

Report on Master Class: Adaptation to Drought

27th – 31st August 2013

International Centre for Plant Breeding Education and Research (ICPBER),
The University of Western Australia (UWA),
Murdoch University (MU),
Department of Agriculture and Food WA (DAFWA)



Captions (clockwise): Group photograph; Vincent Vadez (ICRISAT) explains canopy light interception; Jamala Mursalova (Azerbaijan) practices measuring leaf water deficit; Ken Flower (UWA) explains the long-term crop rotation trials at WANTFA Cunderdin



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Background

Across the globe drought is one of the biggest threats facing agriculture today, with devastating and far reaching effects on entire landscapes and regions. The Food and Agricultural Organization of the United Nations (FAO) ranks drought as the single most common cause of severe food shortages in developing countries. In Australia drought can cost the Australian grain producers in excess of AU\$1 billion per year. Consequently Australian researchers and growers are at the cutting edge of coping with agricultural drought. Climate change is predicted to increase the frequency of droughts.

InterDrought is a major international platform to debate key issues and strategies relevant to increase the yield and stability of crops under drought conditions by genetic and crop management approaches. Perth, Western Australia hosted InterDrought-IV from 2 to 6 September 2013 (see <http://www.interdrought4.com/>). The mission of InterDrought is to explore the possibilities of scientific and technological applications to crop improvement and management under drought-prone farming by linking progress made at the molecular level to that at the whole plant and crop levels in the field. With the world's top drought researchers converging on Perth in September 2013, we leveraged on their presence to run a Master Class on Adaptation to Drought in the week prior to the Conference.

The Master Class on **Adaptation to Drought** aimed to increase participants' understanding of:

- Practical selection for drought tolerance: Phenotyping
- New techniques for drought selection: Genotyping
- Understand crop management options to cope with drought

Participants (Annexure 1)

There were 19 participants in the Master Class - all experienced and practicing drought scientists from a wide range of different developing countries: Argentina, Azerbaijan, Bangladesh, Burkina Faso, Kenya, India (2), Iraq, Pakistan (3), Sudan, and Tanzania - together with six Australians (Annexure 1). Twenty-one percent of participants were female. The selection process for participants is described in **Lessons Learned**.

Co-sponsorship

In addition to the Crawford Fund, co-sponsors of the Master Class were the Australian Centre for International Agricultural Research (ACIAR) (1 Iraqi), Grains Research and Development Corporation (GRDC) (5 Australians), the University of Western Australia (UWA), Murdoch University (MU) and Department of Agriculture and Food WA (DAFWA). FAO shared the cost of airfares and sponsored the MC participants to also attend InterDrought. Four participants were fully or partially self-funded.

Schedule (details in Annexure 2)

Day 1 (Tue. 27th August) at UWA: We opened the course with Eric Craswell of the Crawford Fund, made an introduction(s), and contextual lectures were given on Drought in the Mediterranean and Semi-arid tropics and on cropping systems in the Mediterranean region in the morning. In the afternoon the MC participants presented mini-seminars (5-10 minutes) on aspects of their own drought research. In addition to 'breaking the ice', this was important to gauge the individual specific interests of MC participants.

Day 2 (Wed. 28th) In the morning by bus from Perth to the Drylands Research Institute (DRI), DAFWA – Merredin (260 km). In the afternoon we had Vincent Vadez (ICRISAT) explain drought phenotyping

in the semi-arid tropics followed by Greg Rebetzke (CSIRO) to introduce the national Managed Environment Facility (MEF) and its role in the delivery of key physiological traits for improved wheat performance under drought. The group was given a tour of DAFWA's facilities at DRI, Merredin. In the evening DRI hosted an Oz BBQ for the group and also for the national MEF group of scientists. Day 3 (Thur 29th) was an on-farm day focusing on farmer approaches to coping with drought through a visit to the farm of Vanessa Stewart & Doug McGuinness, and on crop management for drought with the NGO West Australian No-Till Farmers Association (WANTFA) at Cunderdin hosted by Ken Flower (UWA). We were re-joined by Eric Craswell on 29th. The MC dinner was in Merredin also with MEF scientists. The co-sponsors Crawford Fund - Eric Craswell - and GRDC - Jorge Mayer - joined the dinner.

Day 4 (Fri 30th) was for phenotyping. At DRI, Merredin we started with Dan Mullan (InterGrain) presenting 'Breeding for drought in a Mediterranean environment' followed by Ben Biddulph (DAFWA) discussing 'Drought tolerance screening: Field operations, Protocols and trial designs for phenotyping'. Then in the field, rotating between the various MEF staff, participants tried all the available equipment for:

- Low cost high throughput sensing platforms (NDVI, Ground cover).
- Canopy temperature
- Phenonet and high throughput sensing of canopy temperature.
- Soil salinity, soil texture and the use of the EM38
- Using portable photosynthesis and fluorescence systems to analyse effects of drought at the leaf level
- Stem water soluble carbohydrate remobilization in wheat under water limited condition
- Canopy light Interception
- Heat stress screening methodologies
- Soil water characterisation (Gravimetric water content, Neutron probe)
- Stressmaster: a web application to model the environment for crop improvement for drought adaptation.

Finally the MC participants had to present for five minutes on *What aspect of my drought research I can/wish to do differently after the course?* Jorge Mayer (GRDC) and a MC co-sponsor joined for part of the day.

Day 5 (Sat 31st) saw us on the bus early back to Perth and to the State Agriculture Biotechnology Centre (SABC), Murdoch University. Mehmet Cakir introduced SABC and gave a lecture on molecular technologies applicable to drought selection, and then led a tour of SABC's facilities. Delphine Fleury - Australian Centre for Plant Functional Genomics (ACPFG) presented Molecular approaches to selection for drought breeding. We then closed the course after undertaking course evaluation and presenting certificates of attendance with GRDC and Crawford Fund represented.

Resource persons

- William Erskine, Director - International Centre for Plant Breeding Education and Research (ICPBER), UWA
- Ben Biddulph, Cereal Physiology researcher at DAFWA
- Mehmet Cakir, MU
- Vincent Vadez, Senior Physiologist at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India
- Neil Turner, UWA
- Greg Rebetzke, CSIRO Plant Industry, Canberra
- Ken Flower, UWA - Lecturer in Production Agronomy and Farming Systems at UWA.
- Daniel Mullan, Wheat Breeder - InterGrain
- Delphine Fleury, Australian Centre for Plant Functional Genomics (ACPFG)
- Vanessa Stewart & Doug McGuinness, Growers near Merredin

- Additional MEF scientists: David Deery (CSIRO); Grant Stainer (DAFWA); Jingjuan Zhang (Murdoch University); Carina Moeller (University of Tasmania); Paul Telfer (AGT); Bob French (DAFWA) and Karine Chenu (CSIRO)

Potential Impacts

Annexure 3 provides a summary of the responses of participants to a series of questions about the impact of the Master Class on them as individuals, on their work and on their institutions as part of a standard post-course survey. The responses provided are very positive, indicating the Master Class was informative, enjoyable and provided a better understanding of the issues related to drought as well as a good way to meet international drought researchers. The highest percentage of feedback was given in relation to the question “The training increased my knowledge of international trends/activities” with 78% of participants - strongly agreeing. Negative comments consisted mainly of language issues and the ability of the non-English speaking participants to keep up with some of the presenters and that the course had a major focus on wheat, which was not directly applicable to most participants.

Lessons Learned

1. The importance of inter-institutional cooperation was clear in the MC among the basic three partner organizations (UWA, MU and DAFWA) and across a broad range of additional organizations involved in interacting with participants (CSIRO, ICRISAT, ACPFG, InterGrain, AGT, WANTFA, UTAS and growers). With this spirit of cooperation we were able to assemble a Drought ‘Dream Team’ for the MC presentations.
2. This MC was all about taking advantage of opportunities for leverage:
 - Leveraging on the InterDrought IV Conference in Perth in Sept 2013 and the attendance of world-class national and international lecturers.
 - Leveraging on the sponsorship of FAO for developing country delegates to InterDrought, so that Crawford Fund paid only part of the cost of participants’ airfares which were shared with FAO.
 - Leveraging on the concurrent meeting of the national Managed Environment Facility scientists at Merredin meant we had access to an impressive range of Australian scientific drought expertise.
 - Leveraging Crawford sponsorship to procure co-sponsorship from GRDC for strong Australian participation and from ACIAR.
3. Selection of MC participants who are active practitioners in drought research was crucial. We developed a robust selection process for the candidates jointly with FAO and the Generation Challenge Program (both involved in sponsoring InterDrought attendees) in an open transparent web-based process with common criteria {under 40 years of age, developing country nationality with research interest in drought}, which received > 100 applications. This resulted in a clear ranking of applicants, which in turn allowed the substitution of new names when a potential participant’s Australian entry visa was declined or additional supplementary funding was unavailable for selected candidates. In the run-up to the course many suitable potential participants fell by the wayside for multifarious reasons, so it was vital to have this larger group of possible attendees in the frame to fill all the seats. Finally with some drop-outs happening very late, we back-filled with two locally-available, young, developing country researchers doing their PhD on drought in Australia.
4. As in a previous Master Class at UWA, the mixing of participants from developing countries with those from Australia proved successful. Although individuals within each group started from different base levels of familiarity with the concepts, the active dialogue and exchange of knowledge during the Master Class encouraged mutual learning to the benefit of all, including the resource persons.

Annex 1 – Master Class Participants

	Name	Position	Affiliation	Male / Female	Nationality	Sponsorship
1	Nouhoun Belko	PhD student	Research Fellow at ICRISAT/ at CERAAS-ISRA (Senegal)	M	Burkina Faso	Crawford
2	Jamala Mohammad Mursalova	PhD student	Genetic Resources Institute, Azerbaijan National academy of Sciences	F	Azerbaijan	Crawford
3	Joseph Simuda Joachim	Agricultural Research Officer -Plant breeding	Lake-zone Agricultural Research and Development Institute Ukiriguru, Tanzania	M	Tanzania	Crawford
4	Nadia Khan	Assistant Professor	Department of Genetics, University of Karachi, Pakistan	F	Pakistan	Crawford
5	Mohamed Elsadig Eltayeb Habora	PhD student	Tottori University, Japan	M	Sudan	Crawford
6	Muhammad Munir Iqbal	PhD student	University of Western Australia	M	Pakistan	Crawford
7	Ejaz Ahmad Waraich	Assistant Professor	Department of Crop Physiology, University of Agriculture, Faisalabad, Pakistan	M	Pakistan	Crawford
8	R. Pushpavalli	PhD Student	ICRISAT, India	F	India	Crawford
9	Mirza Nazim Ud Dowla	PhD Student	Murdoch University	M	Bangladesh	Crawford
10	Pedro Sansberro	Director Maestría en Producción Vegetal (UNNE)	Instituto de Botánica del Nordeste, Corrientes, Argentina)/ Investigador Independiente (CONICET)/ Director Especialización en Manejo de Recursos Forestales (UNNE)/ Profesor Adjunto (UNNE)	M	Argentina	Self
11	Mujahid Hamdan	Researcher	Office of Agricultural Research, Abu Graib, Baghdad, Iraq	M	Iraq	ACIAR
12	Sylvester O. Oikeh	WEMA Project Manager	African Agricultural Technology Foundation (AATF) PO Box 30709-00100, Nairobi, Kenya	M	Nigeria	Self
13	Wendy Vance	Researcher	Murdoch University, WA	F	Australia	ACIAR/Self
14	Ramalingam Poornima	PhD student	University of Tokyo, Japan	F	India	Self
15	Lee Hickey	Research Fellow	Winter Cereals Pre-Breeder, Queensland Alliance for Agriculture and Food Innovation	M	Australia	GRDC
16	Tiago Tomaz	Research Officer	Cereal Physiology Group at the Managed Environment Facility DAFWA Merredin, WA	M	Australia	GRDC
17	Bill Bovill	Research Scientist	CSIRO Plant Industry, Canberra	M	Australia	GRDC
18	Peter Kennedy	Res. Scientist Mol. Plant Breeding	Department of Environment & Primary Industries, Horsham, Victoria	M	Australia	GRDC
19	Matthew Rodda	Res. Scientist – Mol. Plant Breeding	Department of Environment & Primary Industries, Horsham, Victoria	M	Australia	GRDC

Annex 2: Schedule

Master Class on Adaption to Drought

27 - 31 August 2013

Schedule

Tue, 27th August 2013 - Day 1, Master Class Introduction at University of Western Australia

09.00 – 09.15 Welcome and Course Introduction - William Erskine
09.15 - 10.00 Introduction to the Mediterranean climatic environment and drought – William Erskine
10.00 – 10.15 Break
10.15 – 11.00 Introduction to the climatic environment of the semi-arid-tropics and drought – Vincent Vadez
11.15 – 12.00 Cropping systems in the Mediterranean-type climate of South-West Australia – Neil Turner
12.00 – 14.00 Lunch
14.00 – 16.30 Participants to share their Drought experiences (5 minutes each with 5 min for discussion)
16.30 Close
Accommodation at Trinity College, Crawley, Perth

Wed, 28th Aug - Day 2, Travel from Perth to Merredin and Introduction to Dryland Research Institute, Merredin

07.00 Departure from Perth to Merredin by bus
11:00
12:15 Lunch at Merredin MEF
13.00 – 13.45 Drought phenotyping in the semi-arid tropics – Vincent Vadez
14.00 – 14.45 Engagement of the national MEF in validation and delivery of key physiological traits for improved wheat performance under drought – Greg Rebetzke, CSIRO.
15.00 – 15.30 Break
15.30 – 17.00 Tour of DAFWA Dryland Research Institute, Merredin –MEF (Biddulph, French), NGNE (Adrian Cox), Agronomy and Break crops (French) and informal meeting of MEF researchers.
17:30 Dinner
Australian BBQ hosted by Merredin Dryland Research Institute and meeting of MEF researchers.
Accommodation in Merredin

Thursday 29th Aug - Day 3, Cropping systems and conservation agriculture in WA Wheatbelt.

08.00 Depart hotel
08.30 – 11.00 Field visit to farmer near Merredin –

- Financial management of drought, decision making process, Vanessa Stewart.
- Agronomic management, machinery, weed control, soil/water conservation, Doug McGuiness.

11.00 – 12.00 Travel to Cunderdin
12.30- 1.15 Lunch at Cunderdin
1.30 – 15.30 West Australia No-Till Farmers' Association (WANTFA) Trials, Cunderdin – Dr Ken Flower, UWA/WANTFA
16.30-17:00 Return to Merredin and Hotels.

~1830 onwards Informal dinner at Commercial Hotel, Merredin joining the Managed Environment Facility researchers.

Accommodation in Merredin

Friday 30th Aug - Day 4, at MEF, Merredin

08.30 - 09.15 Breeding for drought in a Mediterranean environment– Daniel Mullan, InterGrain.

09.30 Introduction to drought tolerance screening: Field operations, Protocols and trial designs for phenotyping at MEF - Ben Biddulph

10.15 – 10.30 Morning Tea

10.30 – 12.00 Session I – Hands-on in the field with the experiments at MEF,

- Ben Biddulph, Low cost high throughput sensing platforms (NDVI, Ground cover).
- Daniel Mullan, Canopy temperature and
- David Deery, Phenonet and high throughput sensing of canopy temperature.
- Grant Stainer, Soil salinity, soil texture and the use of the EM38.
- Tiago Tomaz, Using portable photosynthesis and fluorescence systems to analyse effects of drought at the leaf level
- Jingjuan Zhang, Stem water soluble carbohydrate remobilization in wheat under water limited condition.
- Carina Moeller, UTAS, Canopy Light Interception
- Paul Telfer, Heat stress in the Australian Environment and screening methodologies used.
- Bob French, Soil water characterisation (Gravimetric water content, Neutron probe).
- Karine Chenu, Stressmaster: a web application for dynamic modelling of the environment to assist in crop improvement for drought adaptation

12.00 – 13.00 Lunch at Merredin MEF

13.00 – 15.00 Session II – Hands-on in the field with the experiments at MEF - Continued

15.00 – 15.30 Afternoon Tea

15.30 – 17.00 Wrap-up session in the DAFWA Merredin conference room: Q&A session and participants to present in five minutes each: *What aspect of my drought research I can/wish to do differently after the course?*

Accommodation in Merredin

Saturday 31st Aug - Day 5, Return to Perth and Western Australian State Agricultural Biotechnology Centre (SABC), Murdoch University

07:00 - 10.30 Departure from Merredin to Perth by bus

10.30 – 12.30 Presentation of SABC facility and molecular technologies applicable to drought selection - Mehmet Cakir

12.30 – 13.30 Lunch

13.30 - 14.30 Molecular approach to selection for drought breeding – Delphine Fleury, ACPFG

14.30 – 15.00 Wrap-up discussion

15.00 – 15.30 Course closing

Accommodation at Trinity College, Perth

Anexure 3

Follow-up course participants' survey

Master Class on Drought Adaptation Questions

This part of the survey assesses the training delivery and the knowledge acquired during the Master Class. Please rate how these statements reflected your perceptions of the training.

A Quality:	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Not Relevant
(1) The content of the Master Class was directly related to my field of work at time of completion	57%	32%	11%			
(2) I was provided with adequate supporting material	69%	26%	5%			
(3) The trainers/ mentors were knowledgeable and provided lectures/information of a good quality	78%	21%				
(4) The content was easy to understand	57%	38%	5%			
(5) The level of English used was good	57%	32%	11%			
(6) There was sufficient time allowed for the Master Class to get a good understanding of the content	47%	47%	6%			
(7) The course was well balanced between theory and practice	57%	27%	16%			
(8) Other? Please specify	<ul style="list-style-type: none"> • Personnel involved in the master class training were approachable and enthusiastic • It was great to have Vincent Valdez from ICRISAT, a very useful contribution. Dan Muller's and Ben Biddulph's talks were very useful too • In terms of language, I was not able to keep up with the speed • Coordination and management was so good • I am thankful to Crawford Fund. It is a great experience and exposure to me. 					

B Knowledge Gained:	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Not Relevant
(1) The training increased my knowledge of international trends/activities	78%	15%	7%			
(2) I increased my capacity to conduct research	36%	42%	15%		7%	
(3) I better understand issues and principles in my field	47%	37%	16%			
(4) I acquired new technical skills	21%	52%	27%			
(5) I acquired new ways to approach work problems	27%	57%	16%			
(6) I learned techniques for managing and organising people and projects	26%	26%	37%	11%		
(7) I learned new or improved ways to communicate with networks within my field of expertise (eg farmers, donors, research organisations, government)	32%	53%	15%			

<p>(8) Other, please specify</p>	<ul style="list-style-type: none"> • The training gave me a better understanding of the wheat/ barley breeding pipeline • The course had a major focus on wheat, which was not directly applicable to most participants. It was high quality stuff, but slightly removed for many • It was good to interact with the other attendees • The course is highly recommended for those in middle career, working on the field of drought adaptation • Interaction between participants was nice and friendly • It would be good to have a special master class on the last two aspects (learned techniques for managing people and projects and communicating with stakeholders)
<p>Other comments: How the Master Class will help/is helping you in your specific area? Specific comments from the five GRDC participants:</p>	<p>1. The master class helped broaden my horizons by allowing me to meet with and understand the work of members of the GRDC, as well as representatives of major cereal breeding companies (namely AGT and InterGrain) and fellow young researchers in the wheat pre-breeding research space (QAAFI, CSIRO and DEPI). This will help foster collaborations in the future, as many synergies in research priorities were seen between our work.</p> <p>I drew a lot from the visit to the SABC and the presentations on molecular breeding approaches, as I hope to become more involved in cereal QTL mapping and other molecular approaches as my career progresses. The most informative and enjoyable experience for me was the farm visit</p>

hosted by Vanessa Stewart and her husband, it was great to gain an understanding of the challenges facing farmers in the eastern wheat belt and how hard it is to maintain profitability. For me personally, this gives me more drive and motivation to play a small part in helping farmers maintain yield through good times and bad through genetic improvement of future germplasm.

The discussions with many of the overseas master class participants was also very thought-provoking and informative, and gave me an appreciation for the problems facing agricultural production systems in dry land areas in a more global context.

Thanks once again for running such a great week of science, I drew a lot from the experience.

2. Drought adaptation is a major component of the wheat pre-breeding work that I do, with many traits that I am currently working with being implicated for improvement of wheat productivity under terminal drought in particular. Prior to taking on my relatively new role, I had little experience in drought adaptation. Attendance at the Master Class gave me a better appreciation for the environments in which traits that I work with are most likely to be useful. This had resulted in a more targeted approach to germplasm development with greater consideration of recurrent parents used in my pre-breeding program. The Master Class was also a very useful way to meet colleagues who are working in similar areas, and provided a great forum for the exchange of ideas. The format of the Master Class was such that it allowed many detailed conversations with the numerous participants – much more so than would have been the case with a shorter and less interactive program. The demonstrations of the variety of phenotyping equipment was useful; as was the explanation of the Managed Environment Facility (MEF) at Merredin. The networking opportunities provided by the joint meeting of the Master Class and the MEF meeting were invaluable. A highlight of the Master Class was the visit to the Stewart farm near Merredin – the interaction was valuable and gave me a better perspective on how growers deal with the financial risks associated with farming in low-rainfall areas with high frequency of terminal drought.

I am very pleased that I was able to attend the Master Class and am thankful to the GRDC for supporting my involvement. I am sure the Master Class would not have been as useful if it wasn't for the effort of Willie Erskine in leading and co-ordinating the workshop. I also gratefully acknowledge the contribution of Vincent Vadez throughout the Master Class.

3. I got the most out of the growers visit. One quote will stay firm in my mind: "Everything we do is about moisture"

Gained better understanding of drought adaptation traits, which I will consider when building my Nested Association Mapping platform for pre-

	<p>breeding in the northern region.</p> <p>I had limited experience in drought adaptation (my past work has focused largely on disease traits), so course also provided a good refresher of the theory concerning drought adaptation and mechanism of tolerance.</p> <p>Course was great for expanding my professional network e.g. I met the other wheat pre-breeder in Australia (Bill), which will likely lead to collaboration in the near future.</p> <p>4. Field pea production is increasingly shifting to short season, low rainfall environments. This has caused drought adaptation to become a major priority. Currently the program targets early maturing varieties, however this master class provided me with a clearer understanding of the many other potential tools available to enhance drought adaptation.</p> <p>5. The drought master class gave me a thorough overview of what it means to breed for drought tolerance, including types of drought tolerance and key physiological traits associated with them. An example of a key target trait is transpirational responsiveness to vapour pressure deficit. Measurably through lysimetric methods, it is an important trait associated with improved water use efficiency. Not just drought avoidance (like shorter season varieties), but an actual adaptation to growing under dry conditions. Until now, breeding for drought in the lentil breeding program has mostly been about avoidance (of terminal drought). I now have a strong framework on which to base the incorporation of drought breeding into the program. Although not happening right now, it is certainly an important aspect for the future.</p>
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