



Wheat to eat: accelerating plant breeding to address global food & nutrition security

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Q&A session

Presenter: Alison Bentley, Director, CIMMYT Global Wheat Program

The webinar recording is available on the IWGSC YouTube channel at: <https://youtu.be/v17ISUKx81s>

Q: Does CIMMYT work on hybrid breeding for wheat? If so could you talk about your approach and goals.

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Q: CIMMYT has been instrumental in collaborating with national research programmes in development of high yielding wheat varieties globally. So, CIMMYT's contribution to food security especially in the developing countries cannot be overstated. I understand that almost all or most of the varieties released or registered in these countries are CIMMYT-bred. In fact, CIMMYT has large collection of global local genetic resources and has plans to use them appropriately which we can see. However, as the Director of Global Wheat Program how do you think that the national research partners could be encouraged to research on the local genetic resources to add value to their work rather than a complete reliance on CIMMYT-bred materials. This applies specifically to the developing countries with diverse agro-ecological context.

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Q: Do you apply early prediction of parents to cross for potential superior performing offspring

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Q: Can you discuss your Product Profile development process?"

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Q: What could be the best possible way to overcome yield plateau or yield barrier?

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Q: What about QTL mapping for blast and stem resistance through speed breeding?

QTL mapping/discovery efforts are underway to uncover greater insight into the genetic control of both blast and stem rust resistance in collaboration with a range of partners around the world. At present blast resistance is conferred by the 2NS translocation and additional sources of resistance are urgently sought. Once identified, these will be targeted via speed breeding. For rust we are currently targeting introgression of Sr22, Sr50, Sr2, Yr57, Yr59, Sr35, Yr15, Yr5, Sr47, Sr25, Sr13 and YrSP via speed breeding.

Q: Do you think that genomic selection is feasible for yield stability?

Yes, if you consider yield stability as performance over several seasons and/or several environments. There is a lot of work ongoing at CIMMYT by Jose Crossa and colleagues on this topic, and on the best models to deploy in order to capture the GxE components influencing prediction accuracy.

Q: Amid drastic climatic changes, though some wheat varieties have trait to withstand heat stress during dough stage but ,what other preventive measures can be practiced to avoid stress in order to gain yield near about potential yield of the variety.

Heat stress at flowering/grain fill is a major stress leading to reduced yields. There is now a body of evidence to support the role of early sowing and shorter-duration varieties (including the CSISA project: <https://www.usaid.gov/results-data/success-stories/saving-india%E2%80%99s-wheat-fields>) alongside mechanization in South Asia. Another important tool is accurate screening of breeding material in heat stress environments, and this is an important component of CIMMYT's breeding strategy

Q: Can you speak more to equitable distribution of resources and research? What guiding principles are you using, and what changes have been made as a result of considering equity?

An important (and complex) question! There are many parts of the Global Wheat Program, many parts of CIMMYT and many other actors working in this space. How we approach equitable distribution of (increasingly limited) resources is a big challenge. Likewise, we work with many partners worldwide and are looking to have these partnerships being equal. The current guidance from our donors is that at least 30% of our project budgets should be allocated to national program partners. Ideally, we will get to a stage of co-design and implementation when this is 50:50.

Q: Are you measuring Cadmium content in the high zinc germplasm? If so, have you observed a correlation between the content of the two elements?

Response provided by Zn breeder Velu Govindan. Annually CIMMYT selects few hundred candidate lines for testing all elements, including Cd using ICP-MS at the Flinders University, Australia. Cd levels are overall much lower than the codex limit of 0.2 mg/kg from our Obregon samples. Also, the Cd uptake and transport pathway in durum wheat is more uninterrupted or continuous than the bread wheat with broken pathway for Cd transport (therefore we think this is more of problem for durum than for bread wheat where we are targeting Zn increase). Further research is needed to test our increased Zn lines under Cd contaminated conditions in the US or elsewhere to understand how they behave in terms of Cd uptake.

Q: In India, anthocyanin-rich wheat (colored wheat) is becoming popular among farmers. Does it really have health benefits? What CIMMYTs experience says

Response provided by Dr Maria Itria Ibba (Head of Wheat Quality at CIMMYT). Thanks to the antioxidant activity of the anthocyanins present in colored wheat, blue, purple and black wheat have proven to have different health benefits. Information about their effect on human health have been summarized in this nice review from Saini et al., 2020 (<https://doi.org/10.1080/10408398.2020.1793727>). However, here at CIMMYT the work on the selection and investigation of colored wheat is still at its infancy and limited to the screening of few lines on the field. In the future we will conduct more studies on this set of material in order to verify ourselves their effective influence on human health, especially taking into consideration the different and most common ways in which wheat is typically processed.

Q: Does CIMMYT working to develop diverse population of wheat varieties instead of single variety being grown on a field at a time? Any work on participatory or evolutionary breeding?

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Q: How is CIMMYT breeding program working to support farmer seed sovereignty like by designing varieties suitable for seed saving? Any efforts to support agroecological ways of farming by making breeding strategy decisions?

Much of the wheat grown in our target areas is grown from saved seed. We don't have a specific emphasis on varieties suitable for saving, but wheat seed generally stores very well, is robust and easy to transport which all make seed saving and informal exchange major components of the wheat seed system.

Q: Wheat is known to be sensitive to ozone air pollution, which is a global issue, estimated to cause about 15% reduction in global wheat production. Would this stress be considered by CIMMYT in the future?

Interesting question and some interesting recent literature on this topic (e.g. <https://onlinelibrary.wiley.com/doi/10.1111/tpj.13298>) including your own work. This isn't a focus of our program at present, but it is certainly an interesting trait to consider and we would be keen to collaborate in this area.

Q: Are there any partnership or collaborations with end-use industries (local or global millers or bakers) in relation to the CIMMYT effort for high nutrition wheat breeding and value chain

Response provided by Dr Maria Itria Ibba (Head of Wheat Quality at CIMMYT). Yes, we are currently working together with small and bigger industries on small projects related with the improvement of the nutritional quality of wheat-based products. For example, we recently conducted a study together with a local Mexican tortilla and milling industry company, to investigate the best bran fractions and the best bran % to be used to obtain high quality tortillas. Also, we are currently working with a bigger food industry company in order to identify the best quality and content of specific components to obtain high-quality bread with higher fiber content.

Q: With respect to the developing concept of plant based-meat, is there currently a plan in CIMMYT to work on protein content/quality in wheat grain?

Response provided by Dr Maria Itria Ibba (Head of Wheat Quality at CIMMYT). In all our analysis, investigation of grain protein content is of fundamental importance, especially because of the effects it has on the overall wheat quality. For this reason, yes, protein content is always within the analysis plan of CIMMYT. Regarding protein quality the situation is a bit more complex. Given the characteristics of the major group of proteins present in the wheat grain (gluten forming proteins), wheat does not suffice enough of some of the essential amino acids necessary for our health, especially lysine. Several studies have been attempted to develop high-lysine wheat but so far, very poor progress has been done, especially because of the genetic complexity of this trait and, I would say, a likely reduction in the functional quality of wheat. A transgenic or genetic engineering approach could be the solution to improve the wheat grain lysine content, but this option has to be carefully considered as it might not find consumer acceptance. Also, I would say that for CIMMYT and the CGIAR is important to promote a healthy and varied diet which include of course also legumes and that would more “easily” contribute to the consumption of all the amino acids necessary for a healthy growth. For these reasons, we are not currently planning to work on the wheat protein quality (intended as aminoacidic content) improvement.

Q: The current nutrition breeding program is conventional or markers assisted breeding base? Any significant advance in development of Iron biofortified bread wheat?

This is ongoing as a core component of the breeding program. See this recent paper for more information: <https://www.nature.com/articles/s41598-018-31951-z>

Q: Is there any work going on selection for improvement of nitrogen use efficiency? what different ways/methods/strategies are being used for identification of high NUE

Not at present (as a core breeding objective) but there is much work underway on nutrient management within the Sustainable Intensification Program at CIMMYT (<https://www.cimmyt.org/work/sustainable-intensification/>). Recent work within the Global Wheat Program has looked at the potential to transfer Biological Nitrification Inhibition (BNI) into wheat (<https://www.pnas.org/content/118/35/e2106595118>)

Q: Are there efforts at CIMMYT to make wheat safe for people experiencing sensitivity to gluten and FODMAPs, as increasing the content of gluten proteins and some fibers might add to the problem?

Response provided by Dr Maria Itria Ibba (Head of Wheat Quality at CIMMYT). Our research portfolio does not currently include research on the improvement of wheat "safety" for people with celiac disease or gluten sensitivity. This is mainly because the number of people in the world with celiac disease is around 1% whereas people who experience gluten sensitivity are between 1 and 13%. Also, often time gluten sensitivity (not celiac disease) is hard to identify and in several cases, people only think that gluten is the responsible for the reaction associated with this sensitivity whereas other components present in a wheat-derived product (and not gluten) could be the actual cause of this condition. Given the relatively low number of people with such conditions, we prefer to focus (at least now) on improving the overall gluten quality in order to better fit the requirements of the different regions across the world for the production of high-quality wheat-derived food products. Regarding FODMAPs, we are planning to conduct some studies to identify the fructan content variability (the major component of FODMAPs) present in our germplasm. Fructan content in fact, apart from contributing to the appearance and persistence of the Irritable Bowel Syndrome, also influences micronutrient bioavailability. Since both wheat biofortification and increased micronutrient bioavailability are one of our major targets, the study of fructan content variation will also be explored within our program.

Q: Seasonal variability in UK appears to be increasing (I believe something similar is happening in the USA) - wet autumns/dry spring/cold spring/summer drought. Are you seeing this variability at CIMMYT? Do breeding values accurately represent field performance with such seasonal variation?

Yes, increasing seasonal variability both here in Mexico (where our main breeding activities are based) and our target environments are big issues. For this reason, we test material over multiple seasons to establish stability of performance (as well as suitable resistance to major pathogens). Both climatic variability and changing pathogen populations are becoming major challenges to "keeping up" with the environment. We are now moving towards earlier testing in our target environments which we hope will allow us to provide germplasm that most accurately adapts to the local conditions.

Q: How is the speed breeding working with winter wheat varieties?

Speed breeding for winter wheat is done in Izmir, Turkey. The plants are artificially vernalized and then transferred to speed breeding conditions (therefore we are only "speeding up" post-vernalization. For spring or autumn cycle the plants take around 12 weeks (84 days) and for the summer cycle 10-12 weeks (75 days) post-vernalization.