*
	n	%	n	%			
Strength of TCAP PIs relationships with MSI institutions (number and percents are for those reporting having "no strong relationship at all" with MSI institutions	12/24	50%	11/25	44%	- 6%	0.018	0.89
PIs' collaboration with non-TCAP MSI faculty (number and percents are for those reporting not collaborating "at all" with non-TCAP MSIs)	19/25	76%	18/25	72%	- 4%	—	—

Table 7. Trends by year in listed knowledge areas viewed to be "very" valuable by TCAP PIs (data is arranged in descending order with respect to observed net change)

	2011		2012		Δ	χ^2	*p*-value
	n	%	n	%			
Factors in crop plants that impact productivity	12/25	48%	15/25	60%	12%	1.002	0.32
Genetics (Mendelian, quantitative, population and molecular)	22/25	88%	24/25	96%	8%	0.852	0.36
Methods for breeding in selfing and outcrossing systems	17/25	68%	17/25	68%	—	—	—
Teaching strategies (inquiry-based learning approaches)	4/24	17%	4/25	16%	- 1%	—	—
Plant breeding strategies (e.g., traditional, molecular, physiological)	24/25	96%	23/25	92%	- 4%	—	—
Experimental design	24/25	96%	22/25	88%	- 8%	2.344	0.13
Data management (collection, analysis, databases)	24/25	96%	22/25	88%	- 8%	1.988	0.16
Causes and resistance to abiotic stress	11/25	44%	7/25	28%	- 16%	1.963	0.16
Causes and resistance to boitic stress	13/25	52%	9/25	36%	- 16%	1.963	0.16
Selection theory and techniques	**23/25**	**92%**	**19/25**	**76%**	**- 16%**	**6.658**	**0.01***

**This item is statistically significant at p < 0.05 level.*

Table 8. Trends by year in listed skill areas viewed to be "very" valuable by TCAP PIs

	2011		2012		Δ	χ^2	*p*-value
	n	%	n	%			
Utilize single nucleotide polymorphisms (SNPs) or genotype by sequencing (GBS)*	3/25	12%	22/25	88%	76%	129.64	0.000
Communicate your scientific ideas	16/25	64%	21/25	84%	20%	3.517	0.06
Make marker assisted selections	10/25	40%	13/25	52%	12%	1.041	0.31
Manage data	18/25`	72%	20/25	80%	8%	0.446	0.50
Make phenotypic selections	19/25	76%	21/25	84%	8%	0.493	0.48
Work cooperatively	20/25	80%	20/25	80%	—	—	—
Define and solve problems	23/25	92%	23/25	92%	—	—	—
Molecular techniques==9	6/25	24%	6/25	24%	—	—	—
Identify new alleles to use for improvement	8/25	32%	8/25	32%	—	—	—
Observe and interpret results	24/25	96%	23/25	92%	-4%	—	—
Statistical analysis	18/25	72%	17/25	68%	-4%	—	—
Make genome wide selections	8/25	32%	7/25	28%	-4%	—	—
Design experiments	23/25	92%	20/25	80%	-12%	3.397	0.06
Consider alternative hypothesis	18/25	72%	14/25	56%	-16%	2.431	0.12
Choose parents and make crosses**	21/25	84%	10/25	40%	-44%	32.81	0.00

*observed change on this item is high but chi-square statistics could not be calculated because of the low count in the 2011 cell

**this item, similar to the first item, appears to be outlier. Care should be taken in interpreting what the data suggests

Table 9. Trends by year in the process of graduating students [only items reported to be "very valuable" by PIs reported]

	2011		**2012**		**Δ**	**χ^2**	***p*-value**
	n	**%**	**n**	**%**			
One-on-one mentoring	19/25	76%	23/25	92%	16%	2.686	0.10
Field experience	17/25	68%	19/25	76%	8%	0.4136	0.52
Laboratory experience	9/25	36%	11/25	44%	8%	0.3906	0.53
Experience presenting results (meetings, papers)	17/25	68%	19/25	76%	8%	0.4136	0.52
Independent development of research designs	15/25	60%	13/25	52%	- 8%	0.375	0.54
Collaboration with faculty other than the advisor	12/25	48%	7/25	28%	-20%	1.042	0.31

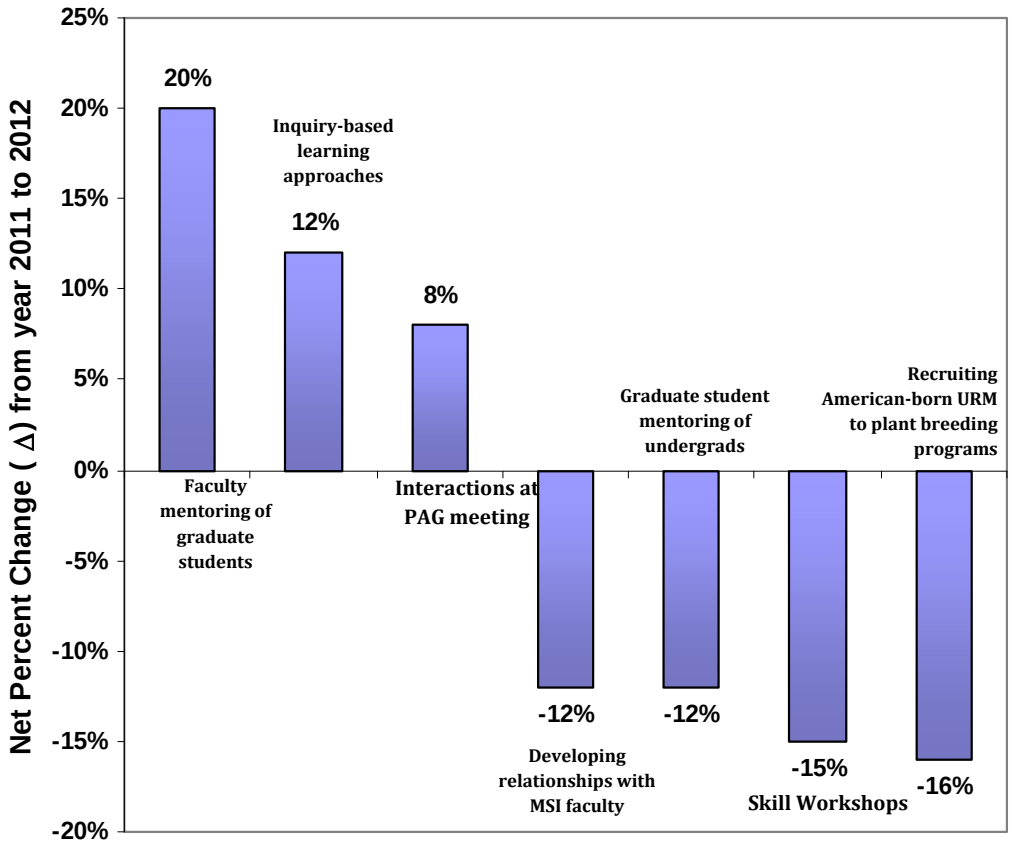

Figure 1. Percent changes in TCAP PIs' view of "how important" a component of TCAP education is from year 2011 to 2012. Percentages indicate increase/decrease in the percent of 25 PIs who viewed an item to be "extremely important". Only items resulting a change of more than 5% were considered for analysis (changes resulting less than 5% were considered to be due to background noise).

Comparisons of the 2012 TCAP PI-Student survey results

An evaluation of the Triticeae Coordinated Agricultural Project (TCAP)

Comparisons of the 2012 TCAP PI-Student survey results

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Introduction

The Triticeae Coordinated Agricultural Project (TCAP), funded by the United States Department of Agriculture (USDA), is an effort to improve the quality of wheat and barley breeding and increase the number of plant breeders, especially from racially and ethnically diverse backgrounds. TCAP's educational component consists of providing education and research opportunities for graduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field.

An evaluation with multiple components is being conducted to assess the progress of TCAP. One of the evaluation components is a yearly survey to assess graduate students' perceptions of plant breeding education, perceptions of TCAP programming, and collaborative relationships and networks over time. This report provides a comparison of the 2012 TCAP PI and graduate student surveys.

Methods

Student confidence in knowledge areas and skill sets in plant breeding highly valued by TCAP PIs in the 2012 surveys were compared. Similarly, students' and PIs' perceptions about educational processes—the importance of certain processes in educating graduate students and the nature of their collaborative networking with others that PIs and students reported - were compared. These were items that could be compared based on the nature of the PI and student surveys. The results of these cross-comparisons are shown in Tables 1 - 4.

2012 TCAP PI-student cross-comparisons study

Summarized by Abdi M. Warfa

We compared student confidence in knowledge areas and skill sets in plant breeding highly valued by TCAP PIs in the 2012 surveys. Similarly, we compared students' and PIs' perceptions about educational processes—the importance of certain processes in educating graduate students and the nature of their collaborative networking with others that PIs and students reported. These were items that could be compared based on the nature of the PI and student surveys.

Student confidence in plant breeding knowledge areas valued by PIs

Students appear to have less confidence in most areas that PIs consider to be very valuable knowledge areas for graduating MS or PhD students in plant breeding. It also appears that certain areas students report having confidence in are considered by the PIs to be less valuable. These findings are summarized in Table 1, which shows percentage of surveyed PIs who consider given knowledge areas in plant breeding very valuable and the percentage of students who report being moderately confident or very confident in those areas.

- 71-76% of the students report being moderately confident or very confident in experimental design, genetics, and plant breeding strategies while 89-93% of the PIs report this to be very

valuable knowledge areas, a difference of about 20 percentile points between the two variables (Table 1). Similarly, only 54% of the students report being moderately or very confident in selection theories and techniques while about 80% of the PIs consider this to be a very valuable knowledge area.

- Reversing the trend of students showing low confidence in areas highly valued by the PIs, an average of 60-68% of the students reported feeling moderately or very confident in "causes and resistance of biotic and abiotic" while only 29-39% of the PIs, on average, considered this to be very valuable knowledge areas in plant breeding. Similarly, 76% of the students report being moderately or very confident in factors in crop plants that impact productivity while only 54% of the PIs consider this to be a very valuable knowledge area, a difference of 22 percentile points.

Student confidence in skill sets in plant breeding valued by PIs

Table 2 shows skill sets in plant breeding highly valued by PIs and student confidence in those skill sets. The data seems to suggest that students are less confident in most skill sets highly valued by the PIs.

- There was mostly an agreement between skills sets that students felt moderately or very confident in and how highly those skill sets were valued by TCAP PIs. For instance, 93% of the PIs reported "define and solve problems" and "observing and interpreting results" to be the most valuable skill set and 84% of the students reported being moderately or very confident in those skill sets. Similarly, 82% of the PIs reported "work cooperatively," "design experiments," "manage data," and "communicate your scientific ideas" to be valuable skill sets while 80 of students felt "moderately" or "very" confident in "communicating your scientific ideas" and 87-88% reported being moderately or very confidents in "working cooperatively" and "manage data" but only 72% reported being "moderately" or "very" confident in designing experiments.

- Student confidence in several skill sets highly valued by the PIs tended to be lower. For instance, 86% of the PIs reported "make wide genome selection" to be very valuable skill set while only 39% of the students reported being moderately or very confident in this skill set. Similarly, 71% of the PIs reported "networking" to be valuable skill while only 35% of the students reported being moderately or very confident in networking.

- Reversing the trend, there were several skill sets in which student confidence was moderate or very high while these skills were less valued by the PIs. For instance, 66% of the students reported being moderately or very confident in single nucleotide polymorphism (SNPs) and genotype by sequencing (GNS) while this skill was valued by only 43% of the PIs. Similarly, while only 29% of the PIs reported "molecular techniques" to be valuable, almost 80% of the students report being moderately or very confident in this skill set.

Students' and PIs' perceptions of educational processes

One item in the surveys asked both students and PIs about the importance of TCAP educational components that are valuable for educating graduate students.

- The highest number of PIs reported one-on-one mentoring to be the most important process (26/28 or 93%) for educating graduate students (Table 3) while only 65% of the students reported similar response. The highest number of students (19/25 or 76%), on the other hand, reported field experience to be extremely important process for educating graduate students and 71% of the PIs (the third highest PI response) similarly viewed field experience to be extremely important process for educating graduate students.

- There were some disagreements between educational processes students viewed to be extremely important and PIs views on those processes. For instance, while 72% of the students reported "laboratory experience" to be important processes for educating graduate students, only 43% of the PIs thought this to be extremely important, a difference of 29 percentile points. Similarly, students viewed "exposure to diverse research methods," "exposure to plant breeding students from diverse ethnic backgrounds," "collaboration with graduate students from OTHER institutions," and teaching methods" to be more important than did faculty (68% vs. 46%, 32% vs. 11%, 20% vs. 7%, and 29% vs. 7% respectively).

Students' and PIs' views of collaborative networking with other

The surveys asked both PIs and students how often they interacted with certain types of people (Table 4).

- Most PIs (79%) reported interacting with their advisees more than once a week while only 55% of the students reported interacting with their advisors more than once a week (Table 4). Interestingly, when asked what the most prevalent topic of the interaction was about, trouble shooting research (48%) or interpreting research results (24%) rose to the top of the PIs response. This is in contrast to 21% and 26% of students who indicated the interactions to have been about trouble shooting research and interpreting research results respectively.

- The lowest numbers of "more than once a week" interactions reported by TCAP PIs were with researchers from business and/or private companies (3% or 1/29 PIs) and with researchers from MSI institutions (4%), researchers at their own institution (4%), and TCAP researchers at other institutions (4%). TCAP students have not interacted with researchers from MSI institutions, business/industry, and TCAP researchers at other institutions more than once a week. However, the students do report interacting with researchers at their own institution more than the TCAP PIs reported (29% vs. 4%, Table 4)

Issues to consider for the TCAP PI-student cross-comparison study

The 2012 TCAP PI-student cross-comparison study highlighted areas of agreement and disagreement between TCAP PIs and TCAP students with respect to knowledge areas and skill sets highly valued by the PIs and student confidence in those areas. The report also highlighted educational processes that both TCAP faculty and students considered to be extremely important and the nature of their collaborative networking with others.

- Data from the survey indicated that most students seemed to have less confidence in most areas that PIs consider to be very valuable knowledge areas or skill sets for graduating MS or PhD students in plant breeding. The disconnect between the knowledge/skill sets PIs consider very valuable and student confidence in those areas perhaps suggesting the need to align knowledge areas valued by educators and the teaching of those areas to students.

- While there were an overall agreement between the students and the PIs about the importance of processes needed to educate graduate students, there were also striking differences in the students' and PIs' perceptions of some of those processes. For instance, there was almost 30 percentile difference between the PIs and students with respect to the importance of laboratory experiences in educating graduate students, with 72% of students viewing this as an extremely important while only 43% of the PIs thought so. This suggests the need to align students' perceptions of what is important for their education and PIs views of what is needed to educate graduate students in plant breeding programs.

- Interactions with MSI institutions and students from MSI institutions appears to be weak. This is an area that, if important to the program, should be considered for improvement by creating strategies that foster collaborative networking with MSI institutions.

Table 1: PIs' views of the value of knowledge areas and student confidence in those areas. Data is sorted in descending order by the percentage of PIs.

Knowledge Areas	**% of PIs' who indicate areas to be "very valuable"**		**% of Students who feel "moderately" or "very" confident in areas**	
	n		**%**	**n**
Genetics (mendelian, quantitative, population and molecular)	25/28	86%	18/24	75%
Plant breeding strategies (e.g. traditional, molecular, physiological)	26/28	93%	17/24	71%
Experimental design	25/28	89%	17/24	76%
Data management (collection, analysis, database)	24/28	86%	22/25	88%
Selection theory and techniques	22/28	79%	13/24	54%
Methods for breeding in selfing and outcrossing systems	19/28	68%	16/23	70%
Factors in crop plants that impact productivity	15/28	54%	19/25	76%
Causes of and resistance to biotic stress	11/28	39%	17/25	68%
Causes of and resistance to abiotic stress	8/28	29%	15/25	60%
Teaching strategies (Inquiry-based learning approaches)	5/28	19%	7/21	33%

Table 2: PIs' views of the value of skill sets in plant breeding and student confidence in those areas. Data is sorted in descending order by the percent of PIs.

Skill set areas in plant breeding	**% of PIs' who indicate skill set to be "very valuable"**		**% of Students who feel "moderately" or "very" confident in skill set**	
	n	**%**	**n**	**%**
Define and solve problems	26/28	93%	21/25	84%
Observe and interpret results	26/28	93%	21/25	84%
Make genome wide selections	24/28	86%	9/23	39%
Work cooperatively	23/28	82%	21/24	87%
Design experiments	23/28	82%	18/25	72%
Manage data	23/28	82%	22/25	88%
Communicate your scientific ideas	23/28	82%	20/25	80%
Networking skills	20/28	71%	8/23	35%
Resource Management skills	20/28	71%	19/25	83%
Statistical analysis	19/28	67%	19/25	75%
Choose parents and make crosses	18/28	64%	13/24	58%
Consider alternative hypotheses	16/28	57%	22/25	33%
Make phenotypic selections	15/28	54%	16/25	25%
single nucleotide polymorphisms (SNPs) or genotype by sequencing (GBS)	12/28	43%	10/24	66%
Identify new alleles to use for improvement	10/28	36%	14/24	41%
Molecular techniques	8/28	29%	19/24	79%
Make marker assisted selections	8/28	29%	14/23	61%

Table 3: TCAP Students' and PIs' perceptions of educational processes. Data is sorted in descending order by the percent of PIs.

How important do you believe the following are in the process of educating graduate students?	% of PIs' who consider item to be "extremely important"		% of Students who indicate item to be "extremely important"	
	n	**%**	**n**	**%**
One-on-one mentoring	26/28	93%	9/25	65%
Experience presenting results (meetings, papers)	21/28	75%	15/25	67%
Field experience	20/28	71%	19/25	76%
Independent development of research designs	13/28	46%	13/25	52%
Exposure to diverse research methods and tools	13/28	46%	17/25	68%
Collaboration with other graduate students in this institution (in this lab or other labs)	12/28	43%	11/25	44%
Independent development of hypotheses	12/28	43%	13/25	52%
Laboratory experience	12/28	43%	18/25	72%
Collaboration with faculty other than the advisor	8/28	29%	10/25	40%
Experience writing grants	8/28	29%	10/25	40%
Exposure to plant breeding students from different ethnic backgrounds	3/28	11%	8/25	32%
Collaboration with graduate students from OTHER institutions	2/28	7%	5/25	20%
Teaching experience	2/28	7%	7/25	29%

Table 4: Item list for collaborative networking questionnaires for both PIs and students. List is ordered from most to the least interactions reported by both PIs and students, respectively.

How often have you interacted with the following types of people?	**Interactions of more than once a week**			
	PIs		**Students**	
	n	**%**	**n**	**%**
My advisee/my advisor	22/28	79%	12/21	55%
Other researchers at U.S. institutions (not TCAP or MSI researchers)	21/28	75%	1/18	6%
Other students at my institution	8/29	28%	11/19	58%
Other researchers outside of the U.S.	5/28	18%		
TCAP students from other institutions	3/29	10%	1/19	5%
Students from minority serving institutions (MSIs)	2/29	7%	1/16	6%
Researchers at my institution	1/27	4%	6/21	29%
TCAP researchers at other institutions	1/27	4%	—	—
Researchers at MSIs	1/27	4%	—	—
Researchers from businesses and/or private companies	1/29	3%	—	—
Non-TCAP students from non-MSIs in the U.S.	—	—	—	—
Non-TCAP students from institutions outside the U.S.	—	—	—	—

Comparison of the TCAP PI-Student Comparison Reports

An evaluation of the Triticeae Coordinated Agricultural Project (TCAP)

Comparison of the TCAP PI-Student Comparison Reports

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Introduction

The Triticeae Coordinated Agricultural Project (TCAP), funded by the United States Department of Agriculture (USDA), is an effort to improve the quality of wheat and barley breeding and increase the number of plant breeders, especially from racially and ethnically diverse backgrounds. TCAP's educational component consists of providing education and research opportunities for graduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field.

An evaluation with multiple components is being conducted to assess the progress of TCAP. One of the evaluation components is a yearly survey to assess graduate students' perceptions of plant breeding education, perceptions of TCAP programming, and collaborative relationships and networks over time. This report provides a comparison of the 2012 TCAP PI and graduate student surveys.

Methods

Student confidence in knowledge areas and skill sets in plant breeding and TCAP PIs' opinions of the value of these areas were surveyed in both years 2011 and 2012. Similarly, students' and PIs' perceptions about educational processes—the importance of certain processes in educating graduate students and the nature of their collaborative networking with others were reported. Student and PI opinions on items that were similar for both years were compared. This report describes the differences in the comparison reports across the two years—in other words compares the comparisons over time.

Summary of Key Findings

Student confidence in plant breeding knowledge areas valued by PIs

Comparison of the two comparison reports shows some movement in the percentage of students who felt moderately or very confident in certain knowledge areas and the percentage of PIs who thought those areas to be very valuable knowledge areas. There were 10 items in the plant breeding knowledge areas that were similar in the surveys both years (Table 1). Of the 10 items shown in Table 1, 6 items (genetics, experimental design, teaching strategies, factors in crop plant that impact productivity, methods of breeding in selfing and outcrossing systems, and causes of and resistance to abiotic stress) showed change. These changes are described below. The remaining 4 items (plant breeding strategies, selection theory and techniques, and data management) did not change. The key highlights of the items that showed change overtime are:

- In the knowledge area of genetics, there was 21% difference between the percentage of students who felt moderately or very confident in genetics in 2011 (67%) and the percentage of PI who thought genetics to be very valuable (88%). This percentile difference decreased to 11% in the 2012 comparison report, mainly accounted for by more students (75%) reporting being moderately or very confident in genetics in 2012 than in 2011 (the percentage of PIs who

considered genetics very valuable knowledge area in 2012, 86%, is very comparable to the percentage in the 2011 report, 88%).

- In the area of experimental design, there was 20% difference between the percentage of students who felt moderately or very confident in this area in 2011 (75%) and the percentage of PI who thought experimental design to be very valuable (95%). This percentile difference decreased to 13% in the 2012 comparison report. The observed 7% decrease between the two reports is mainly accounted for by the percentage of PIs who considered experimental design very valuable decreasing from high of 95% in 2011 to 89% in 2012 while the percentage of students reporting being moderately or very confident remained comparable between the years (76% vs. 75% in 2012 vs. 2011 respectively)

- With respect to the areas of "Causes of and resistance to abiotic stress" and "methods of breeding in selfing and outcrossing systems," the percentages changed overtime mainly because of more students reporting being confident in these areas (42% in the 2011 report vs. 70% in the 2012 with respect to "causes of and resistance to abiotic stress" and 42% in the 2011 report vs. 60% in the 2012 report with respect to "methods of breeding in selfing and outcrossing systems"). This higher student percentages are reflected in the difference in the percentiles shown in both reports.

- In both comparison reports, we noted reversal in the trend discussed above of students showing low confidence in areas highly valued by the PIs: students were showing high confidence in knowledge areas less valued by PIs. Although the trends remained the same (students showing high confidence in areas valued less by the PIs), there was some movement in the percent points reported in the 2012 comparison report vs. the 2011 report.

    - With respect to teaching strategies, there was 24% difference between the percentage of students who felt moderately or very confident in this area in 2011 (42%) and the percentage of PI who thought it to be very valuable (18%). This percentile difference decreased to 14% in the 2012 comparison report, mainly accounted for by decrease in the percentage of students who reported being confident in teaching strategies (33%) in 2012 vs. 2011 - the percentage of PIs who considered teaching strategies very valuable knowledge area in 2012, 19%, was very comparable to the percentage in the 2011 report, 18%.

    - With respect to "factors in crop plants that impact productivity," there was 10% difference between what was reported by the students and what was valued by the PIs in 2011 vs. 2012. Again, this percentile change (from 32% in 2011 to 22% in 2012) is mainly accounted for decrease by the percentage of students reporting being moderately or very confident in this item in 2012 (76%) vs. 2011 (83%).

Student confidence in skill sets in plant breeding valued by PIs

There was not much change between the two reports in the skill set areas that PIs felt were very valuable and student confidence in those areas (Table 2). Students and PIs were mostly in agreement with respect to the listed skill set areas. For instance, "define and solve problems" and

"observing and interpreting results" were reported to be the most valuable skill set by the PIs in both years and most students reported being moderately or very confident in those skill sets.

- The percentage of PIs who reported "make genome wide selections" as valuable skill set was much higher in the 2012 data versus the 2011 data (86% vs. 30%, Table 2) and this change mainly accounted for the difference between the two comparison reports with respect to this item (30% of the PIs vs. 25% of the students in the 2011 comparison report vs. 86% of the PIs vs. 39% of the students in the 2012 report)

- While some trends remained constant (e.g., skill sets in which student confidence was moderate or very high while these skills were less valued by the PIs), the percentages changed (Table 2). For instance, 66% of the students reported being moderately or very confident in single nucleotide polymorphism (SNPs) and genotype by sequencing (GNS) while this skill was valued by only 43% of the PIs in the 2012 report. While the percentile difference between the PIs and the students remain exactly the same in 2012 vs. 2011 (23%), there was increase in both the percentage of students who reported confident in SNPS and GNS in 2012 vs. 2011 (66% vs. 41% respectively) and the percentage of PIs who thought it very valuable (43% vs. 18% in 2012 vs. 2011 respectively)

Students' and PIs' perceptions of educational processes

One item in the surveys asked both students and PIs about the importance of TCAP educational components that are valuable for educating graduate students (the prompt question for the items states: How important do you believe the following are in the process of educating graduate students?). There were 13 items listed as educational processes (Table 3).

The key highlights of the comparison reports are (Table 3):

- In 2011, there was 17% difference between the percentage of students (58%) and PIs (75%) who thought one-one mentoring to be extremely important. This percentile difference increased to 28% in the 2012 comparison report, mainly accounted for by both more PIs (93%) and students (65%) reporting this being extremely important process in 2012 than in 2011.

- In both years, we noted disagreement between educational processes students viewed to be extremely important and PIs views on those processes.
    - In the 2012 report, 72% of the students perceived "laboratory experience" to be important processes for educating graduate students while only 43% of the PIs thought this to be extremely important, a difference of 29 percentile points. In the 2011 report, it was noted that 58% of the students thought laboratory experience was extremely important while 47% of the PIs did so, a difference of 11%. Thus, while the percentage of PIs who viewed laboratory experience as extremely important remained similar (43% vs. 47% in 2012 vs. 2011 respectively), the percentage of students who viewed laboratory experience extremely important increased 14% in 2012 (from 58% to 72%), accounting for the difference in the percentile points noted.

- In 2011 report, 75% of the PIs and 58% of the students reported field experience to be important. In the 2012, 71% of the PIs and 76% of the student reported field experience being important. Thus the number of students who viewed field experiences important changed from 58% to 76% while that of the PIs remained roughly the same.
- The number of students who perceived "independent development of research designs" to be important changed from 33% to 52% while the percent of PIs remained roughly the same.
- The percentage of PIs who viewed "exposure to diverse research methods and tools" to be important changed from 62% in 2011 to 46% in 2012 while the percentage increased from 58% in 2011 to 68% in 2012.
- There are similar other changes shown in the report, with the percentages increasing or decreasing conversely.

Concluding remarks

Data from the comparison reports indicated that most students seemed to have less confidence in most areas that PIs consider to be very valuable knowledge areas or skill sets for graduating MS or PhD students in plant breeding. TCAP students and faculty were overall in agreement about what educational processes were most important. While these trends continued in years 2012 and 2011, there was some movement in the percentages reported, with percentile decreases or increases accounted for by changes in the percentage of student responses or the percentage of PIs. In the plant breeding knowledge areas, four items (genetics, experimental design, teaching strategies, and factors in crop plant that impact productivity) showed change. While these may signal changes, it is important to keep in mind that the 2012 student data includes new student cohorts who may have different perspectives and perceptions and therefore caution has to be taken in interpreting this data.

Table 1: Comparison of changes overtime in the comparison reports with respect to plant breeding knowledge areas (areas with substantial changes from 2011 to 2012 are highlighted in gray; data is sorted in descending order by the percentage of PIs reported for the 2012 data)

	2011 Comparison Findings				2012 Comparison Findings			
	% of PIs' who indicate areas to be "very valuable"		% of students who felt "moderately" or "very" confident in areas		% of PIs' who indicate areas to be "very valuable"		% of students who felt "moderately" or "very" confident in areas	
	n	%	n	%	n	%	n	%
Genetics (mendelian, quantitative, population and molecular)	36/41	88%	8/12	67%	25/28	86%	18/24	75%
Plant breeding strategies (e.g. traditional, molecular, physiological)	38/41	93%	9/12	75%	26/28	93%	17/24	71%
Experimental design	39/41	95%	9/12	75%	25/28	89%	17/24	76%
Data management (collection, analysis, database)	36/41	88%	9/12	75%	24/28	86%	22/25	88%
Selection theory and techniques	38/41	93%	5/12	42%	22/28	79%	13/24	54%
Methods for breeding in selfing and outcrossing systems	28/41	69%	5/12	42%	19/28	68%	16/23	70%
Factors in crop plants that impact productivity	21/41	51%	10/12	83%	15/28	54%	19/25	76%
Causes of and resistance to biotic stress	21/41	51%	5/12	42%	11/28	39%	17/25	68%
Causes of and resistance to abiotic stress	18/41	45%	5/12	42%	8/28	29%	15/25	60%
Teaching strategies (Inquiry-based learning approaches)	7/41	18%	5/12	42%	5/28	19%	7/21	33%

Table 2: Comparison of changes overtime in the comparison reports with respect to plant breeding skill sets (areas that changed from 2011 to 2012 are highlighted in gray; data is sorted in descending order by the percentage of PIs)

	2011 Comparison Findings				**2012 Comparison Findings**			
	% of PIs' who indicate skill to be "very valuable"		**% of students who felt "moderately" or "very" confident in skill set**		**% of PIs' who indicate skill to be "very valuable"**		**% of students who felt "moderately" or "very" confident in skill set**	
	n	%	n	%	n	%	n	%
Define and solve problems	36/40	90%	11/12	92%	26/28	93%	21/25	84%
Observe and interpret results	39/40	97%	9/12	75%	26/28	93%	21/25	84%
Make genome wide selections	12/40	40%	3/12	25%	24/28	86%	9/23	39%
Work cooperatively	30/40	75%	12/12	100%	23/28	82%	21/24	87%
Design experiments	35/40	88%	7/12	58%	23/28	82%	18/25	72%
Manage data	28/40	70%	10/12	83%	23/28	82%	22/25	88%
Communicate your scientific ideas	26/40	65%	9/12	75%	23/28	82%	20/25	80%
Networking skills	-	-	-	-	20/28	71%	8/23	35%
Resource Management skills	-	-	-	-	20/28	71%	19/25	83%
Statistical analysis	30/40	75%	9/12	75%	19/28	67%	19/25	75%
Choose parents and make crosses	36/40	90%	11/12	92%	18/28	64%	13/24	58%
Consider alternative hypotheses	31/40	775	8/12	66%	16/28	57%	22/25	33%
Make phenotypic selections	31/41	77%	6/12	50%	15/28	54%	16/25	25%
single nucleotide polymorphisms (SNPs) or genotype by sequencing (GBS)	7/40	18%	5/12	41%	12/28	43%	10/24	66%
Identify new alleles to use for improvement	15/40	37%	4/12	33%	10/28	36%	14/24	41%
Molecular techniques	10/40	25%	8/12	66%	8/28	29%	19/24	79%
Make marker assisted selections	18/40	45%	7/12	75%	8/28	29%	14/23	61%

Table 3: **C**omparison of changes overtime in the comparison reports with respect to students' and PIs' perceptions of educational processes (areas that changed from 2011 to 2012 are highlighted in gray; data is sorted in descending order by the percentage of PIs)

How important do you believe the following are in the process of educating graduate students?	**2011 Comparison Findings**				**2012 Comparison Findings**			
	% of PIs' who indicate skill to be "very valuable"		**% of students who felt "moderately" or "very" confident in skill set**		**% of PIs' who indicate skill to be "very valuable"**		**% of students who felt "moderately" or "very" confident in skill set**	
	n	%	n	%	n	%	n	%
One-on-one mentoring	30/41	75%	7/12	58%	26/28	93%	9/25	65%
Experience presenting results (meetings, papers)	28/41	67%	9/12	75%	21/28	75%	15/25	67%
Field experience	30/41	75%	7/12	58%	20/28	71%	19/25	76%
Independent development of research designs	23/41	57%	4/12	33%	13/28	46%	13/25	52%
Exposure to diverse research methods and tools	25/41	62%	7/12	58%	13/28	46%	17/25	68%
Collaboration with other graduate students in this institution (in this lab or other labs)	20/41	50%	5/12	42%	12/28	43%	11/25	44%
Independent development of hypotheses	23/41	57%	4/12	33%	12/28	43%	13/25	52%
Laboratory experience	19/41	47%	7/12	58%	12/28	43%	18/25	72%
Collaboration with faculty other than the advisor	18/41	45%	6/12	50%	8/28	29%	10/25	40%
Experience writing grants	9/41	22%	4/12	33%	8/28	29%	10/25	40%
Exposure to plant breeding students from different ethnic backgrounds	5/41	13%	-	-	3/28	11%	8/25	32%
Collaboration with graduate students from OTHER institutions	4/41	10%	1/12	8%	2/28	7%	5/25	20%
Teaching experience	4/41	10%	2/12	17%	2/28	7%	7/25	29%

Appendix B: Interview Data

TCAP graduate and undergraduate student interview results in Year 2

An evaluation of the Triticeae Coordinated Agricultural Project (TCAP)

TCAP graduate and undergraduate student interview results in Year 2

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Introduction

The Triticeae Coordinated Agricultural Project (TCAP), funded by the United States Department of Agriculture (USDA), is an effort to improve the quality of wheat and barley breeding and increase the number of plant breeders, especially from racially and ethnically diverse backgrounds. TCAP's educational component consists of providing education and research opportunities for graduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field.

An evaluation with multiple components is being conducted to assess the progress of TCAP, including yearly surveys and interviews. The aim of the evaluation is to assess faculty and students' involvement in the TCAP, perceptions of plant breeding education, perceptions of TCAP programming, collaborative relationships and networks over time, and the partnership with MSI institutions to promote the plant breeding field. This report presents the findings from the interviews with graduate and undergraduate TCAP students.

Methods

Evaluators attempted to get a representative sample of students to interview based on institution, race/ethnicity, and gender; however, after a low response rate to the initial interview invitations – interviews were open up to all fully-funded students. An incentive of a $10 online gift card was given to all students who participated in the interviews.

Graduate students

Between November 2012 and February 2013, 8 of 27 TCAP-funded graduate students were interviewed as part of the second year evaluation of the TCAP. Five of these students were also interviewed during the first round of interviews in year one. Of the other three students who were interviewed for the first time, one student has participated in the TCAP since its inception and two of the students received TCAP funding this past academic year. Of the students interviewed, there were three female students and five male students. Students represented a total of five TCAP institutions. Students were asked about their involvement and perception in the TCAP's educational component, collaborations with others in the TCAP, mentoring experience, interactions with minority students, and feedback on potential collaborative small group research. Interviews were conducted over the phone and lasted about 15 to 35 minutes. A copy of the interview protocol is provided in Appendix A.

Undergraduate students

In February 2013, 2 of 38 TCAP-funded undergraduate students were interviewed. An additional undergraduate student who is not currently receiving TCAP funding, but is being mentored by a TCAP-funded graduate student, was also interviewed. All three students attend the same institution. Of these three students, there were two female students and one male student. Students were asked about their involvement and perception in the TCAP's educational component, relationships with others in the TCAP, and their future plans. Interviews were conducted over the

phone and lasted about 15 to 20 minutes. A copy of the interview protocol is provided in Appendix B.

Summary of key findings from the graduate student interviews

Of 27 fully-funded graduate students, eight graduate students from five different institutions were interviewed as part of the second year evaluation of the TCAP. Most students (6 of 8) have been part of the TCAP since the program began in the 2010-11 academic year. Additionally, all students were in their second year of graduate studies, while one student was in their 5th year of studies.

Involvement and perceptions in the TCAP

Graduate students became involved in the TCAP through their advisors and/or as a result of the research that they are doing. All students reported being involved in the online activities (webinars, modules, online forum) and mentoring, with a couple students even working together to coordinate the online webinars/modules. Many students mentioned particularly enjoying the association mapping course and reporting that they learned a lot. Two students reported not being active this year mainly as a result of time conflicts with their courses and inconvenient scheduling.

> *"[The association mapping and genomic selection course] was probably one of the more helpful courses that – I think, um, I think they are finally getting the swing of the online and everything. That one was really useful… It was actually very hands-on – going through and actually running the software code and stuff like that. I think that's the kind of thing that we don't – graduate students don't get that as much through our typical, normal coursework. So I think that's why that one was particularly helpful. " – Student #3*

> *"I took all the courses organized by TCAP and I can say all the webinars. I took three courses, including, umm, umm, mentoring, plant breeding, quantitative genetics, association mapping, and I completed the entering-mentoring program. So, I am active participants of TCAP-organized courses. [**Interviewer**: **What was your perception of these courses?**] I can say most of these courses were helpful. I have a question about the entering-mentoring program [whether it works or not] … but the other courses – plant breeding, quantitative genetics, association mapping – these were very successful. " – Student # 6*

> *"I have participated the meeting in San Diego - meeting with other graduate students. They also have the online courses that I participated in… My interaction [generally] with TCAP has actually being quite enjoyable. Umm, I mean it is a great source of funding, and I mean organizing data sets and all the other things coming out of these different groups. Umm, I thought the recent online courses actually have been quite helpful and it's being enjoyable to see some of the, umm, different students giving kind of seminar like presentations on their work or proposed work." – Student # 7*

> *"I have taken couple of webinars and I participated in some genetics and … It I not really soft skills but anyway I am planning on taking the mentoring class next semester." – Student # 8*

In addition, students who have been in the TCAP since its inception commonly mentioned improvement in the coordination of the online activities – in particular the online courses.

> *"It's been pretty positive – the educational components are a lot stronger this year than last year – overcoming technical difficulties and organizing what works well and trying to coordinate class with different schools." – Student #2*

> *"I think they started off somewhat shakey. The first course started off pretty disorganized and I think it was just – I think the facilitators were just having trouble making the transition onto the online environment and not being use to that kind of structure and how to – how to really engage the students. But I think that's improved a fair bit in the last – especially in this last module that they've done." – Student #3*

> *"The online component has improved dramatically … compared to last year when I took that whole semester with the class. Now it's got much better and I hope it keeps improving, so improvement in that area – technical, bringing people together, and communication stuff.* ***[Interviewer: What do you think led to the improvement?]*** *It flows much better now. People are comfortably using the software now and they are comfortably using talking online. In the beginning we had so many problems with people logging, difficulty in finding documents, but now those are much better" – Student # 8*

Overall, students reported that being part of the TCAP was a positive experience. They felt the most significant portion of the TCAP was the opportunity to network within the TCAP, the online courses, and the opportunity to be a mentor.

> *"I think it's very important and useful that we have the opportunity – and sort of some guidance – in mentoring undergraduate students. I think – at least for me – that's, I think really helpful because I'd like to go into academia and it's useful to have this sort of experience in mentoring someone that's less experienced that you are and trying to teach someone about your project is challenging sometimes, but I think it's really useful." – Student #1*

> *"One of the nice things is meeting and getting to know the other students involved and what their projects are… As well as having easier access to professors – so sometimes I think as a grad student you can feel kind of isolated and it's nice to know that there are other students to have connections and go talk to other students around the country or other professors around the country that are working on similar things and have resources that can help you along." – Student #3*

> *"As a student, I think the online courses are significant for me.* ***[Interviewer: What makes them significant for you?]*** *Because the courses are pretty specialized and they are really – I couldn't take those courses at my universities and the ones that are teaching those courses are experts in the field so it's a great opportunity for us that are not in those big universities." – Student #4*

"I would say the most significant portion [is] being the fact that some of the greatest minds of our day in the field are teaching these [online] courses. There's no way that you can get all of these different breeders and bioinformaticists at a single institution. And so to be able to take courses from them – from Mark Soros and Jean Jannick – from Jorge Dubcovsky, from Clay Sneller – from all of these other really bright minds – I think that's, that's really neat that you can do that and have those courses and offerings to learn from experts in their field without being at those institutions. I think that's the biggest component – is the accessibility." – Student #5

Collaboration with others in the TCAP

Most students reported having connections with other TCAP students; however, there were few research collaborations. Students have connected with one another or collaborated primarily because they have similar research projects. Students have communicated through email, the online forum, and the Adobe Connect online room. Several students also mentioned meeting other students face-to-face at the annual PAG meeting and how that facilitated their collaborative efforts.

"I would say that it is really important to have the opportunity to go to the PAG meetings and actually meet each other. Because it was definitely weird last year to talk to these people you didn't know and try to figure out what school they went to and what they were working on." – Student #1

"I have enjoyed meeting other graduate students who may be doing similar things or have, have knowledge that our lab doesn't have. I think that is quite nice, to get to know some of the students at the annual meeting and knowing their specialty and their interests." – Student 7

"In [the] online [forum] basically students from different universities come together and share their thoughts and what is going on with their projects and, again, sometimes learning from what they have done. But again there are professors from universities, so any question you have about something or is not clear to you, either in your project or something else … yeah, so sort of collaborative effort and people coming together trying to help each other and learn from each other, that is very cool." – Student # 8

Some students were asked if the collaborative relations resulted mainly as a result of their participation in TCAP activities, of which they responded in the affirmative, as illustrated by Student #7 below.

"Yes. I mean I am down here in [Western State] and I got to know students in Minnesota, North Dakota, and all over the country as well as whole faculty from Cornell to, umm, you know, University of Minnesota … it is a well of resources just having those connections and knowing which of your colleagues are working on certain and different things" – Student # 7

Overall, interactions among students are social or focused on troubleshooting. For example, a couple students mentioned working together on figuring out how to use the canopy spectral reflectance and Jazz spectrometer instrument. As for interactions with PIs, students reported mostly meeting them at the PAG meeting. Students did not report collaborating with TCAP principle

investigators (PIs), only interacting with them at the PAG meeting. Despite this, all students greatly valued the opportunity to network with other TCAP students and PIs.

> *"There's been connections with other students who have similar projects on the online forums.* ***[Interviewer: Can you give me examples of how you have worked together?]*** *Yep – so with one of the students – we collaborated to come up with the best techniques of using an instrument – the Jazz – so the best calibration settings. Likewise, with one of the students - we were discussing different sampling techniques with that same instrument." – Student #2*

> *"We have been in a short meeting down in San Diego [at PAG meeting]. We met and discussed how things were going in our own projects. Yeah, it looks like we're benefiting from the program, there is no doubt. Everybody is working to make the project work but that was only one day and we couldn't discuss everything." – Student #6*

Students were asked what factors helped collaborations, as well as what factors made collaborations difficult. A couple students felt collaborations were easier when their advisors had pre-existing relationships with those they wished to contact, as well as when interactions and communication is in real-time. Of the factors that made collaboration difficult, a couple students specifically said that scheduling across multiple time zones was difficult.

> *"I guess like time differences sometimes – trying to coordinate across two, or three, or four time zones. And the fact that we are trying to often talk online – you know one person forgets to come to the meeting and you have to reschedule or something like that. You can't just go down the hall and find them to come to the meeting. And still – the people I haven't met – it's just hard to think of who they are and who they're working with and what they're doing." – Student #1*

> *"I guess when – attending the webinars and different courses when we're meeting in real time – even if it's not meeting to collaborate – it's meeting to attend the webinar or discuss a paper for the one of the online classes – the proximity – even if it's over an online interface – being in the same chat room at the same is a lot more beneficial compared to a board forum." – Student #2*

Mentoring experience

Half of the graduate students (4 of 8) who were interviewed were currently mentoring an undergraduate student. Overall, students felt that mentoring was a beneficial experience to share and affirm their plant breeding knowledge, as well as to guide mentees into the plant breeding field. However, some students reported having mixed experiences with mentoring. Typically, graduate students felt their mentoring experiences were more positive when their mentee was interested in plant breeding and invested in the research. Several graduate students reported that it was difficult to gauge students' interest in plant breeding and that they were unsure what was expected from them as mentors and what to expect from their mentees. Furthermore, a couple graduate students felt mentoring was a big time commitment in terms of balancing the work they had to do and teaching and supervising the work of their mentees. One student mentioned there was no strong enforcement in their institution with respect to mentoring undergraduate students.

"[Mentoring experience] has been kind of mixed depending on the student. It's been pretty fun and valuable when the student is interested in learning and getting something out of the experience, but not necessarily very valuable if – I had an intern who was kind of from a different background… She was more interested in pursuing [non-plant breeding field] – so in her instance, she just needed an internship but didn't have any particular interest in plant breeding. That was very different from my current mentee who is really interested in the field... The time commitment isn't ideal. The learning process of the undergraduate can be slope – helping students with their project takes time from your own project – even if you're working on the same material, but it's not the same project. It's difficult to balance field work with lab work." – Student #2

"I think the mentoring thing – I think the education team should do something to make it more – there's not really – there's no clear cut steps on how to implement that in institutions when I think about. There should be guidelines on how to do the mentoring thing – I know they have some guidelines, but it's not clear… There should be clear guidelines and expectations and results." – Student #4

"One of the things that is difficult is – it takes time. It saves time if it's done right. It saves time as well. You know because you have someone else to help you with the project – and if you can get someone who is invested in the project and feels like they're not just coming to job… I don't want to bring someone onto a mentored research position that looks at this as coming to a job… There's no investment there – there's no ownership." – Student #5

*"There is no any, any strong enforcement in the university where I am. I don't know if that is [because] universities specialize that … there is a weak enforcement here. I don't know. [**Interviewer: and how would you feel about if the university – if your PI, for example, were to find an undergraduate student for you to mentor**?] … It would be much more the responsibility of the PI, because we have, we have some other interest to involve some undergraduate students in a really cute project that we want badly in order to have a complete sense of what we are doing … I believe it will quite helpful for both the project and the students" – Student #6*

Some students mentioned participating in the entering-mentoring course. One student, who was not mentoring undergraduate students but successfully completed the program, was not sure how well the program worked.

Interactions with minority students

Not many graduate students reported having worked or interacted with under-represented minority students. Of the few who have had interactions with under-represented minority students, they felt it is no different from interacting with any other students.

"I think any interaction that you have with people brings a broader perspective – you look at things in different ways. Anyone from a different background – whether they be a minority student or not – or someone from a different country or someone from a different part of this

country – everyone has a different background and has a different take on what is life and what is the world and those interactions change you." – Student #5

"It is actually curious thing because the PI in our lab is from [South American Country] and there are actually quite number of [ethnically diverse students] working in our lab … It is fun diverse group. The interactions have been quite good – just learning about how things are different in other places and things like this, I think it has been quite nice. We get diversity of points of few, I guess, and different experiences." – Student #7

Feedback on collaborative small group research

Some students were asked about TCAP's potential idea to institute small collaborative research groups, of which all but one student liked the idea of collaborative small group research and reported that they would participate. Several students felt this idea would be best and most helpful for analyzing data. The one student who was not interested reported already being involved in similar types of group work.

"I would probably be very interested in an approach like that… Since the TCAP is so collaborative, and many institutions are collecting similar types of data, it makes sense to have a forum in place to discuss the most appropriate data collection and analyses. I think it would help all parties have more accurate data." – Student #1

"I would be very interested in the described activities. I think that data analysis methods are something that we don't normally learn in classes." – Student #2

"I think that this would be helpful to have more support in analyzing data. If students are reaching similar points in their data analysis at the same time, someone could present on some simple way to do an analysis with their own data. This could be helpful by giving other students a bit of a jump start on their data, as well as providing a reinforcement to the student presenting." – Student #3

"I am not terribly interested in participating at this time. That is not to say that I do not think it would be a useful experience, but I am already engaged in many like opportunities here at [current institution]… I guess I feel I am at a stage where I know whom to ask and where to turn when I do need help, which I feel is less time consuming than a regularly scheduled group session." – Student #5

There were some concerns among the students about the small research groups. They were concerned about how the small group work will be done, how groups will be formed, and whether these groups would meet students' needs due to students being at different parts of their graduate career.

"My concerns would probably be what type of discussion forum these would be. Sometimes message boards are daunting, but live meetings through AdobeConnect or else wise can be too – especially if too many people are involved." – Student #1

"I think the biggest difficulty is that everyone is in slightly different places in their project. Therefore, the needs of each student will vary with time. While I think direct contact with other students or faculty is the most useful way to give help, if the group structure is too rigid, the learning may not take place at the time – which is most conducive to learning when the student is actively applying the techniques being learned. So, I think it is a tricky balance between continued availability of collaboration and asynchronous learning opportunities that can be used." – Student #3

"I am just concerned with how they form the groups. Will they first access the level of knowledge of each group member on the topics they would want to work on? For me this is important because if other members are already very advance than the other member that are still new to the topics would be left behind. Another solution would be to have a quick review or lecture before doing the actual task, just to get everyone on the same page." – Student #4

Issues to consider

- Students primarily collaborated with other students if they shared similar research projects; however, none of the students reported collaborating with TCAP PIs outside of their institution. The educational team should continue to promote more opportunities for collaborations and interactions among students and PIs.
- Graduate students value the opportunity to be mentors; however, several students reported not knowing what was expected of them and their mentees, and a couple students felt the experience could be time consuming. Additionally, a couple graduate students reported it being difficult to gauge their mentees' interest in plant breeding and felt that mentoring experiences were more positive when mentees were interested and invested in plant breeding. The educational committee should consider outlining what is expected of graduate students as mentors, as well as expectations of undergraduate students as mentees. The committee should also provide guidelines and resources for graduate students about how to gauge plant breeding interest in their mentees, strategies for increasing awareness and interest in plant breeding careers, and what to do in instances where mentees are not interested in plant breeding.
- Overall, most students who were asked about the collaborative small group research were interested in the idea – particularly in analyzing data. If the educational committee decides to move forward and implement this idea, the committee should review and take into consideration students' concerns.

Summary of key findings from the undergraduate student interviews

Of the 38 TCAP-funded undergraduate students, two students participated in the interviews. Of these two students, one student has been part of the TCAP for about a little over two months and the other since the inception of the project (worked in their lab for almost three years). An additional undergraduate student who is not funded by the TCAP, but is being mentored by a TCAP-funded graduate student also participated in the interviews. All three students interviewed were from the same institution. One student was a sophomore, while the other two were seniors.

Involvement and perception in the TCAP

All three students became involved in TCAP by applying for a job posting or research grant opportunity that led them to working with TCAP principle investigators (PIs) and graduate students at their institution. Students felt the TCAP was a "great opportunity" to gain research experience and receive research funding. All three students associated the TCAP with its research component of being a nation-wide effort of researchers improving barley and wheat breeding.

> *"To me TCAP means [a] big research grant. I tell my friends, 'I am on grant.'" – Student #3*

The two students who currently receive TCAP funding were asked about their expectations of the TCAP. Both students expected to receive hands-on research experience and gain more knowledge about the plant breeding process. Both also commented that the experience would give a glimpse of what a plant breeding graduate program would be like. In this way, the students felt that the TCAP experience was helpful.

> *"I expect to get some hands on [research experience] – more knowledge about the [plant breeding] process because I'm working with a graduate student and she's explaining a lot of things about statistics and how they're doing things in their program. I'm also learning about how to go about – what to expect from graduate school if I take this route in the future." – Undergraduate" – Student #1*

> *"I was hoping I will see what research is like and may be figure an answer to research question. I was excited about having an experiment of my own… I definitely don't work as much on my project as though I would be but even working in a lab with the graduate student I am working with, that definitely helped." – Student #3*

Students primarily reported conducting data collection duties, including planting seeds, caring for plants daily, documenting plant line observations, weighing samples, and counting kernels. One student mentioned also conducting experiments with the plants and writing up the results. They work primarily on their graduate mentor's research project. Students reported enjoying their work in the lab and did not feel there was anything that they particularly did not like to do. As for future work, one student was looking forward to harvesting and another was hoping to learn more about and perform association mapping. One student reported having prior research experience in plant breeding through summer jobs/internships and/or working in other labs.

> *"I mostly am just doing data collection for my graduate students' thesis project… Maybe next fall, I'll do a project on my own. For now, I'm observing and helping out… The data collection is fine – I like organizing and talking with [graduate student] about what to do." – Student #1*

> *"I did a lot of field work, lab work. I basically do all the things [graduate student] asks me to do, like weighing and stuff– a lot of data analysis, spreadsheet, etc." – Student 3#*

Of the three students interviewed, two students have not participated in any real-time online TCAP activities. However, two students reported viewing some of the online course recordings (one particularly mentioned the association mapping course), but both felt the content was too advanced to fully understand what it was about.

"I'm working on getting through the lecture series on association mapping, but I feel like it is over my head. I wish there were a more structured way to learn it at an undergraduate level." – Student #2

Relationships with others

Students reported working most closely with graduate students. They regarded graduate students as mentors and felt graduate students were very informative and helpful. They reported that graduate students helped them learn more about plant breeding by providing them with current academic literature, explaining the steps of the research, and teaching them how to do lab work. They also felt that graduate students were helpful in advising them about graduate school.

"[Mentor] got me set up and as far as lab work – I do most of it by myself, but [mentor] taught me how to do everything. When we were starting, [mentor] explained the basis behind the research and been working with me to decide what to do with side experiments. ***[Interviewer: To what extent do you feel that you've learned from your mentor so far?]*** *I've learned a pretty good amount. I didn't really know much about barely before I started the program so she taught me a lot about that. I've also – I've learned a lot about what to expect about being a graduate student in a breeding program – how they have research obligations instead of teaching obligations mostly and how much statistics is involved and what classes [mentor] wished [mentor] should've taken as an undergrad that [mentor would] advise me to do if I want to follow [in mentor's] footsteps." – Undergraduate student #1*

"[Mentor] has provided me with extensive literature related to my project and he's always checking up on my everyday to make sure that my project is moving forward and that the barley is being taken care of… If I ever have questions about graduate school, [mentor] has also answered a lot of those questions as well… I've been working in another lab as a general employee for three years and I think the structure of this program – seeing [mentor] everyday and having [mentor] supervise this project – is really helped me learn a lot just because it's so much more focused than what I do in the other lab." – Student #2

"I was hired under [mentor] but [mentor] became my advisor. Like this summer, I did a lot of field work and although I did not had as much an independent research [as I wished], I did not know much about it. So [mentor] really helped me." – Student #3

Other people that students reported working with was PIs and lab workers. One student reported meeting biweekly with the PI and their graduate student mentor to check in about the research. All three students reported working with lab technicians and assistants regularly to get their work set up and completed.

Future plans

All three students reported wanting to go to graduate school. One mentioned working in industry first and eventually going to graduate school afterwards and wasn't sure whether they will do masters' degree or pursue PhD. The other two were unsure if they would go right after graduating with their bachelor's degree and both reported wanting to work first before attending graduate

school. Two students reported wanting to pursue plant breeding, while third was undecided about what program to pursue.

> *"At this point, I want to go to graduate school – but I don't know if I want to do it right away after college. I think I want to try working and see what I really do want to do." – Student #1*
>
> *"After I graduate, I will at some point be going to graduate school for plant breeding. But I haven't quite yet decided whether or not I will go into the workforce for a year or two first." – Student #2*
>
> *"Right now I am just trying to see what industry is like, trying to get an internship in research station at [Seeding Company]. And after that, depending on how I feel about it either go to graduate school or stay in industry* ***[Interviewer: Are you thinking about PhD program?]*** *Right now I am just thinking about masters but it would be nice to do Ph." – Student #3*

Issues to consider

Based on the key findings from the interviews, the following are issues for the educational committee to consider. However given that only three undergraduate students were interviewed and that all three students were from the same institution, findings are biased and results, as well as issues to consider, should be interpreted carefully and within the context of the completed interviews.

- Undergraduate students who were interviewed are not involved in TCAP online activities. The educational committee should consider ways to increase undergraduate involvement and ways to make online activities and content appropriate at an undergraduate level.
- The three students who were interviewed reported having positive mentoring experiences with graduate students. This component seems to be very effective in teaching undergraduate students about plant breeding research and graduate education.
- One of the undergraduates interviewed mentioned that although they enjoyed working on the project they wished the research project had more structure to it. To this end, the education team should consider providing mentoring experiences for the TCAP graduate students on how to work with undergraduate students.
- There was a low response rate to the interview invitations, even after offering a $10 online gift card incentive. Evaluators and the educational committee should brainstorm ways to increase awareness of the annual program evaluation activities, as well as strategies for increasing participation of undergraduate students appropriately.

Appendix A: TCAP graduate student interview protocol

Good morning, my name is _____ and my colleague is _____. We are part of the evaluation team for TCAP and we are working with the TCAP educational committee to gather information about TCAP's educational component.

Let me first tell you about what the education portion of TCAP entails. TCAP's educational component consists of providing education and research opportunities for graduate and undergraduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field. Furthermore, the program aims to broaden graduate student education in plant breeding to include experiences that prepare students to be effective researchers in academia or industry by developing non-technical skills (soft skills) as well as creating opportunities to develop collaborative relationships and networks over time.

The questions today will center on your perceptions of TCAP. Information from today's interview will be used only for evaluation purposes. In our evaluation reports that will be shared with key stakeholders, we will not share who said what and great care will be taken to make sure that no one will be able to identify what you said. As you share your opinions today, please be as open and frank as you feel comfortable with being.

Our discussion today should take about 30-40 minutes. I will also be taking notes today so please bear with me. This interview will be recoded and if at any point you would like me to turn off the recorder just let me know.

Are you okay with being interviewed and providing your feedback about TCAP? (Need to ask for IRB purposes)

Background/Overview of TCAP participation

1. **NEW Students:** What led you to where you are today in your plant breeding program?

   Probes:
   - Interest in plant breeding
   - Recruitment in plant breeding program

   OLD Students: How far along are you in your program?

2. [So, I described to you what the education portion of TCAP entails] Please describe your involvement in the educational component of TCAP.
   a. What activities have you been involved in?
   b. What in your opinion is the most significant component of the TCAP educational program? Why?

[Further probes for Question 2]

- You have mentioned/did not mention participating online activities. What is your opinion of the online activities?
- How many new connections that have facilitated your work, with students or faculty, have you made as a result of participation in TCAP?

3. To what extent have you collaborated with students or others from other campuses as a result of using the on-line community (passel or PBNT)? How has this collaboration affected you?

Probes:
- With whom? Amount? About what? When?
- Follow up: How valuable to you are these opportunities to collaborate with other students or faculty? (would responses to be the same as the last part of #3 above?)

Follow up question:,
- [If response is positive]: What factors helped you to collaborate with students/others from other campuses?
- [If response is negative]: What factors make it difficult to collaborate with students/others from other campuses?

4. **NEW Students**: How do you feel about mentoring an undergraduate student?

   Old Students: How has your experience mentoring an undergraduate been so far?

   Probes:
   - What do you like/dislike about being a mentor?
   - To what extent do you feel this experience will be beneficial to you?
   - What concerns, if any, to you have about mentoring an undergraduate?

5. **[Both new and old students]** Have you had any experiences interacting with URM (blacks, Hispanics, and Native Americans) student?

   Follow up: to what extent do you feel you have learned something from your interactions with URM students or faculty?

Feedback on potential small group activities

The education team seeks to develop innovative approaches to graduate education that will equip students with technical knowledge as well as interpersonal skills that prepare them to be effective in their careers. It plans to pilot an approach that involves small groups of students and faculty working online to collaborative perform tasks such as analyze data or discuss experimental design.

6. How to what extent would you be interested in being involved in activities such as this? Do you have any concerns about this?

Additional comments about TCAP experience

7. Is there anything else you would like to add that would assist us in our understanding of your experience with TCAP?

Appendix B: TCAP undergraduate student interview protocol

Good morning, my name is _____ and (if interviewing in team) my colleague is _____. We are part of the evaluation team for the TCAP and we are working with the TCAP educational committee to gather information about the educational components.

Our conversations today will center on your perceptions of TCAP and will be used only for evaluation purposes. We will summarize all interviews that we do into evaluation reports that will be shared with key stakeholders; however, we will not share who said what and great care will be taken to make sure that no one will be able to identify what you said. As you share your opinions today, please be as open and frank as you feel comfortable with being.

This interview should take about 30 to 45 minutes. I will also be taking notes today so please bear with me. This interview will be recoded and if at any point you would like me to turn off the recorder just let me know.

Are you okay with being interviewed and providing your feedback about TCAP? (Interviewer Note: Need to ask for IRB purposes)

Background/Overview of TCAP participation

1. What are you majoring in? How far along are you in your program?

2. How did you become part of this [the TCAP] program?

Probes:
- What does the TCAP mean to you? What do you know about the TCAP?
- What do you expect to get out of the TCAP?
- To what extent do you feel being part of the TCAP is helping you?

3. Tell us about your research experience.

Probes:
[About project]
- How did you get involved in your research project? Did you join ongoing project or did the ideas originate with you?
- What are your main responsibilities in your lab? What do you like doing the most/the least? Are there things that you would like to do that you are not doing right now? If yes, what would like you to do more of?
- Have you had an opportunity to share or present your research? Where did you share/present your research?

[About relationships]
- Who do you work most closely with in your lab?
- Who mentor you in the lab? How does your mentor help you in your lab?
- To what extent do you feel you have learned from your mentor?
- Have you done anything related to plant breeding outside your research experience?

4. Have you participated any online activities as part of your project?

Further probes for a "yes response"

- Do you know who organizes the online activities?
- What is your perception of the online activities? Strengths/Weaknesses?
- Do you have any suggestion on how it can be improved?

Future Plans

5. What are your plans after graduating college?

Probes:

- Do you intend to go to graduate school?
    - If yes, where? What program? Do you plan to pursue master's degree or a PhD program?
    - If no, why not?
    - How did you come to your decision?
- Do you plan to continue working in/studying plant breeding?

Additional comments about TCAP experience

6. Is there anything else you would like to add that would assist us in our understanding of your experience with TCAP?

Results of the Year 2 PI Interviews

An evaluation of the Triticeae Coordinated Agricultural Project (TCAP)

Results of the Year 2 PI Interviews

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Introduction

The Triticeae Coordinated Agricultural Project (TCAP), funded by the United States Department of Agriculture (USDA), is an effort to improve the quality of wheat and barley breeding and increase the number of plant breeders, especially from racially and ethnically diverse backgrounds. TCAP's educational component consists of providing education and research opportunities for graduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field.

An evaluation with multiple components is being conducted to assess the progress of TCAP, including yearly surveys and interviews. The aim is to assess faculty and graduate students' perceptions of plant breeding education, perceptions of TCAP programming, collaborative relationships and networks over time, and the partnership with MSI institutions to promote the plant breeding field. This report presents the findings from the interviews with TCAP principal investigators (PIs).

Methods

In November 2012 through January 2013, 4 of 34 TCAP PIs were interviewed as part of the second year evaluation of the TCAP. Evaluators selected PIs for the interviews based on their geographic location, gender, ethnicity, and school size. All interviews were conducted over the phone and lasted about 20 to 55 minutes. PIs were asked about their and their students' involvement and perception of the educational component; their relationships with MSI faculty and students and how they saw themselves working with TCAP and MSI faculty in the future; and their beliefs about a programming idea to have small groups of students and faculty working online to collaboratively perform tasks such as analyze data or discuss experimental design. As a note of caution, the perceptions discussed in this report may not be representative of TCAP PIs given the small number of PIs interviewed. It should be noted that PIs likely have a range of participation in and perceptions of the TCAP's educational component that may not have been captured in the findings. A copy of the interview protocol is provided in Appendix A.

This report presents data concerning the main components of the interviews: involvement with and perception of the educational component, collaborations with MSI and TCAP faculty, and opinions of programming suggestion. Brief comparisons of these results with the results from last year are provided. Within these three sections summaries are presented followed by bulleted, italicized quotes. If included, questions posed by the interviewers are bolded. This followed by a summary of the main ideas suggested through synthesis of the data.

Summary of key findings

Involvement with and Perception of the Educational Component

Faculty were asked about their and their student's involvement in the educational component of the TCAP and what they thought was working well or could be improved. Overall, the faculty were

not highly involved although this had quite a large range. There was not a clear picture about what the educational component was, how it worked, or how it fit into the scientific portion of the TCAP. They did report that their students were involved and that they encouraged their students to participate. Even with the lack of full understanding, the faculty had positive perceptions about the educational component with no suggestions for changes. They felt the educational staff worked very hard. They felt the programming was relevant to both industry and academia and that it might be particularly good for industry because the students were getting a broad range of skills. They felt that the money to hire students was very helpful.

> *"They're going to get some plant breeders that they might have not gotten otherwise. We have a budget for training graduate students and a budget for training undergraduate students. … Industry is beginning to have well-trained employees in plant breeding." –Male PI #1*

> *"I've heard a lot of comments from industry – they are worried about that we will have a break of future new breeders. So our training of this set of students (i.e. TCAP students) will help that concern." – Female PI #1*

> *"This TCAP project is about trying to make plant breeding variety develop more efficient, more effective – essentially revolutionizing mapping using association type mapping versus five-parental mapping populations. So I think it has a very high potential to revolutionize plant breeding. Also, to hopefully train graduate students who are going to be very marketable in public and private sectors."* **Interviewer: What is the most marketable thing that they're going to have?** *"I think probably the most marketable things is that they not only have actually performed modern mapping techniques and know how to do it. If you have someone who knows how to do association mapping as well as traditional plant breeding, and someone who has a background in and knows how to do marker work – then they're going to essentially get a complete package and be able to hit the ground running when they are hired." –Male PI #2*

In terms of their students' involvement the faculty believed their students had been active participants. The faculty had positive comments about the seminars and the effect of the course although the course was less well known. One of the most common examples of good interaction was description of the work the students did to get the sensors to perform effectively. Another was student presentations/posters.

> *"It was difficult in the beginning. I've been in involved in similar things before. What impressed me was that the mini-course that was put together was really effective. It was almost like a real course where students come in, they listened to lectures, they did laboratories, they did exercises, they handed in homework, they get positive feedback – this is something that I can see that is working. And this is different from previous experiences that I've had." –Male PI #1*

> *"The TCAP provides student assistantships – it is enough to let them explore. For example, we have a travel budget assigned for students. And my student is able to attend the annual TCAP meeting and student workshops and also – my student also presented TCAP evaluation results at worker's meeting. ... They [the TCAP] are doing very well and plus the online seminar series*

and one class – we call it the association mapping class that is supported by the TCAP project – all of my students, no matter the funding source – they all attend the online teaching seminar series and association mapping class." – Female PI #1

In comparison to last year the faculty seemed more aware of the educational component and more positive and more able to describe their students' involvement.

"The project is certainly meeting their goals – if not exceeding them. I'm happy with the way the project is going. Jamie Sherman deserves a lot of credit – she works hard on this." –Male PI #1

"Overall, I think it is going good. I have budget constraints, but I am appreciative that I have a budget." – Female PI #1

Collaborations with MSI and TCAP faculty

Faculty were asked how they interacted with MSI faculty and underrepresented minority (URM) students and how they saw collaborations working in the future with both MSIs and TCAP institutions. Most of the faculty had not had any interactions with MSI institutions. Often they responded that their department or institution interacted with other institutions to help recruit URM students rather than personal involvement.

In terms of them interacting with URMs there was quite a range of experience. All responded that there were no differences between URMs and other students and that differences were related to the individual student not to race or culture.

"We work very hard to communicate to our students what the expectations are for a degree. We don't really treat anybody any differently – at least I don't anyway." –Male PI #1

"It's not that we're not willing and acceptable in teaching all people – I think the universities are pretty open minded, but it's just identifying students who – that's their career choice and that's what they want to do. I think there again it gets back to essentially making those (URM) students aware of the career opportunities early on in their undergraduate programs so they will at least know that these types of programs exist and are interesting." –Male PI #2

"I found the most successful thing is treating them the way I treat everybody else." –Male PI #3

The PIs went on to describe how they worked with their students, which was very hands-on and individualized. They would provide answers to any questions the students had and really try hard to meet individual needs. In terms of future personal contact with MSIs or TCAP institutions, most felt that what they had would continue; that complementary research goals held collaborations together. They had their research groups and would continue to work with them as they had before TCAP. There would be some movement of members in and out. They felt their institutions would continue to work to increase the number of URMs.

The information this year was very similar to last year. There may have been some movement toward more recognition of MSIs.

Programmatic suggestion

The faculty were generally supportive of encouraging student work in small groups. However there were questions about whether this would be the most efficient use of faculty time. The thought was that they already do this with their own students and that it might be better to share their expertise in a way the allowed greater numbers of participants.

> *"I think that it makes better use of faculty time if the courses were bigger. Our time is so limited – just making time for the one mini-course, it was a major undertaking. Small groups – if you do more than one small group – that takes time. … The problem is that I think that many faculty are already over-stretched and taking on additional activities is difficult. If we can combine activities for multiple students – that would make it more feasible." –Male PI #1*

> *"I can see that being successful. I see the small group effort – some applied. In my opinion, anything you can do that can get more applied science or more applied information or practical use to students is all the better. At the level that the graduate students are at, they need to be moved from theory into applied mechanics and so anything that the group can do to make more applied education happen is an onus."* **(Would your students participate in that?)** *"If it fit their programs and their needs." –Male PI#3*

Issues to consider

As was the case last year and as would be expected, faculty are most knowledgeable about the components of the TCAP they are involved with. Because faculty had different levels of involvement with the educational component of TCAP, they did not understand it very well. Despite this lack of in-depth understanding, they have very positive and hopeful perceptions of it and what it could accomplish. They did feel that their students were involved in the seminars and other opportunities and they said they encouraged that involvement. It appears knowledge and involvement has increased since last year.

In terms of collaborations, the involvement described above has seemingly increased the amount of interaction at least of the students. Involvement with MSIs is still low. The faculty do not see any need for 'special' attention to URM students, but they believe they provide all of their students with individualized attention. The faculty appear to be driven to collaborate to enhance their research, they believe that if the research is productive the collaboration will continue.

The new programmatic suggestion, although well received, raises the issue of what is the most efficient way to involve faculty in the educational component. There needs to be a balance in time spent between what faculty can do for the educational component and what they do for their own students.

Appendix A: PI Interview Protocol Year 2

Good morning, my name is _____. I am part of the evaluation team charged by the TCAP educational committee to gather information about the educational component of the TCAP.

Let me first tell you about what the education portion of TCAP entails. TCAP's educational component consists of providing education and research opportunities for graduate and undergraduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field. Furthermore, the program aims to broaden graduate student education in plant breeding to include experiences that prepare students to be effective researchers in academia or industry by developing non-technical skills (soft skills) as well as creating opportunities to develop collaborative relationships and networks over time.

The questions today will center on your overall perceptions of the TCAP program. Information from today's interview will be used for evaluation purposes only. In our various evaluation reports that will be shared with key stakeholders, we will not share who said what and great care will be taken to make sure that no one will be able to identify what you said. As you share your opinions today, please be as open and frank as you feel comfortable with being.

Our discussion today should take about 30 to 40 minutes. I will also be taking notes today so please bear with me. I will also be recording. If at any point you would like me to turn off the recorder just ask.

Are you okay with being interviewed and providing your feedback about TCAP? (Need to ask for IRB purposes)

Overview

8. I just described to you the education portion of TCAP. Can you please describe for me your involvement with the educational component of TCAP?

   Probes
   - What components have you participated in? How did you get involved?
   - What are your perceptions of the educational portion of TCAP?

   Further Probes:
   - What components of the TCAP have been working well? Why?
   - In your opinion, what is the most important part of the TCAP educational program? Why?
   - Please describe the successes and challenges of this program? In your opinion, what can be done to improve the educational component?
   - As a PI, what has been the most rewarding part of being part of the TCAP? What challenges, if any, have you experienced as a PI in the TCAP

- To what extent do you feel TCAP educational program addresses the interests of plant breeding industry (i.e. potential employers, plant breeding companies, industry scientists, other industry people who work with plant breeders)?

Collaborations

9. Have you or your students interacted with others as a result of the TCAP education portion?

   Probes:
   - Please describe any interactions that you, your graduate and/or undergraduate students have with other TCAP faculty members or students.
   - In what ways are your graduate and/or undergraduate students involved in TCAP?

10. How would you describe your relationship with MSI faculty and students?

11. Have you had any experiences interacting with URM (blacks, Hispanics, and Native Americans) student?

Probes:
- What have you found successful in working with URM groups?
- What challenges have you found working with URM groups?

12. How do you see yourself and/or your institution collaborating with TCAP and/or MSI faculty in the future?
    - In your opinion, what supports collaboration across institutions? What limits collaboration?
    - To what extent do you feel TCAP is contributing to supporting collaborations across institutions?
    - In your opinion, how will collaborations with faculty at MSIs affect recruitment of American-born underrepresented minorities to plant sciences?
    -

Additional comments about TCAP experience

13. The education team seeks to develop innovative approaches to graduate education that will equip students with technical knowledge as well as interpersonal skills that prepare them to be effective in their careers. It plans to pilot an approach that involves small groups of students and faculty working online to collaborative perform tasks such as analyze data or discuss experimental design.

    To what extent would you be interested in being involved in activities such as this?
    - To what extent do you think your students would be interested in this?
    - Do you have any concerns about this?

14. I don't have any more questions for you; however, is there anything else you would like to add that would assist us in our understanding of TCAP?

MSI student interview results in Year 2

An evaluation of the Triticeae Coordinated Agricultural Project (TCAP)

MSI student interview results in Year 2

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Introduction

The Triticeae Coordinated Agricultural Project (TCAP), funded by the United States Department of Agriculture (USDA), is an effort to improve the quality of wheat and barley breeding and increase the number of plant breeders, especially from racially and ethnically diverse backgrounds. TCAP's educational component consists of providing education and research opportunities for graduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field.

An evaluation with multiple components is being conducted to assess the progress of TCAP, including yearly surveys and interviews. The aim of the evaluation is to assess faculty and students' involvement in the TCAP, perceptions of plant breeding education, perceptions of TCAP programming, collaborative relationships and networks over time, and the partnership with MSI institutions to promote the plant breeding field. This report presents the findings from the interviews with students from partnering MSIs. In the 2012-13 academic school year, there were seven partnering MSIs including Chicago State University, Fayetteville State University, Lehman College – The City University of New York, Rust College, University of Arkansas – Pine Bluff, and Texas A&M University.

Methods

Between December 2012 and February 2013, 6 of 23 students from partnering MSIs were interviewed as part of the second year evaluation of the TCAP. Of the six students who were interviewed, there were four female students and two male students. Two students were undergraduate, and the remaining students were graduate students. Two of the graduate students interviewed participated in the TCAP in the 2010-11 academic school year and have since received their Bachelor's degree and are currently enrolled in graduate school.

Evaluators attempted to get a representative sample of students to interview based on institution and gender; however, after a low response rate to the interview invitation – interviews were open up to all students. Students received a $10 online gift card for participating. All interviews were conducted over the phone and lasted about 15 to 30 minutes. Students were asked about their involvement and perception in the TCAP's educational component, relationships with others in the TCAP, and future plans. A copy of the interview protocol is provided in Appendix A. The interview protocol served as guide for evaluators and questions were modified for graduate students.

Summary of key findings

Involvement with and perception of the TCAP educational component

Overall, students primarily became involved in the TCAP through their advisors. Advisors offered students the opportunity to get involved and participate in TCAP-related research projects. Students also participated in some online activities, such as participating in webinars, listening to pre-recorded lectures, and browsing through posted presentations. One student presented at a

national conference and posted the presentation online. However, students generally associated with the TCAP research portion of wheat and barley breeding rather than the educational portion.

Students are quite involved in research. They primarily worked on pre-existing research projects, rather than projects generated by students themselves.

> *"One of my professors gave me the opportunity to work in his lab where we did, umm, a research project on, umm, locating [genes] in wheat. And a lady from [a different] institution came, a plant breeder, and she presented her research in our school, and it was about plant breeding. And that is how I got interested in it. I have never heard of plant breeding before actually! " – Student #3*

Students' primary research responsibilities included: reading academic plant breeding literature, performing data collection responsibilities, working in the field harvesting, conducting experiments in the lab, performing plant and insect care duties, and assisting graduate students. Students reported liking the opportunity to discuss their research with other graduate and undergraduate students in the lab, and working in the field the best. While other duties were not so favorable, such as the need to be on campus frequently to care for insects and repetitive data collection duties. One student wanted to be doing a particular type of work, but did not have the equipment at their institution to do so. Most students reported no research experience in plant breeding prior to participating in the TCAP. Students also reported they liked the research experience, especially field work.

> *"Well I actually really, really enjoyed experiencing the field work. And understanding the planting seasons and what to look for when selecting a good line." – Student #2*

> *"I enjoyed the hands on field work. The research experience was great." – Student #3*

Overall, students worked most closely with the PIs/advisors in their lab and considered advisors as mentors. Students felt their advisors have taught them about plant breeding and conducting plant breeding research, as well as helping them to write proposals and work on their theses.

> *"I basically learned how to do research from [advisor]. I had very little research experience when I came into the lab." – Student #1*

Several students reported having the opportunity to complete a summer internship at the partnering TCAP institution. They felt the experience was very positive and reported learning and understanding more about plant breeding.

> *"I think it was a very positive experience – I come from a smaller institution – so got to see what research is like in a more research intensive institution… Everything was okay – everybody was very helpful and I had plenty of resources… The most important thing I learned in my time there is that – research is research. Most of the time it's never going to go the way that you want it to go – it's very unpredictable… I have to think about maybe research is never wrong - you just have to look at it a different way to interpret your results." – Student #1*

"With my background, coming into the internship, I never knew all of the different diseases that can effect plants – and all the different stress factors that are on the plant from the changing of the environment. That was really an eye opener and it basically got me excited about studying plants." – Student #2

"It was absolutely amazing ... And being that I have been working with plants for the past two years, it was absolutely amazing to see how much space and how much resources they have in their plant breeding department. Here, we basically have a green house ... and out there, we got to work in a huge field, and it was great. And, umm, I am a big fun of hands on and I would rather be out in the field than in the lab, running gels or something like that. So, I thought that was absolutely amazing. I got to work on different "versions of such and such" and that was very helpful. Umm, yeah, it was absolutely a positive experience. I can't say there was one negative thing about working up there ... I absolutely wouldn't hesitate to go back!" – Student #4.

Two students reported presenting their projects at conferences and enjoying that experience.

"We [had] different opportunities to present our project in different conferences, like a poster and PowerPoint presentations about it. ***[Interviewer: Has that been helpful?]****. Yes. In going to conferences, we get the opportunity to learn about what other people are doing in the same field." – Student #3*

When asked about what could be improved about the TCAP project and in terms of recruiting minority students to plant breeding, several MSI students reported that most MSI undergraduate students are not aware of plant breeding and the TCAP project. Some offered recommendations on how this could be changed.

"I would say most people are like ... most undergraduates were not exposed to [TCAP], do not know about it ... so it need to be broadcasted more so people can learn more about it and go in, specially [mumbled] research in plant breeding." – Student #5

"Get the word out there, may be, umm, go into small universities such as the one I work in, and presenting just what works because I am sure there are many other students who don't know about plant breeding. And, you know, that could be obtained from somebody coming out and speaking about what plant breeding is and how useful it is today."– Student #3

Overall, students greatly valued the opportunity to participate in the TCAP.

"Being in the program – it means a lot to me. It's giving students more opportunities to take part in some research and I'm grateful for that. It's different experiences with other graduate students and other mentors – it broadens your horizons." – Student #1

"The main thing – is just how much the experience I had with the TCAP internship impacted my decision to come to [current TCAP institution] to actually study plant breeding. And without that, I'm not sure if I would've actually came." – Student #2

"I actually thing it is a great program. Umm. and like I said, I didn't even know what plant breeding was before, and I am biology major and it just opened up a lot of research opportunities for me to go forth in my educational career." – Student #3

"A strong point about the project is you learn about the importance of plant research. And It actually strengths people who want to go into research and may not know about plant breeding, kinda opens another door and you get a lot of experience as well." – Student #5

Relationship with others in the TCAP

Students who participated in summer internships were more likely to have more frequent contact with TCAP faculty and students outside of their institution than students who did not have that experience. Students who completed a research summer internship at their partnering TCAP institution reported being able to maintain relationships with TCAP PIs and graduate students afterwards – mainly through email. One student reported continuing the research and is currently still working with TCAP PI and graduate students. Another student reported developing a close mentoring relationship with a TCAP graduate student after completing the internship, where the TCAP graduate student helped give advice about graduate school and being a PhD student. In addition, a different student was inspired to pursue plant breeding as a result of contact with a plant breeder researcher from TCAP institution.

Future plans

Students were asked about their future plans. Of two students who were completing their master's degree, one student plans to work for a year before pursuing a doctorate's degree – preferably in program with a combination of microbiology and entomology – and the other student plans to pursue doctoral studies in a field other than plant breeding. Two current MSI students are considering their partnering TCAP institution as an option for pursuing graduate programs – one is considering pursuing a doctorate's degree, while the other is considering a master's degree, both in plant breeding.

The two former MSI students who participated as MSI students last academic year are currently enrolled in a graduate programs – one in a PhD program in a crop science at the partnering TCAP institution as a result of participating in the research summer internship; the other in a non-TCAP institution pursing a master's degree in biomedical field with the hopes of entering a MD/PhD program. When one student was asked what they would like to do once they complete their PhD, the student responded,

"At the moment, I'm thinking I'd like to be a consultant to the growers; so kind of that liaison between the growers and the plant breeders at the universities, so I can discuss with the growers what's needed in their area."– Student #1

Students reported that their advisors are very involved in helping to guide students and their future plans. Advisors frequently email different opportunities to students and encourage students to go to their partnering TCAP institutions for graduate studies.

*"**Interviewer: Have you thought about where you might go?** For a PhD, because I went for the summer at [TCAP institution] – I think that would be a good option. I know everybody and they offered me a chance to come back if I would like. Right now, that's my only concrete choice, but I do like [a non-TCAP institution] too." – Student #1*

"Definitely continue my education. Now, I am actually thinking about doing more research in wheat … at [TCAP institution]. **[*Are you thinking about PhD, or -*]** Actually, I am not so sure yet but, uh, depending on the research, yes, I would potentially do a PhD*." – Student #3*

Issues to consider

Based on the key findings from the interviews, the following are issues for the educational committee to consider:

- Students who completed a summer research experience at partnering TCAP institutions were very appreciative of the opportunity and felt it was a very positive experience. Additionally, these students were more likely to interact with TCAP PIs and students and consider the TCAP institution as an option for graduate studies. If possible, funding should be allocated to offer summer research opportunities to all MSI students.
- While most MSI students are undergraduates, there are a couple graduate students pursuing a master's degree. To encourage greater interaction among students, the educational committee should consider inviting graduate MSI students to all activities for TCAP graduate students.
- MSI students commented that many undergraduate MSI students are unaware of plant breeding programs. These students tremendously appreciated the exposure they got through the TCAP program and recommended the program "broadcasted" more widely to MSI institutions. Efforts should thus be made to advertise TCAP institutions and TCAP projects at MSI institutions
- Students reported enjoying presenting their projects and getting results. Different venues should be made available for these students to present their research projects.

Appendix A: MSI student interview protocol

Good morning, my name is _____ and (if interviewing in team) my colleague is _____. We are part of the evaluation team for the TCAP and we are working with the TCAP educational committee to gather information about the educational components.

Our conversations today will center on your perceptions of TCAP and will be used only for evaluation purposes. We will summarize all interviews that we do into evaluation reports that will be shared with key stakeholders; however, we will not share who said what and great care will be taken to make sure that no one will be able to identify what you said. As you share your opinions today, please be as open and frank as you feel comfortable with being.

This interview should take about 30 to 45 minutes. I will also be taking notes today so please bear with me. This interview will be recoded and if at any point you would like me to turn off the recorder just let me know.

Are you okay with being interviewed and providing your feedback about TCAP? (Interviewer Note: Need to ask for IRB purposes)

Background and Overview of Project

15. What are you majoring in? How far along are you in your program?

16. How did you become part of this [the TCAP] program?

Probes:

- What does the TCAP mean to you? What do you know about the TCAP?
- What do you expect to get out of the TCAP?
- To what extent do you feel being part of the TCAP is helping you?
- What did you know about plant breeding prior to your research experience?

17. Tell us about your research experience.

Probes:

[About project]

- How did you get involved in your research project? Did you join ongoing project or did the ideas originate with you?
- What are your main responsibilities in your lab? What do you like doing the most/the least? Are there things that you would like to do that you are not doing right now? If yes, what would like you to do more of?

[About relationships]

- Who do you work most closely with in your lab?
- Who mentor you in the lab? How does your mentor help you in your lab?
- To what extent do you feel you have learned from your mentor?
- Have you done anything related to plant breeding outside your research experience?

18. Have you had the opportunity to visit your TCAP collaborator institution? If yes, please tell me about your experience.
    Probe:
    - What went well?
    - What could be improved?
    - What is something important that you learned during your visit?
    -

4. Please describe your interactions with TCAP faculty and graduate students.
    Probe:
    - How often do you communicate?
    - What do you communicate about?

5. Have you participated any online activities as part of your project?

Further probes for a "yes response"

- Do you know who organizes the online activities?
- What is your perception of the online activities? Strengths/Weaknesses?
- Do you have any suggestion on how it can be improved?

Future Plans

6. What are your plans after graduating college?

Probes:

- Do you intend to go to graduate school? If yes, where? What program?
- Do you plan to continue working in/studying plant breeding? How did your involvement in the TCAP program impact your decision to pursue or not pursue plant breeding as a career? [If planning attending graduate school] Do you plan to pursue master's degree or a PhD program?
- How was your advisor involved in your graduate school decision making process?

Additional comments about TCAP experience

7. Is there anything else you would like to add that would assist us in our understanding of your experience with TCAP?

Results of the Year 2 MSI and Collaborator Interviews

An evaluation of the Triticeae Coordinated Agricultural Project (TCAP)

Results of the Year 2 MSI and Collaborator Interviews

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Introduction

The Triticeae Coordinated Agricultural Project (TCAP), funded by the United States Department of Agriculture (USDA), is an effort to improve the quality of wheat and barley breeding and increase the number of plant breeders, especially from racially and ethnically diverse backgrounds. TCAP's educational component consists of providing education and research opportunities for graduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field.

An evaluation with multiple components is being conducted to assess the progress of TCAP, including yearly surveys, and interviews. The aim is to assess faculty and graduate students' perceptions of plant breeding education, perceptions of TCAP programming, collaborative relationships and networks over time, and the partnership with MSI institutions to promote the plant breeding field. This report presents the findings from the interviews with MSI faculty and their TCAP faculty collaborators.

Methods

In November 2012 through January 2013, seven MSI faculty and six TCAP faculty collaborators were interviewed as part of the second year evaluation of the TCAP. All interviews were conducted over the phone and lasted between 25 to 55 minutes. Both sets of faculty were asked about their and their students' involvement with and perceptions of the educational component, their collaboration with each other and students, how the collaboration affected them, how they saw themselves working together in the future, and how they supported their students. Slightly different versions of the interview were used with the different types of faculty in order to tailor the questions to the context. The MSI faculty were specifically asked about requirements they had to recommend graduate school institutions to their students. Copies of the interview protocols are provided in Appendices A and B.

This report presents themes that emerged through analysis of the interview data. Themes included supports and challenges to: face-to-face interactions, collaborations, and educational components. There appeared to be a range of answers within the themes with themes overall being positive. Those MSI sites that participated in Year 1 site visits generally had more positive responses. These MSI sites had been selected for the year one site visits based on initial perceptions of how likely their collaboration was to continue through the five years of the project. The summaries of the key themes are presented below followed by italicized quotes. If included, questions posed by the interviewers are bolded. This presentation of the themes is followed by a summary of the main ideas suggested through synthesis of the data.

Summary of key findings

Face-to-face interactions

Some of the MSI sites were visited by their collaborating TCAP faculty members. In those cases both the MSI faculty and their TCAP faculty collaborators felt the visits had positive outcomes. Both felt that the visits strengthened the collaboration. Both also felt that they learned more about each other and about each other's context with the TCAP faculty learning more about the MSI faculty member's skills and what their labs were capable of.

> *"Site visits are important. The visit opened more avenues of discussion. Without the site visits, all we would be doing is sending e-mails. After the site visit, [TCAP collaborator] sees what we are doing [and] realizes that we are doing something significant now. I think the communication is getting better and better and better." – MSI PI #4*

> *"Definitely a visit. Both me to their university and them up here. That is first and foremost. I think you have to know who you are working with and be able to talk with them and meet them in person, and see what facilities you have to work with- so that definitely helps the collaboration. Good communication helps. So its really just good communication, knowing what [MSI PI partner] needs, what our goals are." – Collaborator #4*

> *"I think our relationship is better. Probably because I went down there and that was very useful for all of us. So I would say better 'cause I can visualize what we are talking about now. It helped me to understand the capabilities of what they are set up to do. For instance, [MSI PI partner] is a [occupation] and I'm not- and I'm more like can grow plants well, and that's not [MSI PI partner's] expertise and we sub-divide our duties for this joint project. So it's nice to see the facilities [MSI PI partner] has, and some are very good. They are excellent, so that's what [MSI PI partner] should concentrate on, I can concentrate on other parts of the project." – Collaborator #6*

The MSI faculty felt that the visit helped to increase student interest in plant breeding and helped to dispel negative perceptions of plant breeders as farmers.

> *"Students have increased their appreciation of the field of plant breeding. For example, when [TCAP collaborators] came and talked to students about the field of plant breeding, [TCAP collaborator] told [their] story. [TCAP collaborator's] original intention, how [TCAP collaborator] wanted to research other things before stumbling into plant breeding and how their interests developed in this field and that has resulted in where [TCAP collaborator] is today. Students learned more. Because in this [geographical] area, whenever you talk about agriculture, students don't like it so much. Because some people don't like it very much because they relate it to what happened in U.S. history. It is not like that. People think of agriculture of going to stay in the sun and driving the tractor. My students don't want that. (Laughter) The point they learn is that plant breeding research is done in the lab and scientists design and produce new crops- then they go to the field to make sure that the crops are growing in the way that they intend. Some of them didn't know this until [TCAP collaborators] came here." – MSI PI #4*

"[TCAP collaborator] was here and it was a very interesting visit and [TCAP collaborator] talked quite a bit and based on what [TCAP collaborator] saw, we talked about ways to improve collaboration with my faculty member. [TCAP collaborator] looked at the program and the research, and specifically addressed students. We arranged students to be able to hear [TCAP collaborator]. The hall was full, more than 100 students were there. [TCAP collaborator] talked to them about the importance of plant breeding and the students appreciated it so much, and some of the students have already made inquiries about what it takes to be a plant breeder." – MSI PI #5

Several of the MSI students made visits to TCAP institutions. How the visits were paid for varied with some support coming from the TCAP institutions and some from the MSI institutions. The TCAP faculty enjoyed hosting the MSI students and found them of high quality.

"In the past year with that money, we were able to support one of my students to go to [TCAP institution] to do – this past summer – to do her research… And [student] get trained there and [student] conducted her research – [student] got good results, of course some results are not ideal, but [student] got results… If I didn't have TCAP money – I would not send my student to [TCAP institution]. Then we would not have such a close relationship. Because of the TCAP, we actually got to send our student to [TCAP institution]. And it was very good to our students because of the work ethics there. And our students, they see with their own eyes how hard you have to work as a graduate student if you want to competitive." – MSI PI #2

In one instance, based in the internship experience, A TCAP collaborator identified a graduate school assistantship at their institution. A MSI student attended the institution in pursuit of a PhD.

"The student visits were great. We had students come up, they worked in different labs. Most of the work was related to the TCAP grant. They worked on drought resistance and collected data. … It was a series of events where everything worked out. So they were interested in breeding. We has some assistantships that were coming up and one of the students that we thought was coming up here, decided not to, which opened an assistantship just about the time that students were coming up for the summer. So we kind of got a feel for the students and we got to meet with them and see them work. One of them fit perfectly into the project we had. Their main advisor will be USDA breeder, that was the project that opened up, and fit really well for the student." – Collaborator #4

"Because of our relationship with TCAP, the student had access to the scholarship. I think that is our #1 achievement." – MSI PI #5

The MSI faculty and the collaborators reported having mentoring relationships with their students. They describe helping students learn how to work in the lab through direct hands-on instruction which was important to them because they felt that is how people learn best. They felt that they tailored their mentoring to each student because each was unique in terms of what they needed and wanted. They tried to find out what the student needed and then determined how they could help provide that.

"We have to be with our students in every step of the way. At least at the beginning of – they are experiment. We have to train our students by ourselves. And our students, if they have questions they have to ask us – not anybody else. So that's a problem for such a small institution – there are very few faculty doing the research. Especially nobody is doing the same research as mine – so I have to be the one to solve all the problems. ***[Interviewer: Okay, alright that makes sense. Do you mentor them in any other way besides research?]*** *Uh yes – for their presentations… I have to really get involved and tell [student] how to do the presentation – the presentation, look at the slides with [student], listen to [student] practice several times before the presentation.* ***[Interviewer: Any other ways you mentor?]*** *Push them to make contact with people and for them to find a mentor for PhD program. Those kinds of things – I actually talk to my students all the time. The reason I want them to go outside – the research is to let people to know them and contact them for the PhD degree." – MSI PI #2*

"For undergrads, for all my students for that matter – we have weekly meetings. They meet with me each week to discuss on project that have been accomplished in the prior week and we discuss a way forward. That's a formal meeting – meaning that on my calendar, on my time table, on their calendar – there's a window of time for us to meet, one hour a week… Outside of this, some of them – depending on their level of experience – I actually work with them in the lab on the bench – saying 'hey, this is how you do this, this is how you do this, this is how you do this' – those such meetings come as needed. In other words, if they are having a challenge doing something – then I find time to deal with them on the research bench and get them to do it hands-on." – MSI PI #3

"Mentoring gives students some direction, because a lot of the students are absolutely clueless. They need direction. They can only get so much out of classes. So mentoring one on one with researchers is an important part of students becoming researchers. I try to talk them about options after undergraduate education. I tell them all about research, where they can apply and I strongly preach to do internships and go to conferences. This year I have encouraged at least three students to move on to graduate school." – MSI PI #7

"I try to be honestly and frankly – I first ask them what they want to do for [their] future. If they want to work on plant breeding, I tell them what we do and I also tell them the mechanics of how to be my students – so working summers in [institution] and taking classes on school campus and after they finish classes they come here to work full time on their projects. I know most of the professors within the TCAP project; so [I] always refer them. For example, some students want to do quantum genetics – more mathematics and informatics and I just refer them – go to Mark Sorrells or Kevin Smith. If people like to do cloning gene function – George Slavry is a good place to go. If they want to do traditional breeding – Carl Griffey and some breeding programs are very good and involved more in breeding – traditional plant breeding. [If students] like disease – I refer them to Mike Humphrey – this kind of thing. I just help students in this way." – Collaborator #1

"I get [undergraduate students] into the lab and I try to get them working on their project. The way we get our undergraduate is usually like they – maybe they just need a job and so they'll start out doing dishes or something like that or threshing seeds. And someone of them will maybe want to do a research project. Our university requires students to do a semester research project and so sometimes we have students contact us wanting to be in the lab to do a project. And in that case, we get, we get, you know, them going on a project that kind of has a umm, you know – hopefully has a little bit of a goal to it – you know it's succinct enough where they can kind of get somewhere in a semester. You know, I want them to understand the project; I want them to be able to write it up. The actual mentoring part really just depends on the student. Some students like to work independently – once I get them going where they know how to do everything they come into the lab and do it, so." – Collaborator #2

"Mentoring is very important. I didn't have this opportunity of being mentored as an undergraduate. When I started teaching, I didn't even know of that word mentoring. But my interest has always been for my students to get further than I am today. How can I get my students to be somewhere better than where I am? In my classroom today, sometimes they call me the preaching professor. I preach! I tell them about life and how they can succeed. How we can work to accomplish our goals and what it takes to get there. You have to direct him or her on how to succeed, using your life experience to direct the student where to go. Very Important! … For those that are looking at plant breeding or plant genetics as a career, I try to get them as much hands on experience as possible, in as many areas as I can so they are walking in the fields, learning the breeding scheme and the structure of the program. In the winter I have them in the lab with me. Just trying to give them a well-rounded experience so that they understand markers. I try to get as involved with them as I can, taking them out and I have great technicians that are dedicated also to helping them. They see that the professors are people just like anyone else. I think undergraduates have this fear of finding out what professors do every day, so I try to give them a sense of what I do every day. Because I want to give them a sense of what I do. A lot of times people hate their PhD and they don't love what they do. They end up writing grants all of the time. So yeah, I spend time in front of the computer, but I also get to spend time in the fields. I'm still doing what I love." – Collaborator #4

Support for students in terms of going on to graduate school was mostly writing letters of recommendation and telling the students what they knew about different institutions and different people. The diversity of the graduate institution was not a primary consideration in terms of their recommendations for their students. The more important consideration was goodness of fit between the graduate student skills and their research interests with their future faculty advisor.

"I think that program has to appeal to that individual. It has to appeal to that individual's goals in life. The requirements for the program must match what the student has. If the program doesn't have what the program is demanding than the student isn't a good fit for the program." – MSI PI #4

"I would look at the research faculty. The graduates and where they are placed. With PhD programs, its more about the advisor, rather than the institution itself." – MSI PI #7

"Any place would be good depending on the interaction of the student with their advisor." – Collaborator #6

The quality of the program was also an important consideration.

"The easiest way for me [to recommend a university] – I come from a state university so I know the state universities pretty well. I know people and probably recommend them to the ones I know." – MSI PI #2

"I've had to edit some of their writings, I've recommended certain programs for them. ***[Interviewer: What makes you decide what programs to recommend? How do you decide that?]*** *For the most part, it's based on the strengths of the program as I perceive it… The current collaboration with TCAP members may make my life a little bit easier in terms of having much more options in the number of institutions I can possibly recommend my students to apply to... I often try to look beyond just the program itself – I look at the – what is it ultimately the student get from meeting that – or directs or guides him or her to his or her career goals. So I think take that into consideration – that is the fact that, I assess or I attempt to assess the university being able to meet the needs of the student in terms of his or her career goals." – MSI PI #3*

"A lot of it is personnel, you get to know a lot of breeders. You want your best students to go to the best programs. It's really hard to recommend your students to go to a program that you might not have respect for or a program that struggles. Just to recommend students to programs that are good and structured. I have seen how they work; they have high-level expectations for students. And again, I'm sending out my best students so I want them to be challenged at the next place that they go to as well. Hopefully they can keep growing and get better. Knowing the interests of students, knowing which programs have areas of interests. You have to look at those programs and what programs are best suited for those students." – Collaborator #4

Collaborations with MSI faculty and their TCAP faculty collaborators

The collaborations were generally working well. Some were much stronger than others. It appeared that several conditions were supportive of collaboration, including previous relationships, mutual interests, and mutual respect for the faculty and institutional capabilities. It appeared that while shared research interests provided the 'glue' for the collaborative relationship, mutual respect and understanding was just as important

"We've been collaborating with each other before TCAP. ***[Interviewer: So you plan to continue like before?]*** *Yes.* ***[Interviewer: What do you think is the most important to support that collaboration?]*** *Well my own research is on plant – plant genetics and plant breeding. TCAP is just aligns with my research goals. And it's training our students – that's great." – MSI PI #2*

"My collaboration is going well. We communicate on a needed basis. In terms of [student], the collaboration has certainly grown. For me, it's always been fine. I've collaborated with [TCAP collaborator] before, and [TCAP collaborator] is a great mentor. I see that if [student] goes in to the PhD program, [TCAP collaborator] will continue to collaborate on this project with me and we will continue to have [TCAP collaborator] a part of this project and we will also have [them] be one of the thesis committee members for [student]. We have pursued grants together before." – MSI PI #7

"I think it's a positive relationship. It's very cordial. We don't touch base, uh you know, like every week or anything like that. When [MSI PI partner] has something to share, [MSI PI partner] shares it. Right now, I'm sort of – if I have something to share, I'd share it with him. So that's kind of the way it is – we're not – [MSI PI partner] doesn't need information from me or anything like that to make it work. He's working away at that. I think that when [MSI PI partner] gets information – the data – we'll probably talk more like when we're in the writing stage or something like that, or if we do get to the point where we can write a grant together." – Collaborator #2

"Certainly enjoyable and fruitful for both of us. I mean it's another sort of learning experience to have students, these undergraduate students that are the main person that I have some input from far away is a new thing to learn. The challenging part is the day-to-day stuff. When you are in your own lab with your own students, you kind of know when stuff isn't going right, but I guess it's a matter of having faith in [MSI PI partner], which I should because [TCAP MSI PI partner] is a very good scientist. [MSI PI partner] can take care of all of that [own their own]. Right, and are we thinking of things the same way? And we do communicate by e-mail and phone, and its fine, something that you have to get used to and do periodically-communicate." – Collaborator #6

Lack of time and money for the MSI faculty sometimes hindered the collaboration. Of critical importance in building collaboration is the ability and willingness of the collaborators to communicate with each other.

"What we need more of is time. Right now, my teaching load is kind of crazy. I'm having a hard time finding the time to work on my project with my student. Last year was bad, but this year is even more. I am teaching more classes this year. My collaborator knows about my challenges. I think [TCAP collaborator] is understanding." – MSI PI #6

"If anything, more funding. Right now, I can fund one. If I can fund more than one to the program, it would be fantastic- and the point is to have more minority representation. And it should be both, continue to fund current students and to add more students. You want to maintain students in the plant sciences, you want to retain students. [Student] is applying to a PhD program in the plant sciences to different universities. [Student] is going down the plant sciences path. That's a huge step forward. … We do have a huge teaching load. That is something TCAP in working with MSI's – if we could get a break with our teaching load as part of the TCAP grant and focus more of the research, that would be a huge, huge advantage for researchers. Because when you teach at a major land grant institution, the faculty have very minimal teaching load as opposed to faculty like us that are doing teaching and research. That makes a huge difference." – MSI PI #7

The ability to communicate and conduct collaborative research was sometimes confounded by distance, for example if the collaborator were at a field station that was already removed from the main institution or if samples traveled long distances, they could be destroyed in transit.

"I think it's working well. ***[Interviewer: Can you think of anything that should be changed or you think that might be improved?]*** *Well, it's hard to say anything, but we definitely want more money. (Laughter from both****.) [Interviewer: What would you use the money for?]*** *We can actually – if we have money that can support a student for at least a year that would be nice. … The students, we don't pay the students. Sometimes, It's hard to make the students work as much as we want. If can actually provide an assistantship for the student – we actually can be able to really hire the students we need to work or make them work." – MSI PI #2*

"In terms of challenges – more money is always better, right? Money is always the issue in most cases. If I had enough resources, I would have been able to keep [two] very good students – but because I didn't have the resources to keep [student] in my lab in the summer, [student] joined [another lab]… In most cases, every little money here and there will go a long way." – MSI PI #3

"The number of students that want to come work with me, up to four, I am not able to work with all of them because I need more funding." – MSI PI #5

"The money my collaborator got was not enough to complete the project. [MSI PI partner] needed to use additional funding to complete the project in order to publish… The work we are doing – the budget is less than what we are doing. For example, we need four people, but we only have two people budget. Also because the budget supported the evaluation – we evaluate for five years and each year we have different sets of materials. In order to let students publish their results, I have to make an extra effort to repeat a second year. … It is extra work I have to put in. For a five-year budget, I see a nine-year project." – Collaborator #1

"I think the money has to be there. There could be an interest to work together, but if there's not the financial support, I don't think it's probably going to happen… No one can work on anything without support. I mean I think [MSIs] can a little bit more than we can because they got support in their budgets, they've got a little bit of research money, but it's not enough... ***[Interviewer: So to what extent do you think the TCAP is contributing enough-supporting enough to these collaborations?]*** *Well, I think that, I think that – I mean I don't know, I'm not… Um... I think most of the MSI faculty feel like they could use more money and I'm sure they could, I guess it just depends on what your goal is. I mean I kind of think of it more as a start up. And then if you can use it that way to write a grant, then you know that would – that would – if that happened it would be a really big success I think… Because the TCAP isn't permanent." – Collaborator #2*

"Part of it is just preparing samples and having them sent there. You always worry if something gets lost or damaged being shipped or they sit on a plane tarmac that is 100 degrees and you kill all of the nematodes in the soil sample, which we can get around. You know, the other thing is just if one of us want to travel or do any kind of work, it is pretty much limited. If [MSI PI partner] wants to come out here and look at the fields, [MSI PI partner] might be able to make one trip per year but it just a full day of travel just to get out here. It would be a different story if [MSI PI partner] was collaborating with [a geographically closer institution]. Just because of where I'm located in the middle of nowhere without a major airport." – Collaborator #4

"It's definitely distance. I mean its not like challenges that can't be overcome. Like for instance, if we are growing plant tissue to send to [MSI PI partner], its just like a little bit of extra work to make sure things are set up appropriately- with the right mail service, the right day, that type of orchestration. Its nothing that can't be overcome, its just a little bit more work than it we were doing something ourselves but it's no big deal." – Collaborator #6

The collaborations were seen as requiring an acceptable amount of time and commitment. The amount of time varied over the course of the research with more necessary at the beginning for the planning, then a decrease, then a second increase in time to engage with the student. Because the students were located at the MSI institution, The MSI faculty spent much more time on the MSI research and MSI students than the collaborators, although the several TCAP faculty communicated frequently and supported MSI students significantly during summer internships when available.

"We do have a very good frequent communication. ***[Interviewer: How much time would you say you spend working with your collaborator?]*** *With [collaborator], probably I'd say about 3%, but you know… I also work on more when the population [data] started.* ***[Interviewer: Do you think your interactions with them have changed at all over the TCAP?]*** *Yes, I think there are more frequent interactions." – MSI PI#1*

*"We've been in contact whenever we needed – we don't count the effort, I think it's quite a routine. Another good thing is – for my student working with [TCAP PI] – [TCAP PI] was very happy with [student's] ability and future and potential... [**Interviewer: How much time do you spend working with [TCAP PI]?]** I think five hours a month probably is fair, but when my student was at [TCAP institution] – I probably [spent time] much more than that because my student constantly contacted me to ask me questions. So sometimes it was five hours a week. **[Interviewer: How much time do you think your collaborator spends?]** For the summer – that's about three months – so two and a half months. I'd probably say at least two hours a day. [**Interviewer: With your student?]** I would think so because when my student went to a new environment and needed a lot of help with everything. " – MSI PI #2*

"Quite a significant amount of time. If you look time in terms of my email correspondences with them, that is quite big. If you look at time in terms of visits that is quite big. I actually made a trip to [TCAP institution] – I spent a whole day with [TCAP PI]… We've been making a deliberate effort in our collaboration." – MSI PI #3

"The program is progressing well. My student did [a] summer internship. [Student] got to work with my collaborator and learn new stuff. It was a great learning experience." – MSI PI #7

"[MSI PI partner is] working on this project and interacting with the students on a daily basis. So [MSI PI's time commitment] is more like 10 hours a week or like – something like that. Or like 5 hours a week, but [MSI PI partner] put more effort into it [compared to me]." – Collaborator #2

"Just having the interns come up, it was a pretty exciting part. Just getting them exposed to a plant breeding program and kind of outside of what they are used to and getting them some hands on work... that was pretty rewarding." – Collaborator #4

There was agreement that the collaborations were valuable and would continue. They felt now that they knew each other it would be easier to continue although at least one person felt it might be easier to collaborate with other MSI faculty that they knew better. There was special interest regarding continuing to have students from the MSI institutions visit the TCAP institutions.

*"The major value is yield – what's going on now – updating information. We have a very structured work on wheat, wheat improvement, we have breeders, we have stress facilities – I'm working on genetics. And I think there is a pathologist and an entomologist - so largely we try to measure their reflectance. **[Interviewer: Yeah, yeah, right.]** The TCAP group also - there are many groups also measuring the reflectance. Sometimes they communicate their work – those kind of information are also valuable for us to think about what we can do and the work we can improve." – MSI PI #1*

"Personal relationship – personality – you really get to feel comfortable with any given individual person regardless, even though I mentioned money at some point – regardless of how much money it is – if a person with whom you are collaborating is difficult to reach or difficult to communicate or doesn't respond to emails or things like that – uh, uh, that's an impediment." – MSI PI #3

"There is a lot of value. Before this project, I didn't know anything about the TCAP project. The project is opening people's eyes into the importance of the project. What has been rewarding is my opportunity to know [TCAP collaborator]. I would not have known him without this program. I would have not been able to know Jamie. I would have not been able to know you. Because now, if I have a question about evaluation, I can give you a call. These are the things we don't even think about. In terms of research, I know I will be able to get 1 or 2 publications out of this." – MSI PI #4

"With any collaboration you get the exchange of ideas and resources. You can work on much bigger projects as opposed to just working for yourself. The only improvement to the collaboration is that I would like more interaction between the institutions. UNL has a large pants sciences program, so if we could get more than just the TCAP program students to participate. If UNL could sponsor more students from C…if there was some sort of established relationship, that would be great." – MSI PI #7

"Just having the interns come up, it was a pretty exciting part. Just getting them exposed to a plant breeding program and kind of outside of what they are used to and getting them some hands on work... that was pretty rewarding. Second, getting more colleagues, more collaborators across the US. To have different colleagues across the US that you can draw on their expertise." – Collaborator #4

Educational Component

The MSI faculty and their collaborators reported only some involvement in the educational component of TCAP and few had in-depth knowledge of the programming. Despite this, they offered very positive comments about the educational component, its leaders and the on-line activities. Some requested on-line courses for credit across institutions

"I think overall it's a very good collaboration and it's a very good program. For me to join or to interact with the TCAP – because you know, I really prefer to be part of a… actually… because it really fits very well for my program and for what I'm doing every day. " – MSI PI #1

"Overall, I think it's going really good. Like I said, I have budget constraints, but I appreciate that I have a budget. … It's better to have a budget even if it's not enough. … It has really helped me and I really appreciate it." – Collaborator #1

"My overall perception is great. It's a great idea. I haven't been able to sit in on any of the online courses. I think the whole concept is good. Mainly I have been involved in the MSI work and also talking with Jamie on developing a nationwide course structure. Trying to get a nationwide system that we can take courses across the country. … Jamie does a good job, and the people that work with her in Nebraska and Minnesota – they seem to do a good job." – Collaborator #4

They believed their students were more involved and that the students had participated in some of the offerings.

> *"I definitely, definitely continue. I, myself, really want to join the big effort in the next cycle." – MSI PI #1*

> *"I think the program as it is, is going quite well. I would very, very strongly want to advocate for an expansion to give students opportunities to travel and form their own impressions of institutions rather than me as a faculty member shoving it down their throat. If the program can extend its arm to accommodate greater support in formal stipend to interact with the other students – graduate students at the TCAP institutions – that will go a long way to enhance the ultimate outcome of the program." – MSI PI #3*

> *"The website seems to be up and running. I think my students like it- everyone has taken the on-line courses or just networking on the website talking to other students. I've never heard any." – Collaborator #4*

> *"Specifically, my student has been involved in the courses and the seminars. The forums, we participate in. The student poster session, we went this year and we will go again next year. I think the online component is going very well. I think the last course they did was very helpful. It was very detailed, but I think the people involved needed the detail. I think the broader courses to start off were very good. The online part seems good. I think having the forums on the plant breeding network is a good idea. They really have been educational for all of us to interact in an online environment like that." – Collaborator #6*

Issues to consider

In summary, the MSI outreach projects appear to be establishing collaborations. There is evidence that faculty value the interactions and are willing to put in the time to make the collaborations successful. Face-to-face interaction appears to enhance the collaborations. Other positive components are mutual understanding and interests, which are also enhanced by face-to-face interactions. Complimentary research interests are important for collaborations but most compelling is the nature of the relationship between the people. All faculty agreed that increasing the number of underrepresented minority students was important and they thought some collaboration would continue even after TCAP funding ended. They all reported they mentored their students in an individualized, hands-on fashion regardless of race or culture. They were uniformly positive about the educational component.

It seems likely that more face-to-face contact would be beneficial both in terms of TCAP faculty going to MSI institutions and for students going to TCAP institutions. Perhaps some funding could be provided to MSI faculty to do more recruiting on their campuses. This would help provide them some extra funding and they would be able to dispel some of the myths about plant breeding. This might provide more students for plant breeding even without the intense experience of directly engaging in research. It might be worth considering supporting collaborations of TCAP faculty and MSI faculty on a one-to-one basis so that faculty could enhance existing collaborations or

collaborations more directly related to their individual research interests. This might help to address issues surrounding why TCAP faculty would choose to collaborate with faculty at MSI institutions.

One issue that would be important to consider would be to carefully determine the indicators of success for the collaborations. What would be most important to consider the initiative successful, e.g., coauthored papers, policy changes in the MSI institutions, students from the MSIs going to graduate school in plant science, sustained relationships, etc. Will it be sufficient to have any of these or is one more important than another? In this vein if one of the major goals is to increase the number of underrepresented minority students in plant breeding some additional strategies might be employed, such as working directly with recruiters at the TCAP and MSI institutions to enhance their perceptions and knowledge of plant breeding as a career. Certainly the collaborative relationships are on the right path. Two MSI students have already been accepted to plant breeding graduate programs. The researchers are looking forward to seeing the collaborative relationships progress.

Appendix A: MSI PI Interview Protocol Year 2

Good morning, my name is _____. I am part of the evaluation team charged by the TCAP educational committee to gather information about the educational component of the TCAP.

[*Let me first tell you about what the education portion of TCAP entails]:* TCAP's educational component consists of providing education and research opportunities for undergraduate and graduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field. Furthermore, the program aims to broaden graduate student education in plant breeding to include experiences that prepare students to be effective researchers in academia or industry by developing non-technical skills (soft skills) as well as creating opportunities to develop collaborative relationships and networks over time.

The questions today will center on your overall perceptions of the TCAP program. Information from today's interview will be used for evaluation purposes only. In our various evaluation reports that will be shared with key stakeholders, we will not share who said what and great care will be taken to make sure that no one will be able to identify what you said. As you share your opinions today, please be as open and frank as you feel comfortable with being.

Our discussion today should take about 30 to 40 minutes. I will also be taking notes today so please bear with me. I will also be recording. If at any point you would like me to turn off the recorder just ask.

Are you okay with being interviewed and providing your feedback about TCAP? (Need to ask for IRB purposes)

Overview

19. I just described to you the education portion of TCAP. Can you please describe for me your involvement with the educational component of TCAP?

    Probes
    - What components have you participated in? How did you get involved?
    - What are your perceptions of the educational portion of TCAP?

    Further Probes:
    - What components of the TCAP have been working well? Why?
    - In your opinion, what is the most important part of the TCAP educational program? Why?
    - Please describe the successes and challenges of this program? In your opinion, what can be done to improve the educational component?

20. Have you or your students interacted with others as a result of the TCAP education portion?

    Probes:

- Please describe any interactions that you, your graduate and/or undergraduate students have with other TCAP faculty members or students.

21. How would you describe your relationship with your TCAP collaborative research partner?

    Probes:
    - How would you describe the amount of time and effort working with your collaborative partner?
    - How have your interactions with your collaborative partner changed at all?

4. What do you see as the value (if any) of working with TCAP institutions?

    Probes:
    - What role does collaborative research play in this value?

5. As a MSI collaborator, what has been the most rewarding part of being part of the TCAP?

6. What challenges, if any, have you experienced as a collaborative partner in the TCAP?

7. How (if at all) has your opinion changed about TCAP institutions as a result of your collaborative research experience with your MSI partner?

8. As a result of this project, how do you see yourself and/or your institution collaborating with TCAP faculty in the future?

    Probes:
    - In your opinion, what supports collaboration across institutions? What limits collaboration?
    - To what extent do you feel TCAP is contributing to supporting collaborations across institutions?

Student Support

9. Please describe how you mentor undergraduate students? Why do you believe mentoring is important?

10. Please describe specific ways that you support your undergraduate students in applying graduate programs?

    Probe:
    - How do you support them applying to plant breeding programs to plant breeding graduate level programs?

Graduate Education

11. What needs to be in place for you to feel comfortable recommending your undergraduate students to TCAP graduate programs?
    - Does the diversity of the institution make a difference?

- To what extent do you feel there are any institutional or cultural differences that concern you in recommending students to TCAP graduate programs? If yes, what concerns you? Why?

12. Can you describe how (if at all) your TCAP research collaboration impacts your comfort recommending students to TCAP institutions?

Additional comments about TCAP experience

13. I don't have any more questions for you; however, is there anything else you would like to add that would assist us in our understanding of TCAP?

Appendix B: TCAP Collaborator Interview Protocol Year 2

Good morning, my name is _____. I am part of the evaluation team charged by the TCAP educational committee to gather information about the educational component of the TCAP.

[*Let me first tell you about what the education portion of TCAP entails]:* TCAP's educational component consists of providing education and research opportunities for undergraduate and graduate students in plant breeding programs and partnering with faculty from minority serving institutions (MSIs) to promote the plant breeding field. Furthermore, the program aims to broaden graduate student education in plant breeding to include experiences that prepare students to be effective researchers in academia or industry by developing non-technical skills (soft skills) as well as creating opportunities to develop collaborative relationships and networks over time.

The questions today will center on your overall perceptions of the TCAP program. Information from today's interview will be used for evaluation purposes only. In our various evaluation reports that will be shared with key stakeholders, we will not share who said what and great care will be taken to make sure that no one will be able to identify what you said. As you share your opinions today, please be as open and frank as you feel comfortable with being.

Our discussion today should take about 45 to 60 minutes. I will also be taking notes today so please bear with me. I will also be recording. If at any point you would like me to turn off the recorder just ask.

Are you okay with being interviewed and providing your feedback about TCAP? (Need to ask for IRB purposes)

Overview

1. I just described to you the education portion of TCAP. Can you please describe for me your involvement with the educational component of TCAP?

   Probes
   - What components have you participated in? How did you get involved?
   - What are your perceptions of the educational portion of TCAP?

   Further Probes:
   - What components of the TCAP have been working well? Why?
   - In your opinion, what is the most important part of the TCAP educational program? Why?
   - Please describe the successes and challenges of this program? In your opinion, what can be done to improve the educational component?

Collaborations

2. How would you describe your relationship your MSI collaborative research partner?

   Probes:

- How would you describe the amount of time and effort working with your collaborative partner?
- How would you describe the investment of your collaborative partner? TCAP investment?

3. What do you see as the value (if any) of working with MSI institutions?

   Probes:
   - What role does collaborative research play in this value?

4. How (if at all) has your opinion changed about MSI institutions as a result of your collaborative research experience with your MSI partner?

5. As a MSI collaborator, what has been the most rewarding part of your MSI collaboration? What challenges, if any, have you experienced with your MSI collaboration?

6. As a result of this project, how do you see yourself and/or your institution collaborating with MSI faculty in the future?

   Probes:
   - In your opinion, what supports collaboration across institutions? What limits collaboration?
   - To what extent do you feel TCAP is contributing to supporting collaborations across institutions?
   - What role does collaborative research play in this value?

Student Support

8. Please describe how you mentor undergraduate students? Why do you believe mentoring is important?

9. Please describe specific ways that you support your undergraduate students in applying to plant breeding graduate level programs.

Graduate Students

10. What needs to be in place for you to feel comfortable recommending your undergraduate students to other TCAP graduate programs?

Additional comments about TCAP experience

11. I don't have any more questions for you; however, is there anything else you would like to add that would assist us in our understanding of TCAP?