An evaluation of the Triticeae Coordinated Agricultural Project (TCAP)

Results from the 2012 PI survey

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TCAP: Highlights of PI Survey Data

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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%.

The demographic background of these 29 PIs 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.

Highlights from the PI 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%