INTERDROUGHT-II

The 2nd International Conference on Integrated Approaches to Sustain and Improve Plant Production Under Drought Stress; Rome, Italy, September 24-28, 2005.

CONFERENCE CONCLUSIONS AND RECOMMENDATIONS

This document has been approved and released by the Organizing Committee and the International Steering Committee of Interdrought-II. It is a call for action by the scientific community, agriculture experts and professionals, sponsors of research, research and aid organizations, and networks of research which deal with sustaining and improving plant production under drought stress and water-limited agriculture.
For a list of the International Steering Committee members please see the Appendix.

Conference statistics

There were 534 registered participants from 59 countries. A total of 450 posters were presented. Oral presentations were delivered during 8 sessions by 28 invited speakers and 44 selected speakers. A total of 9 panelists led the final discussion of the plenary sessions which led to the following conclusions and recommendations.

Conference conclusions

The conclusions are derived from the oral presentations, posters and the discussions at this conference as well as from the reality experienced during the decade that has passed between INTERDROUGHT-I (1995) and InterDrought-II (2005).

A. Water available for irrigation is becoming scarce and this trend may increase drastically in the future with the likely scenario of global environmental change. The cost of water is rising or expected to rise. Demand for cereals is also expected to rise in view of the increasing request for cereals for food purposes and, more recently, biofuel production. Cropping patterns are changing so that irrigation water is reserved for high value crops while the commodity and grain crops are increasingly being grown under dryland and rainfed conditions. Cropping with insufficient moisture supply will become more widely adopted. Deficit irrigation will likely become the major system for field irrigation. Water scarcity will cause greater use of recycled and brackish water which can lead to soil salinization and the accumulation of toxic elements.

B. Research is not well prepared to deal with the above-mentioned problems for the following reasons:

1. As a result of the spectacular development and attraction of molecular plant biology, emphasis in research and education in plant and agriculture sciences has shifted to an appreciable extent from plant breeding, agronomy and physiology towards biotechnology and molecular biology. This has resulted in a general reduction in the expert workforce and the research/teaching infrastructure of these disciplines. Education in agronomy, soil science, plant breeding, and plant physiology is hindered in terms of available teaching capacity and studentships.
2. The increase of research funds in biotechnology and genomics has been paralleled by a decrease of funding for plant breeding, agronomy, and physiology.
3. While basic research in plant biotechnology research towards the genetic improvement of crop productivity in water-limited conditions has expanded in recent years, the collaboration with plant breeding has been insufficient (with the exception perhaps of the private sector). This lack of collaboration hinders the delivery of biotechnology-based solutions to the end-user in the field, i.e. the farmer. There is an exponential growth of information in genomics with a proportionally minute rate of application of this information to effective problem-solving in farming under water-limited conditions.

C. At the same time, conventional plant breeding has been making well-recorded achievements in releasing improved varieties that perform relatively well under water-limited conditions, almost everywhere around the world.

D. Although substantial progress has been achieved during the past decade in our capacity to identify and clone genes and QTLs, the contribution of marker-assisted selection (MAS) towards improved crop production under water-limited conditions has not met the original expectations. There has been success with MAS in improving root health traits, such as nematode resistance or aluminum tolerance, which lend support to plant water status under drought conditions. Besides cost considerations, the main technical problem faced by MAS for drought resistance traits is their accurate phenotyping and mapping. It is perceived that further efforts towards more effective MAS should be encouraged and carried out with a clear focus on target environments. A more effective mining within germplasm collections (including wild relatives) for allelic diversity at target regions will be instrumental to enhance the effectiveness of MAS and its impact on the release of more drought tolerant cultivars.

E. Transgenic technology is coming of age in the sense that certain genes conferring drought resistance that were identified in model organisms are now being tested in the field in transgenic crop plants, with encouraging results. Successful case histories should be duly reported and further confirmed by multidisciplinary scientific teams operating under field conditions.

G. There has been some progress made in crop management under water-limited conditions. Some of this progress was based on information developed years ago, such as conservation and minimum tillage methods. Other avenues of progress have been achieved by novel approaches such as cropping system simulations with farmers' participation. A new concept for crop management systems that cope with drought conditions is the hypothesis that cropping systems in the arid-zones must be flexible.

H. Physiological/genetic plant simulation models are important for enhancing research effectiveness on plant drought stress and water-use efficiency. The development of such models is progressing with respect to their physical component but development is lagging in the plant biology component due to our limited knowledge in plant stress physiology. There is still insufficient understanding of how genetic factors that control yield interact with the environment across a broad range of water regimes.

I. The most prevalent physiological constraint to sustaining and improving plant production under drought stress is reproductive failure under stress. This is a universal problem of crops for which their reproductive parts are the harvestable yield. Several new ideas are now emerging for the possible solution of the problem. Research into this problem offers promise and should be encouraged.

Conference recommendations

1. A balance of research efforts is needed between genomics and the applied agricultural sciences. Without a strong link with research on plant breeding, agronomy, soil science, and plant physiology, the contribution of genomics to crop production under drought stress will remain marginal.
2. Plant biotechnology research aimed at enhancing plant production under limited water supply should be funded with pre-conditions by sponsors that assure effective collaboration with research at both the whole plant and field level. The seriousness of the problem (#A above) which is often used to justify biotechnology research cannot allow biotechnology research to be continued just within its own domain.
3. Any research that claims to impact plant production under water-limited conditions must address crop yield or its major components in the research plan and the research report. Claims of an impact must be substantiated with field data and compared with the performance of the best available materials for the target environment.
4. With due consideration of legislative and social issues, transgenic technology should now be taken as an additional, potentially important tool to enhance our understanding of the adaptive response of plants to drought as well as to improve crop yield and its stability under water-limited conditions. The current interest in structured mutant grids for forward- and reverse-genetics (*e.g.* TILLING) approaches indicates that mutation technology should be enhanced and reconsidered as an important tool for identifying gene function and, in some cases, also for breeding purposes. Because this technology does not involve the legislative and social concerns typical of GMOs, its utilization for breeding purposes provides additional opportunities where cultivation of GMOs is restricted.
5. Marker-assisted selection offers great potential for plant breeding under water-limited conditions. At the initial molecular mapping exercise, accurate phenotyping conducted under properly controlled management of the stress level is a crucial prerequisite for success. When complex, low heritable traits are to be mapped, collaboration with experienced plant breeders, agronomists, soil scientists and/or crop physiologists is essential. Acquisition of reliable plant and soil data in collaboration with relevant experts is also important for an accurate interpretation of the experimental results. Lack of such collaboration has been at the root of many past failures in this respect.
6. Considerable effort should go towards understanding better the physiological processes that determine yield in any stress environment and their genetic control. The primary function of the vast majority of genes having an effect on yield is still unknown. The identification of gene function and attempting to evaluate its impact on crops' yield requires an integrated approach from molecular genetics through to crop physiology.
7. In view of past unfortunate scientific reports in peer-reviewed scientific journals, we call upon all scientific journals on plant, crop and soil science to require a minimum set of data in manuscripts submitted for publication on the subject of drought stress, plant water relations and associated topics. We urge that the measurement of plant water status in a comprehensive and instructive manner is required in order to justify statements about drought stress, water deficit, drought adaptation, etc. As a minimum, a proper measure of tissue/plant water potential or tissue/plant relative water content should be required.

8. Educational institutions should be encouraged to maintain and strengthen training of students in plant breeding, agronomy and crop physiology as well as molecular biology, so that scientists qualified in these disciplines are available for the public and private sectors.

We remain confident that the integrated approach herein advocated will be instrumental to advance our understanding of drought tolerance and to more effectively exploit this information to improve and stabilize crop yields under water-limited conditions. We hope that the legacy of the InterDrought Congress series will continue, thus providing inspiration to young scientists willing to pursue the challenges of drought-related research.

Signed Date: 30 Oct. 2005

The Interdrought-II Organizing Committee

Abraham Blum *Chair* | *Roberto Tuberosa* *Vice Chair* | *Henry T. Nguyen* *Program* | *José Luis Araus-Ortega* *Funding*

APPENDIX

Members of Interdrought-II International Steering Committee

Name	Affiliation	Email
J.L. Araus-Ortega	University of Barcelona, Spain	josel@porthos.bio.ub.es
Dorothea Bartels	University of Bonn, Germany	dbartels@uni-bonn.de
John Bennett	IRRI, Philippines	j.bennett@cgiar.org
Abraham Blum	Plantstress.com, Israel	ablum@plantstress.com
Hans Bohnert	University of Illinois-Urbana Champaign,USA	bohnerth@life.uiuc.edu
John Boyer	University of Delaware	boyer@cms.udel.edu
Salvatore Ceccarelli	ICARDA, Syria	s.ceccarelli@cgiar.org
R.C. Chandra Babu	Tamil Nadu Agricultural University, India	Chandrarc2000@yahoo.com
Manuela Chaves	Universidade Técnica da Lisboa, Portugal	mchaves@isa.utl.pt
Bill Davies	University of Lancaster, UK	w.davies@lancaster.ac.uk
Greg Edmeades	Pioneer-DuPont, USA	greg.edmeades@pioneer.com
Brian Forster	Scottish Crop Research Institute, UK	bforst@scri.sari.ac.uk
Tom Hash	ICRISAT, India	c.t.hash@cgiar.org
Zhikang Li	Chinese Academy of Agric. Sci., Beijing,China	z.li@cgiar.org
Lijun Luo	Shanghai Academy of Agric. Sci., China	Lluo61@yahoo.com
Sagadevan Mundree	University of Cape Town, South Africa	mundree@science.uct.ac.za
Henry Nguyen	University of Missouri, USA	NguyenHenry@missouri.edu
Martin Parry	Rothamsted Research, UK	martin.parry@bbsrc.ac.uk
John Passioura	CSIRO, Australia	john.passioura@csiro.au
Steve Quarrie	University of Belgrade and UK	quarrie@eunet.yu
Arjula Reddy	University of Hyderabad, India	arjulsl@uohyd.ernet.in
Jean Marcel Ribaut	CIMMYT, Mexico	j.ribaut@cgiar.org
Richard Richards	CSIRO, Australia	richard.richards@csiro.au
Rachid Serraj	IAEA, Austria	R.Serraj@iaea.org
Robert Sharp	University of Missouri, USA	SharpR@missouri.edu
Kazuo Shinozaki	RIKEN Tsukuba Institute, Japan	sinozaki@rtc.riken.go.jp
Pasquale Steduto	FAO, Rome	Pasquale.Steduto@fao.org
Francois Tardieu	INRA, Montpellier, France	Francois.Tardieu@ensam.inra.fr
Roberto Tuberosa	University of Bologna, Italy	Roberto.tuberosa@unibo.it
Neil Turner	CSIRO, Australia	neil.turner@csiro.au
Len Wade	University of Western Australia	lenwade@ozemail.com.au
Qifa Zhang	Huazhong Agricultural Univ., Wuhan,China	qifazh@mail.hzau.edu.cn