

Wheat Initiative



Proposal number¹: 2012-01-V2

Date of reception¹: 15/06/2013

EXPERT WORKING GROUP TOPIC SUBMISSION²

Expert Working Groups (EWG) are established where a particular topic of direct relevance to the Wheat Initiative would benefit from bringing together experts in that specific field. The EWG would provide them with a platform for discussion, information sharing, consideration of specific problems, identification of research priorities and gaps. The EWG should have clear objectives and these could include (but are not limited to) specific activities such as contributing to the development of the Wheat Initiative Strategic Research Agenda, producing a position paper for publication or addressing a particular challenge through a research programme. An output should be annual reports to the Scientific Board for dissemination to the Research Committee, the Institutions' Coordination Committee and the wheat research community through the Wheat Initiative website.

Expert Working groups are established following the attached flow diagram. Organised consortia addressing wheat research challenges can be endorsed by the Wheat Initiative as EWGs following the same process.

Topic title

Expert Working Group on Durum Wheat Genomics and Breeding

Proposer(s)³

Proposer 1	Name	Roberto
	Surname	Tuberosa
	Institution	DipSA, University of Bologna
	Address	Viale Fanin 44, 40127, Bologna, Italy
	Email	roberto.tuberosa@unibo.it
	Telephone	+39-051-2096646
Proposer 2	Name	Luigi
	Surname	Cattivelli
	Institution	CRA-Genomics Research Centre
	Address	Via San Protaso, 302, Fiorenzuola d'Arda 29017, Italy
	Email	luigi.cattivelli@entecra.it
	Telephone	+ 39-0523-983758

¹ For Secretariat use only, do not fill out.

² Please send the completed form to H el ene Lucas, Wheat.Initiative@versailles.inra.fr

³ Add lines for other proposers if needed.

Summary

The much smaller acreage of the durum crop as compared to that of bread wheat has meant that durum research activity has lagged behind that for bread wheat and has received substantially less attention and lower funding. The **EWG on Durum Wheat Genomics and Breeding (EWG-DGB)** aims to bring together and synergize the activities of those stakeholders interested in promoting (i) specific research actions focused on improving durum wheat productivity and quality and (ii) collaborations with the scientific community active in genomics of bread wheat. To this end, this EWG will identify a number of research priorities to ultimately boost and sustain durum wheat improvement and cultivation, increase consumers' acceptance of durum-derived products and stimulate a closer interaction with the bread wheat genomics community.

From a breeding standpoint, enhancing selection gains of durum breeding programs and releasing improved cultivars will require a closer integration between conventional breeding and genomics-based activities such as gene/QTL mapping and cloning, functional analysis of relevant genes/QTL, identification of beneficial alleles at target loci, MAS, genomics selection, etc. This, in turn will be achieved through a coordinated action between public institutions and private seed companies. In this context, the sequencing of the durum wheat genome – in the wake of what has already been achieved in bread wheat – represents an essential starting point that will provide novel opportunities toward a more effective genetic tailoring of this valuable crop. A closer interaction between the durum and bread wheat communities will speed up the sequencing of durum while providing novel opportunities for comparing gene functions in both species and harnessing valuable allelic variation of interest also for wheat breeding.

Detailed description (5 pages maximum)

Rationale

Global production of durum wheat has fluctuated between 30 and 40 million tons/year over the past decade, which is about 5 to 7% of the bread wheat production. Although durum wheat is a relatively small crop on a global basis, it represents a main crop and staple for specific regions (e.g. the Mediterranean Basin) and is the essential raw material for specific end-products (e.g. pasta, couscous, etc.) consumed worldwide.

Durum wheat cultivation is often restricted to regions where environmental stresses (e.g. drought, salinity, high temperature, low nutrients, etc.) and diseases frequently curtail grain yield and quality. The release of improved varieties with greater yield potential, better quality and the ability to mitigate the negative effects of stresses is thus required to make durum wheat a more profitable and sustainable crop in these regions as well as in more productive ones.

The much smaller acreage of the durum crop relative to that of bread wheat has meant that durum research activity has lagged behind that for bread wheat and has

received substantially lower attention and funding. Consequently, valuable opportunities exist for enhancing the rate of genetic gain in durum improvement through the application of genomics-based approaches. The application of those approaches and, eventually, the availability of the wheat genome sequence coupled with its tetraploid nature will also facilitate the exploitation of durum for cloning loci of breeding interest located on the A and B genomes and for the introgression of traits from *T. dicoccoides* and *T. dicoccum*, the wild relatives of tetraploid wheat.

The structure of the durum wheat chromosomes, essentially identical to the corresponding homologs in bread wheat, and the achievements in bread wheat sequencing provide a pivotal starting point for durum wheat genome analysis. Nevertheless, specific attention should be paid for transferring genomics knowledge from bread to durum wheat and vice-versa for the identification of agronomically important loci, beneficial alleles at such loci, molecular markers for breeding purposes and, more generally for the effective exploitation of genetic resources in both species.

Description of the EWG aims

The EWG-DGB aims to synergize the research activities in this area and identify research priorities in order to enhance the selection progress in durum wheat breeding while enhancing the level of interactions with the bread wheat community. The EWG on durum wheat will work in close contact with other EWGs in the Wheat Initiative (e.g. the EWG on the IWGSC coordinated by K. Eversole) whose findings are relevant and transferable to durum wheat. Once the EWG-DGB is established, a global survey will be carried out to identify the research priorities for durum wheat genomics. Examples of some relevant research activities that will be subject to the evaluation of the durum wheat community are given below:

- **Sequencing of durum wheat genome.** The progress in sequencing technology and bioinformatics and the advances in bread wheat sequencing now allow us to realistically plan a re-sequencing project for durum wheat germplasm. Based on current technology and on the expected sequencing information that will derive from the bread wheat sequencing project, re-sequencing-like strategies could be deployed to run a survey of allele diversity in durum cultivated and wild (emmer) germplasm. In turn, the sequencing survey of the durum wheat germplasm will provide basic knowledge required to contribute to a better understanding of the functions that determine yield and quality in this crop while allowing for a more extensive and effective deployment of genomics-based approaches in durum wheat breeding. This information/knowledge will allow for an unprecedented level of structural and functional comparative analysis on the durum, emmer and bread wheat haplotypes at key loci.
- **Germplasm resources.** Durum wheat is characterized by a vast number of landraces and wild relatives (*T. dicoccum* and *T. dicoccoides*) fully inter-crossable

with cultivated varieties. In view of the fact that durum wheat can act as a “bridge” between tetraploid wild relatives and bread wheat for the introgression of relevant features, exploring the wild relatives of tetraploid wheat will allow breeders to harness novel beneficial allelic diversity also in bread wheat. An initiative based on extensive phenotypic characterization coupled with genomic information in wild wheat germplasm and on the development of introgression lines represents a priority to better exploit the available biodiversity in order to improve yield *per se* and adaptation to abiotic (e.g. drought, heat, salinity, etc.) and biotic (e.g. fungal diseases, particularly mycotoxins) stresses in cultivated wheat.

- **Marker-based breeding activities.** The relatively small number of markers mapped in durum wheat has limited the investment of the main seed companies in marker-assisted selection (MAS). This will be achieved by (i) assembling a SNP-based durum and emmer consensus map based upon the 90K Illumina Chip that was recently made available. This consensus map will be compared to a similar SNP-based consensus map of bread wheat. From a breeding standpoint, enhancing selection gains of durum breeding programs and releasing improved cultivars will require a closer integration between conventional breeding and genomics-based activities such as gene/QTL mapping and cloning, functional analysis of relevant genes, comparative meta-analysis between durum and bread wheat for the identification of beneficial alleles at target loci, MAS, genomics selection, etc. The main selection targets will include resistance to abiotic (e.g. drought, heat, salinity, etc.) and biotic (e.g. *Fusarium*, rusts, *Septoria*, viruses, etc.) stress, and morpho-physiological traits influencing yield potential and yield stability. In view of the end-use of durum wheat, particular emphasis will be devoted to quality traits and semolina yield as specified below.
- **Quality traits.** Durum wheat production is characterized by specific quality traits (e.g. protein content, color of semolina, etc.) and often grain price is based on quality parameters with a relevant impact on growers’ income and consumers’ choice. The role of nitrogen and its link with protein quality is also a topic of great interest for the pasta industry. Besides quality traits, semolina yield is also of great interest for the milling industry. Collectively, all these traits will be considered for research and breeding activities

Expected deliverables/output of the EWG

The world production of durum wheat is concentrated in a few countries across Southern Europe (mainly Italy and Spain), Turkey, North Africa (Algeria, Morocco and Tunisia), North America (Canada and USA) and Australia. In this scenario, international coordination activities as those promoted by the Wheat Initiative are essential to integrate and harmonize the different research activities and funding opportunities. The EWG-DGB will provide a reference point for a worldwide interaction among projects and scientists working on durum wheat and will help the Wheat Initiative Scientific Board to

identify the most urgent priorities in the field of durum wheat genomics and breeding, also in view of the needs and goals of the bread wheat community.

After a worldwide survey, the EWG will produce a list of priorities for durum wheat genomics and breeding and will explore possible interactions and complementarities among research groups active in durum wheat/emmer and also other groups active in bread wheat only. Through the activity of the EWG we expect to catalyze the interest of as many countries as possible on the objectives described above while providing novel opportunities for a closer collaboration with the bread wheat community. A first step in order to strengthen the collaboration within the durum wheat community will be achieved by assembling a SNP-based durum consensus map based on the available SNP-based maps in durum. This consensus map will then be compared to a similar consensus map available for bread wheat.

Timeline of Activities

During the first year, a survey will be conducted in order to gather information on genomics and marker-assisted breeding activities in durum wheat. This information will be archived on the Wheat Initiative website, thus providing an easily accessible view on who is doing what and where. This will also provide opportunities to parties interested in establishing bilateral or multilateral collaborations within this and other EWGs.

Based on the results of the survey, a Strategic Agenda will outline the perceived research priorities. The Strategic Agenda will be circulated widely to all interested Parties and action will be taken according to the possible funding opportunities that will eventually arise. On a case-by-case basis, links will be sought with members of this and other EWGs to evaluate the feasibility to write and submit research proposals to public and private funding agencies.

The EWG-DGB will meet annually at the Plant & Animal Genomics (PAG) congress in San Diego and whenever dedicated international congresses will be organized. A short report will be distributed once a year to those on the mailing list of the EWG-DGB.

Alignment with the Wheat Initiative objectives

The objectives of the EWG-DGB are fully integrated in the Wheat Initiative strategy. Although durum wheat genomics is largely based on advances in bread wheat genomics, increasing attention is being devoted to promote durum wheat genomics in order to more effectively harness wheat biodiversity for the release of new durum wheat cultivars. This, in turn, will also provide novel research opportunities for bread wheat research and breeding. The EWG-DGB will investigate and manage these objectives and, on a case-by-case basis, will align them to the Wheat Initiative objectives.

The EWG-DGB will work in close contact with other EWGs of the Wheat Initiative whose findings are relevant and transferable also to durum wheat.

Potential links with other Wheat Initiative activities
<p>From an operational standpoint, the main links will be with other EWG members who might be interested in establishing collaborative programs that also target durum wheat and/or exploit durum datasets/materials.</p> <p>The EWG-DGB will liaise with the organizers of the biennial Wheat Congress to verify the opportunity to organize a dedicated session during the Congress that will deal with durum wheat.</p>
Supporting countries/institutes
<p>A number of public Institutions in Italy are actively engaged in research activities dealing with genomics applied to plant breeding of durum wheat. Recently (February 2011), a number of scientists from these Institutions were invited to attend a workshop on durum wheat genomics and breeding organized by Dr. P. Langridge and colleagues at the ACPFG (Adelaide, Australia). Following a number of presentations and extensive discussions, a document was prepared to summarize the main issues touched during the workshop. The document is attached and provides a valuable operational framework for the writing of the Strategic Agenda and further actions to be undertaken by this EWG.</p>
Potential participating countries ⁴
<p>Contacts will be sought with colleagues active in durum genomics and breeding activities worldwide. Based on previous contacts, a number of colleagues in Argentina, Australia, Austria, Canada, China, Ethiopia, France, Germany, India, Iran, Italy, Kazakhstan, Mexico (CIMMYT), Morocco, Spain, Syria (ICARDA), Russia, Turkey, Ukraine and the USA will be contacted. A number of contacts have already been established and will be further pursued to explore new collaborative opportunities. A first informal meeting with colleagues interested in the activity of the EWG-DGB was held at the Plant & Animal Genome meeting in January 2012.</p>
Resources (budget requirement, potential funders, etc.)
<p>The EWG-DGB will liaise with potential donors (public and private) to raise awareness to the needs of the research required to meet the future challenges faced by durum wheat production and the potential benefits arising from this research for bread wheat breeding. Seed companies active in durum and bread wheat breeding and food companies producing pasta, couscous and other durum-derived products will be</p>

⁴ Not limited to current members of the Wheat Initiative.

contacted to verify their interest in supporting research activities proposed in the Strategic Agenda.

Additional funding opportunities will be sought through funding agencies interested in raising the sustainability of wheat production where durum wheat-derived products are a major staple, thus influencing local food security.

Other comments

Synergizing genomics activities carried out in bread and durum wheat will positively impact the research activities of members of both communities and will strengthen their overall competitiveness.

Date of submission to the International Scientific Coordinator

15 June 2013

Wheat Initiative: process of establishment of a new Expert Working Group

