Safeguarding future wheat

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The theme of this year's conference is 'Outcomes, impacts and the way ahead' for international agricultural research. Within this context, global wheat and safeguarding wheat for the future could not, arguably, be more relevant.

Wheat is eaten by 2.5 billion people globally (Figure 1). It is important that we also remember that 1.5 billion people who eat wheat around the world live in the global south. This is the region of the world where over 50% of the world's wheat is also grown, and it includes many of the most food insecure regions of the world. The recent impacts of the Ukraine–Russia conflict on global wheat have highlighted the multifaceted and multi-dimensional challenges that face our global wheat system, both in terms of securing our food security and for wheat as a geopolitical instrument.

At CIMMYT in Mexico we work to incorporate and accumulate genetic innovations to improve our wheat for the world. We also look to encompass and incorporate new innovations and new science and make them available to smallholder farmers. These innovations are not just innovations in science; they are also in the next generation of wheat and agricultural

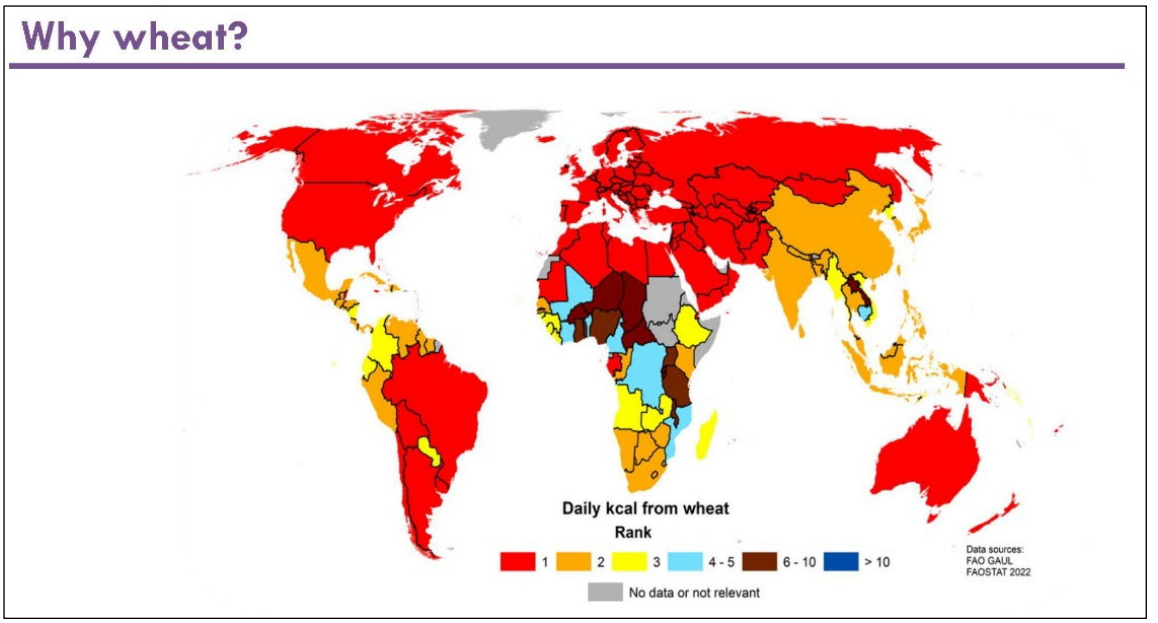


Figure 1. Wheat is eaten globally. (Map produced by Kai Sonder, CIMMYT.)

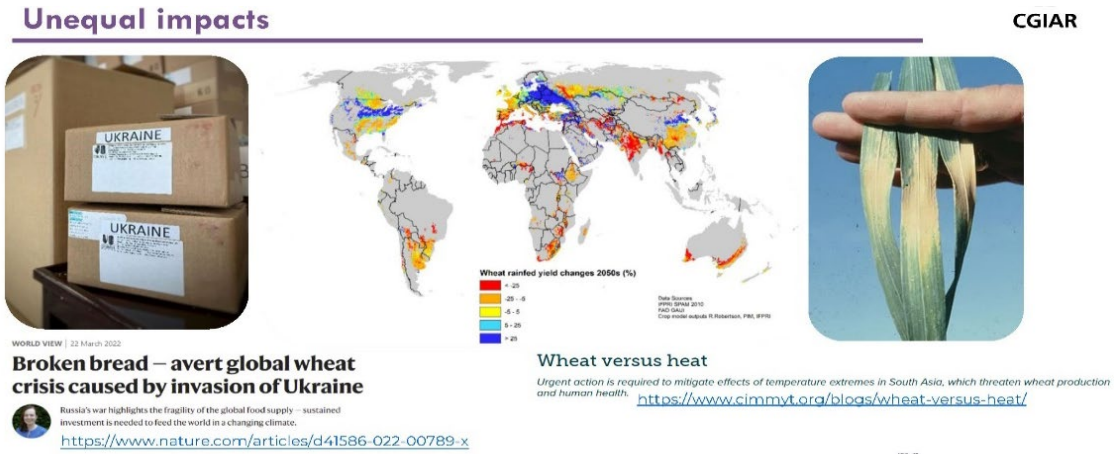


Figure 2. (Map produced by Kai Sonder, CIMMYT.)

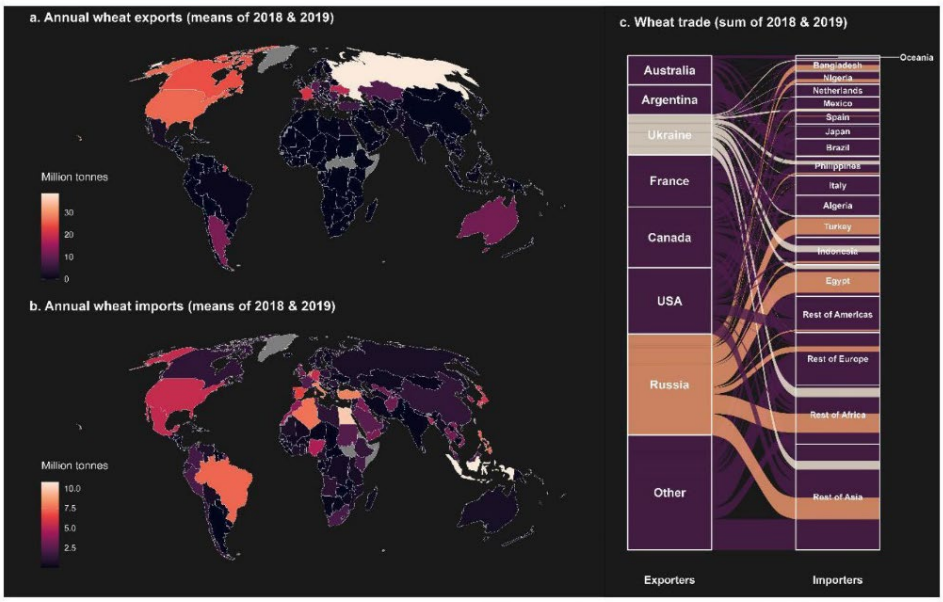
scientists. I myself was very fortunate to have my first experience of working in wheat in the international context as a Crawford Fund-sponsored scholar visiting the CIMMYT wheat program in Turkey in 2003.

Challenges to wheat production

We need to talk about unequal impacts (Figure 2; Bentley 2022a,b). We know that the current geopolitical challenges and the biophysical challenges that face wheat have great negative impacts, particularly in the global south. We have been highlighting the impacts of the Ukraine–Russia war on global wheat. They reveal inequalities that already existed due to much of the background to wheat production. We see huge impacts and huge vulnerabilities on food security in the global south as a result of this conflict. We can see this at the regional level; we can see it at the country level; and we can also see it at the level of the household. We know that, through gender inequality, females have greater responsibility for absorbing food shocks at the household level. Also, as wheat production changes and as the value of wheat production changes, there are significant gender implications on incomes and decision-making about agricultural and food production.

When we look at the biophysical challenges that face global wheat production, we can see from the forecasts of climate change that the effects are also likely to be most negatively felt in wheat-producing areas of the global south. We have recently highlighted the impacts of heatwaves in South Asia just before harvest, significantly reducing wheat yields; these had a real knock-on effect to wheat markets. We have also been highlighting that wheat requires rural populations, rural labour forces, to produce it, and that the impacts of heat and heat-related health disorders and health decline are very relevant when we think about how we adapt our crops to future climates. People need to be able to farm and produce cereals in these hotter, drier and more challenging environments. Therefore, we need to be thinking about some of these aspects of our research or breeding in a wider societal context.

Supply dependency



www.cgiar.org

Bentley *et al.* (2022) Nature Food https://doi.org/10.1038/s43016-022-00559-y

Figure 3. Ukraine, France, Canada, USA and Russia are major wheat producers.

We heard this morning, from Philip Pardey and others, about concentration: concentration in the spending of agricultural R&D; concentration in the funding of agricultural research for development. We also see the same thing when we look at the wheat market. The world relies on five major wheat-producing countries for most of its supply (Figure 3), and this has led to much of the vulnerability that we have seen in the market. Russia and the Ukraine are both in this group of the top five producers and exporters of wheat. We know from many examples that when we have this concentration, we introduce vulnerability into the system, and that is exactly what we have seen with the invasion of Ukraine. Many of the countries in the global south have for many years relied on Russia and the Ukraine and the other top three producers for cheap wheat. The availability of cheap wheat, readily available in a ship that sails across the world, has been underpinning a massive component of our food security.

Looking at these trends in supply dependency or the dependency on imported cheap cereals, we see that this is crucial to understanding the current vulnerabilities in Africa and Asia, which include many of the most food insecure countries of the world. This dependency on being able to buy and access cheap imports of cereals to underpin food security in some of these regions is projected to increase over time (Figure 4).

Proposals for practical action

At CIMMYT we have been proposing practical actions in response to the current wheat crisis (Figure 5). These range from short-term mitigation of the food security impacts of the current crisis, through to a longer-term view on what can be done to build greater resilience.

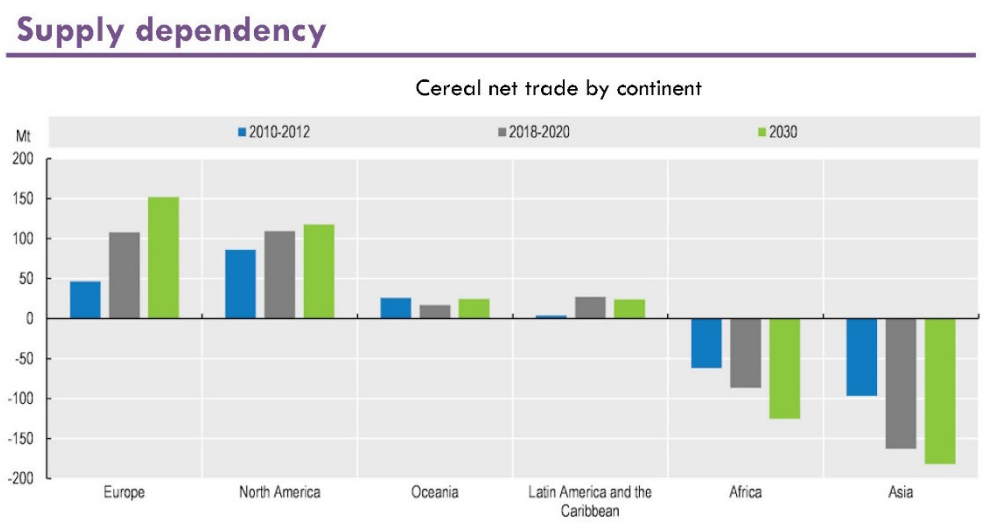


Figure 4. *Source:* OECD-FAO Agricultural Outlook OECD Agricultural Statistics 2021.

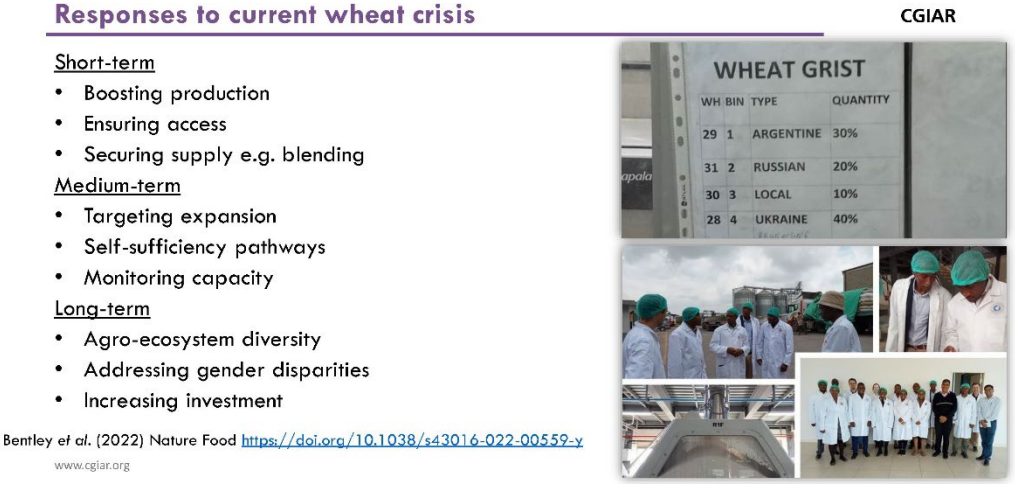


Figure 5.

In the short term, proposals include boosting production, market controls and ensuring access, as well as securing supply. Supply issues are very noticeable in East Africa, where no wheat imports into the port of Mombasa represents a significant food security threat. If you visit one of the largest mills in East Africa, you see on the wall the composition of the wheat grist – the wheat flour that sustains much of Africa's urban and peri-urban population, which is growing rapidly. It shows their current reliance on 60% of their wheat from Russia and the Ukraine. That absence represents a very significant deficit in the supply that is available now, today, to feed and to secure the livelihoods of those populations.

In the medium term, we suggest actions targeting expansion, supporting self-sufficiency pathways through bundled packages of plant breeding, agronomy and policy, as well as monitoring capacity. What if all the PCR machines that were requisitioned for COVID-19

testing were turned into a capability for genomics-based surveillance of pests and pathogens in crops and crop products that move across the world? There is great potential to scale-up the monitoring of crop production and the monitoring of biosecurity hazards as crops and commodities move across the world.

In the long term, there needs to be a focus on achieving agro-ecological expansion within the boundaries of the system. We also need to think about how to address gender disparities that we know exist in agricultural production systems. And there needs to be increasing investment, instead of investment that is 'firefighting' from one crisis to another; that is, sustaining investment in agricultural science as a foundational component of global food security.

CIMMYT global wheat improvement

At CIMMYT, we are very focused on the biological and genetic aspects of wheat improvement. We work on accelerating the generation of new genetics and making those available across the world. We also go 'upstream' from this, looking at the genetics that might be needed in the future as environments become hotter and drier, searching out the traits that need to be incorporated to build climate adaptation (Figure 6).

At the other end of the spectrum, CIMMYT has programs looking at the consumer and the farmer – trying to understand their changing demands so we can better design wheat genetics and biology to match those future needs. For that, we are using some innovative concepts such as video product concept testing, a method commonly used in the design of consumer goods. We are trying out the same testing approach for seed, to understand what people want now as well as what they are going to want in the future. We are examining consumer

Figure 6. Some aspects of work at CIMMYT.

demand, patterns of urbanisation, and how consumer demands are changing, and how, as geneticists, plant breeders and agronomists, we can satisfy these changing needs.

CEAT innovations In Australia

In my work with CEAT, the Centre for Entrepreneurial Agri-Technology at the Australian National University, through an Agri-Innovation Fellowship, we are also looking at innovations from different sectors. As we have already heard at this conference, many agricultural innovations have come from outside the agricultural innovation space.

For instance, we are considering ways to accelerate the rate of developing new seed varieties. Vaccines that used to take ten years to develop were available in a year for COVID-19 through, obviously, large investment, and also through parallelisation of many of the processes. A seed variety takes ten years to develop, so we are examining if any of the learnings from COVID-19 vaccine development can be applied to the development of seed varieties. What if seeds were vaccines? Could we make this possible? Are new innovations possible when we look at these processes and the building blocks of what we know has been achieved for COVID 19?

With CEAT we are also looking at the use of alternative financing and technology products to disseminate seed in places where no formal seed sectors exist. In countries such as Afghanistan, where wheat is a hugely important component of food security, it is very difficult to move seed and track the uptake of seed varieties because of the lack of a formal seed sector. Can we use blockchain technology to enable the movement of seed to farmers, and to reach the most inaccessible areas of those countries?

Supporting greater diversity in crop sciences

At CIMMYT we strongly believe in supporting the next generation and this really resonates with the work of the Crawford Fund and many of the activities in the CIMMYT program.

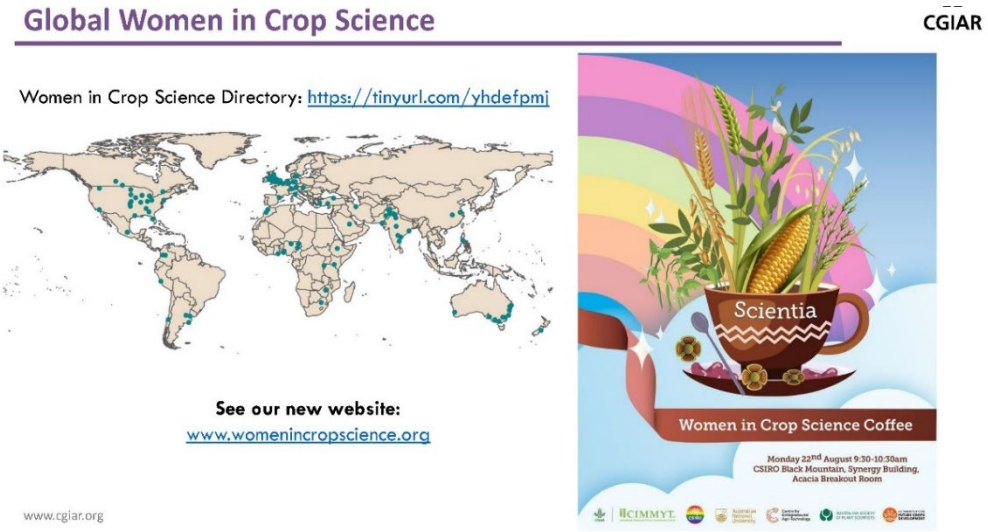


Figure 7. Global Women in Crop Science, www.womenincropscience.org

I want to highlight the coming together of the Global Women in Crop Science community (Figure 7), which has now developed a directory of women working across the crop sciences. I encourage people to join. We have launched a website and are trying to support the community in this space and build resources and a more equitable future.

The future for wheat

In summary, I believe that the future of wheat, and safeguarding wheat and the way ahead, involves collaboration, innovation and the coming together of diverse communities and ideas, to ensure future impact.

Further information

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Dr Alison Bentley is the Director of CIMMYT's Global Wheat Program, based in Mexico. Her research combines genetics and genomics to develop and deliver new tools and technology to improve plant breeding, crop production and adaptation to climate change. At CIMMYT, Alison leads a team of scientists using scientific approaches to develop improved wheat germplasm. This germplasm captures packages of traits providing productivity, resilience, and broad adaptation, supporting global wheat improvement and smallholder livelihoods. Prior to joining CIMMYT in November 2020, Alison worked in the UK, focused on translation of fundamental scientific breakthroughs into tangible impacts for the agri-food sector. She has a doctorate in agricultural science and PhD in agriculture from The University of Sydney, Australia.