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I’d like to offer some illustrative examples of how scientific partnerships and exchange of plant genetic resources in international agricultural research have generated benefits for US farmers and consumers.

1. It is widely accepted that the greatest transformation in world agriculture of the last century was the Green Revolution, which averted famine particularly in the wheat and rice-growing areas of numerous countries in Asia by boosting levels of farm productivity several times over, lowering prices for consumers, raising income and demand for goods and services. Most of us here are familiar with the history of this transformation.

   • You will remember that the key technological impetus was short-statured varieties that were fertilizer responsive and didn’t fall over in the field when more of the plant’s energy was poured into grain rather than the stalk and leaves.

   • Less well known is that the origin of the genes that conferred short-stature in wheat was a landrace from Korea--transferred to Japan, named Daruma, and bred into Norin 10. Norin 10 was named for a Japanese research station, tenth selection from a cross. Later, Norin 10 was brought as a seed sample by an agronomist advisor who served in the MacArthur campaign after WWII. At Washington State University it was crossed to produce important US wheat varieties. The most extensive use of Norin 10 genes outside Japan and the US was by Norman Borlaug, who won the 1970 Nobel Peace Prize. He was the founder of the World Food Prize (won, for example, by Gebisa Ejeta). (L.P. Reitz and S.C. Salmon, 1968, Origin, History and Use of Norin 10 Wheat, Crop Science, Vol. 8, Nov-Dec. 686-689; Borejevic K. and K. Borejevic, The Transfer and History of “Reduced Height Genes” (Rht) in Wheat from Japan to Europe, 2005, Journal of Heredity 96 (4): 455-459).

2. Many US institutions were involved in this transformation, such as the Ford Foundation, the Rockefeller Foundation, USDA, USAID and the US
Wild tomato species
Department of State). The US became a major player in the international consortium for scientific research called the Consultative Group on International Agricultural Research (the “CG”).

- A study by Pardey et al., undertaken in the late 1990s, found that the US gained up to 13.7 billion from 1970 to 1993 from use of varieties from CIMMYT, the wheat center of the CG. US investment amounted to 2 cents per 100 dollars earned, and a benefit-cost ratio for 190 to 1. Taxpayer contributions were repaid many times over (Pardey, P. G., J. M. Alston, J. E. Christian, and S. Fan. 1996. Hidden Harvest: U.S. Benefits from International Research Aid. IFPRI Food Policy Report. Washington, D.C.)


- They identified 2800 species provided by 189 countries and distributed to at least as many.

- The US is the top four provider of the materials circulated and the second top recipient. Considering unique germplasm (seed samples not counted twice), the US provided 6300 over this time period and received 40,000. In numbers alone, we received more than 6 times what we gave.

- Most of these were, by the way, public (not private)

4. The nature of plant breeding is that the job is never done….that is, problems continue to evolve in farmers’ fields and plant breeding is a perpetual search for novel gene combinations, shuffling these in different ways to overcome new challenges. Today’s challenges don’t like those faced by Norman Borlaug and colleagues in 1970. Famine is less often the issue than healthy nutrient balances, to which plant breeding can contribute through fortified varieties (e.g., the World Food Prize winner Jan Low, for work with Orange Flesched Sweet Potato). We are vulnerable to continually changing environmental stresses---we need traits for heat
tolerance, salinity tolerance, tolerance to drought in some places and too much moisture in others.

- Crop wild relatives play a critical role in this search, because they are not the cosseted, prized plants of our plant breeding programs, but have adapted under natural conditions.
- Dempewolf et al. reviewed past studies and data on use of wild relatives in crop improvement, finding wheat, potato, sunflower, tomato among the top ten. They found over 4000 potential and confirmed uses of CWR across 127 crops. Tyack and Dempewolf assembled estimates of commercial value of use of CWR reported in studies, ranging from 16 mill/year to 1.7 billion/year in USD 2012 terms. That high value was in a study led by the National Research Council (Dempewolf, H., G. Baute, J. Anderson, B. Kilian, C. Smith and L. Guarino, 2017, Past and Future Use of Wild Relatives in Crop Breeding, Crop Science 57: 1070-1082; Tyack, N. and H. Dempewolf. 2015. The economics of crop wild relatives under climate change. In R. Redern, S.S. Yadav, N. Maxted, M. E. Dulloo, L. Guarino and P. Smith (eds.), Crop Wild Relatives and Climate Change. John Wiley & Sons).
- The lower value is Lypopersicon—a “serendipity” found during a collection expedition for potato in 1962 in Peru, the sample was provided to Dr. Rick, Wisconsin tomato breeder who found that the offspring and elite tomato lines had 2% higher soluble-solids content. Rick estimated a commercial value of 16 mill per year at a collection cost of only $42. As Hugh Iltis described it, “tiny, slimy seeds of a useless, ugly weed stuck to an old newspaper...costing 30 minutes of our time” (research funded by the National Science Foundation). See “High Iltis, Serendipity in the Exploration of Biodiversity: What Good are Weedy Tomatoes? Ch 10 In E. O. Wilson, Biodiversity).
- Going back to wheat, we have the recent example of Hessian fly. From 2000-2015, average temperatures rose from 1 to 2 degrees F above the 20th century average, with periods of time between rainfall lengthening....resembling more conditions in the Mideast that the US Midwest....scientists sought natural resistance to Hessian fly, around
Aegilops tauschii ("Goat grass")
for centuries in the Mideast and since the birth of the US. Losses in the spring of 2016 were estimated at 10 percent yield in that year in the Midwest. The fly injects a protein-based substance in to the wheat that makes it into a “nutritious slurry” ..the crop becomes greener and is great fly-feed but cannot mature properly. Aegilops tauschii, wild grass native to the Fertile Crescent, is resistant. See of a. tauschii was brought back from Syria in the midst of the war. One of the individuals who transferred the seed was Dr. Ahmet Amri, who received his PhD from KSU and was responsible for the germplasm collections housed at ICARDA, the International Center for Agricultural Research in the Dry Areas.

https://e360.yale.edu/features/how-seeds-from-war-torn-syria-could-help-save-american-wheat

- A. tauschii (commonly known as goat grass) is resistant to many other diseases and stresses, and one way of move these traits more quickly into modern wheat varieties is via the synthetic hexaploid. Scientists at CIMMYT and Kansas State University “reenacted” what happened naturally in the process of plant evolution...the natural crossing of tauschii with an relative of durum wheat (emmer) to create what we know as bread wheat.....the chromosomes tauschii gives (DD) are particularly diverse compared to modern bread wheat. The synthetic hexaploids are like a natural bridge for introducing needed diversity from the wild.

5. I’ll wrap up with two final points.

- Funding of international scientific exchange, and the exchange of plant genetic resources is a necessary condition for a functioning food system and the well-being of US farmers and consumers. It pays off many times over, contributes to stability and rising incomes that lead to demand for our goods and services.

- But investments of this type don’t pay off today. They pay off 15-20 years down the road. Much of what the plant breeders do is protect yields against pests and diseases and other types of stress—avoiding hardship and disaster from crop failure. Without investments today, it is the next generation that will suffer.