



# **INFORMING THE PLANT BREEDING CURRICULUM DEVELOPMENT PROCESS**

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# CONTEXT AND PURPOSE

- There appears to be a *shortage of well trained plant breeders* to meet the current demands of universities, research centers and private sector businesses (add source).
- To better prepare future plant breeders, a web-based Delphi survey was conducted to determine what *knowledge, experiences, skills, and specialties* are important to plant breeding curriculum.
- This Delphi study draws on opinions from a broadly based stakeholder group within the plant breeding discipline on a global scale.



# MATERIALS AND METHODS - PARTICIPANTS

- Participants were selected based on their involvement with plant breeding and to ensure representation from a breadth of disciplines, crops, countries and institutions.
  - Recommendations were made by the GIPB, PBCC, and NCCPB as well as academic and industry experts
- Invitations to the study also stated to forward the invite to other “similarly qualified” participants.
- Participants were self-assigned into four groups

<b>GROUP INVOLVED IN PLANT BREEDING</b>	<b>Invited</b>	<b>Round 1</b>	<b>Round 2</b>	<b>Round 3</b>	<b>Participation rate</b>
<b>Public sector breeders in developed countries</b>	<b>118</b>	<b>77</b>	<b>49</b>	<b>40</b>	<b>52%</b>
<b>Private sector breeders in developed countries</b>	<b>107</b>	<b>46</b>	<b>31</b>	<b>27</b>	<b>59%</b>
<b>Recent graduates of breeding graduate programs</b>	<b>63</b>	<b>36</b>	<b>26</b>	<b>22</b>	<b>61%</b>
<b>Breeders in developing and emerging countries</b>	<b>108</b>	<b>49</b>	<b>35</b>	<b>34</b>	<b>69%</b>

# MATERIALS AND METHODS - QUESTIONS

- **Round 1** - Participants were asked to respond in short answer form the following four questions:
  - 1) What *knowledge* (topics or subject matter) is essential to have obtained at the completion of a graduate degree in plant breeding?
  - 2) What *experiences* should a student have while pursuing a graduate level plant breeding degree that will contribute to his/her future success?
  - 3) What *skills and competencies* should a student obtain by the completion of a plant breeding graduate program?
  - 4) What *specialties* within a plant breeding (or to complement plant breeding) should be developed over the next 10 years?

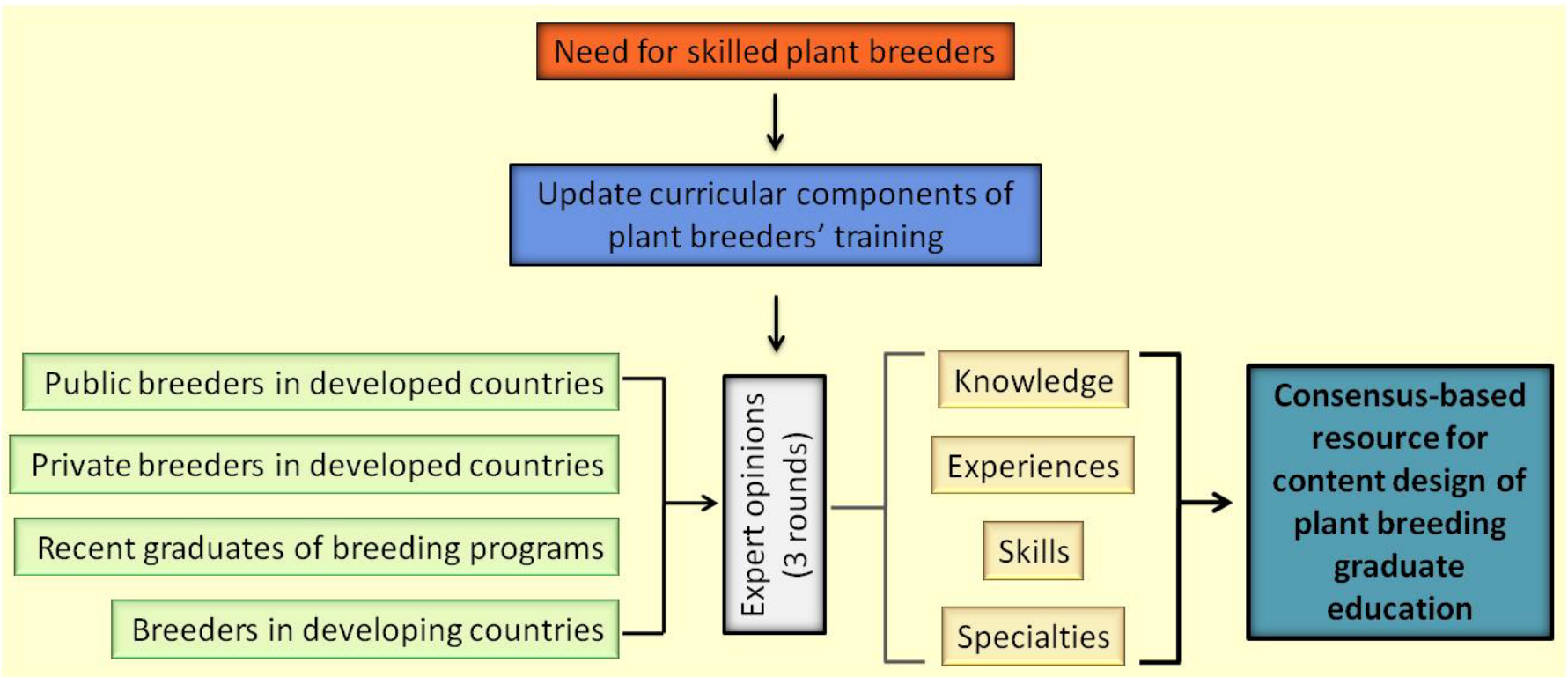


# MATERIALS AND METHODS - CONTINUED

- **Round 2** – Responses from Round 1 were distilled and clustered and participants were asked to rate the importance of items based on a 1-5 Likert-type scale
  - 1 = unimportant, 2 = somewhat important, 3 = neither important nor somewhat important, 4 = important, and 5 = very important
  - Responses from Round 2 that were rated as 3.75 made it to Round 3.
- **Round 3** – Participants were provided with the group mean ratings and their previous personal rating and asked if they still agreed with their initial rating.



# MATERIAL AND METHODS SCHEMATIC



# RESULTS – STAKEHOLDER DEMOGRAPHICS

- **208** Respondents
- **43** countries including the U.S. were represented
- **35** commercial companies were represented
- **50** universities; 30 in U.S. and 20 in other countries
- **11** governmental agencies world wide
- **16** NGO's world wide



# RESULTS - KNOWLEDGE

- 198 unique knowledge responses rated as important (3.75 or higher) in 17 categories
- Categories in *plant breeding, genetics, statistics, and experimental design* rated very high

TOPIC	PUBLIC		PRIVATE		RECENT GRADUATES		DEVELOPING	
	MEAN	#	MEAN	#	MEAN	#	MEAN	#
Plant breeding	4.21	18	4.48	13	4.59	9	4.44	19
Genetics	4.42	5	4.45	4	4.46	11	4.18	7
Statistics	4.29	7	3.95	4	4.53	4	4.47	5
Biological science	4.10	3	3.91	2	4.11	6	3.98	2
Policy and law	3.78	3	3.70	3	4.06	3	4.23	3
Production science	3.83	1	3.78	1	4.09	4	4.11	2
Experimental design	4.63	2	4.65	2	4.82	2	4.80	2
Plant pathology	4.06	2	4.30	3	4.00	1	4.15	2
Plant diversity and evolution	3.93	3			4.15	3	4.06	2
Computer proficiency	4.13	1	4.41	2	4.36	1	4.30	3
Plant reproductive biology	4.17	3	4.19	1	4.32	2		
Scientific communication	4.23	1			4.36	2	3.92	2
Biotechnology			3.80	3	3.55	1	3.97	1
Ethics	4.13	1	4.26	1			4.16	1
Program and personnel management	3.76	1			4.23	1		
Business			3.70	1			3.81	1
Genomics	4.35	1			3.86	1		

# RESULTS - EXPERIENCES

- 141 unique experience responses rated as important (3.75 or higher) in 14 categories
- Categories in **scientific communication, plant breeding, data management, experimental design** rated very high

TOPIC	PUBLIC		PRIVATE		RECENT GRADUATES		DEVELOPING	
	MEAN	#	MEAN	#	MEAN	#	MEAN	#
Scientific communication	4.29	12	4.04	9	4.38	6	4.04	9
Practical aspects	4.18	6	4.10	7	4.31	6	4.04	4
Plant breeding	4.47	6	4.35	6	4.45	5	4.32	5
Data management	4.41	5	4.42	3	4.64	3	4.44	5
Interaction and networking	4.10	3	4.11	1	4.36	3	3.98	3
Collaboration and teamwork	4.14	3	3.85	2	4.43	2	4.01	3
Teaching and mentorship	4.51	1	3.81	1	4.45	1	4.07	2
Experimental design			4.52	2	4.82	1	4.76	1
Program and personnel management			4.30	1	4.11	2		
Germplasm	4.05	1			3.95	1	4.12	1
Field visitation	3.72	1			4.09	1	4.18	1
Computer proficiency			4.07	1			4.15	1
Funding	3.87	1			4.09	1		



# RESULTS - SKILLS

- 301 unique skill responses rated as important (3.75 or higher) in 24 categories
- Categories in **practical breeding, experimental design, analytical aptitude, field work, data management, statistics, computer proficiency, intrapersonal, communication, and collaboration and teamwork** rated very high

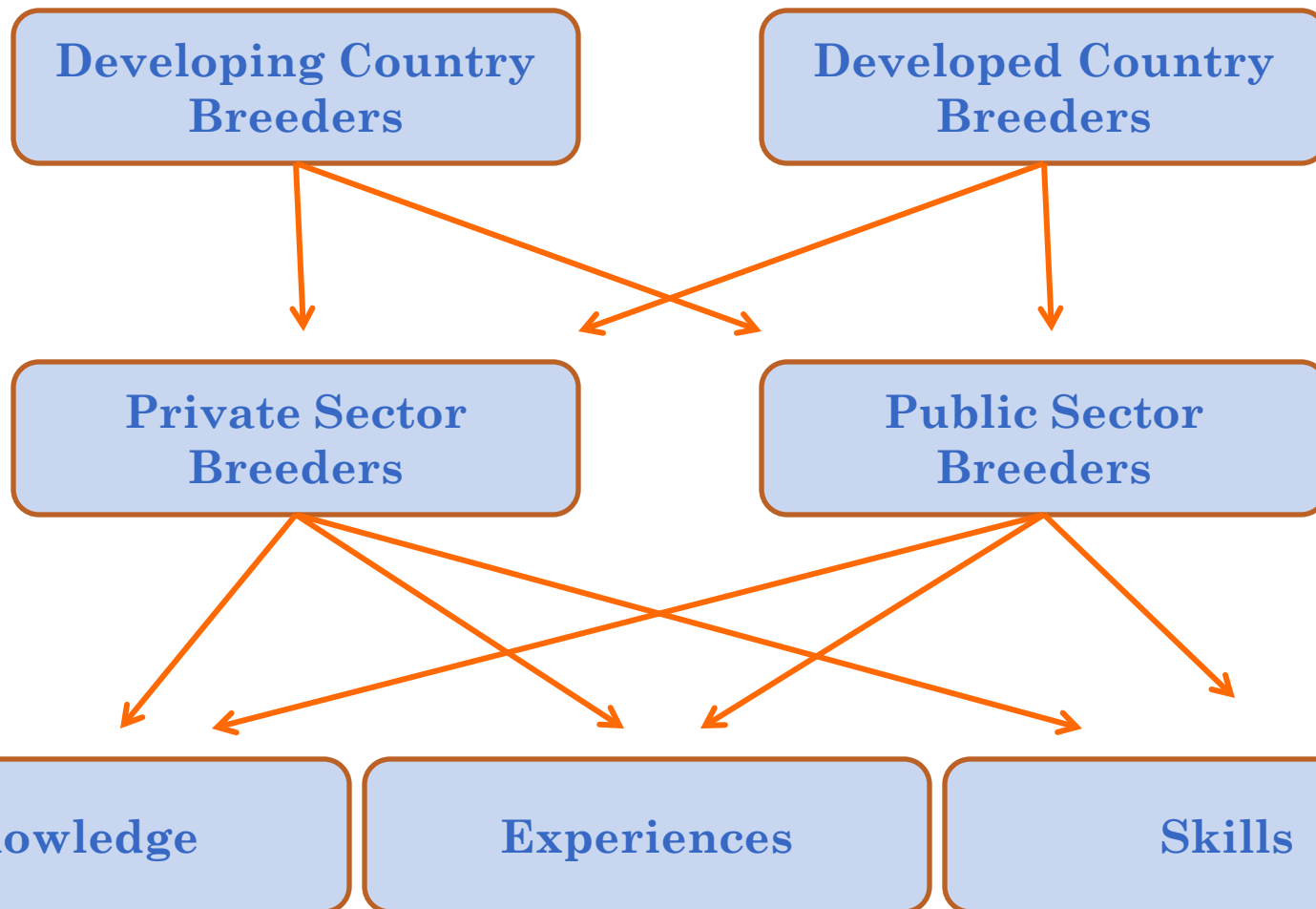
TOPIC	PUBLIC		PRIVATE		RECENT GRADUATES		DEVELOPING	
	MEAN	#	MEAN	#	MEAN	#	MEAN	#
Practical breeding	4.10	16	4.19	7	4.51	20	4.19	15
Intrapersonal	4.39	15	4.20	21	4.58	9	4.26	3
Communication	4.16	10	4.12	6	4.15	6	4.16	6
Experimental design	4.23	12	4.42	4	4.73	3	4.42	6
Analytical aptitude	4.63	3	4.33	4	4.78	6	4.39	8
Field work	4.06	4	4.27	5	4.17	5	4.22	4
Molecular	4.12	4	4.04	3	3.95	7	4.29	1
Data management	4.46	2	4.31	4	4.59	3	4.10	4
Statistics	4.43	6	4.41	1	4.39	2	4.38	4
Program and personnel management	4.11	3	3.96	1	4.15	5	4.07	3
Computer proficiency	4.38	3	4.36	3	4.95	1	4.24	2
Collaboration and teamwork	4.19	4			4.55	2	4.17	2
Interdisciplinary	3.94	3			4.00	1	4.41	2
Leadership	3.92	1			4.00	1	3.89	4
Research			4.11	1			4.50	2
Lab techniques	3.71	2			3.82	1		
Interpersonal			4.19	1			4.12	2

# RESULTS - SPECIALTIES

- 41 responses under specialties were rated at 3.75 or higher
- Specialties rated as very high included breeding for **abiotic and biotic stress tolerance**, **plant molecular breeding**, and **breeding for the developing world**

SPECIALTY	PUBLIC	PRIVATE	RECENT GRADUATES	DEVELOPING
Breeding for abiotic stress tolerance (e.g. drought, salt)	4.23	4.48	4.59	4.59
Breeding for biotic stress tolerance (e.g. pests, pathogens, nematodes)	4.33	4.30	4.45	4.29
Plant molecular breeding	4.33	4.33	4.23	4.19
Germplasm management and utilization	4.10	3.70	3.91	4.03
Molecular breeding coupled with standard breeding	4.59		4.59	4.64
Biostatistics and biometrics	3.95		4.14	3.94
Data/Database management and analysis		3.74	4.18	4.09
Breeding for health and nutrition	3.84		3.68	4.12
Bioinformatics	3.95		3.86	3.74
Quantitative geneticists	3.92		4.55	
Novel trait development			4.32	4.15
Plant breeding for the developing world	4.12		4.23	
Biotechnology (excluding transgenics)			3.82	4.09
Plant intellectual property law			4.09	3.79
Genetic resources management	3.72			4.12
Transgenics and transformation (e.g. GMO)		3.85		3.97
Information technologies in plant breeding	3.92		3.82	
Breeding for improved seed quality and storage			3.68	3.72

# RESULTS – GROUP COMPARISONS



# PRELIMINARY FINDINGS - BROAD

- This study provides consensus information about the preparation of plant breeders from diverse stakeholders with first-hand experience
- There is a need for connecting skills and knowledge through a planned set of experiences in plant breeding graduate programs, especially due to the applied nature of the field
- The findings will provide administrators, educators, employers and students with a common information base on which to build graduate programs



# PRELIMINARY FINDINGS - NARROW

## ○ Developing and emerging countries

- In addition to genetics, experimental design, statistics, and basic plant breeding, emphasis was placed on ***cross-disciplinary work, collaboration and networking***

## ○ Public sector

- Besides field and lab experience emphasis was placed on ***scientific communication*** experiences including writing a thesis, scientific publication and presenting work in written and oral formats

## ○ Private sector

- A high degree of importance was placed on intrapersonal skills including: ***initiative, critical thinking, efficiency, sound decision making*** and interpersonal skills - ***teamwork and management***



# LOOKING INTO THE FUTURE

- University curriculum development
- Short course expansion
- Internship collaborations between public and private sectors
- Student exchange programs between countries
- Grant proposals for plant breeding education programs



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More information can be found at  
<http://sbc.ucdavis.edu>