

Transnational Flows of Expertise and Seed in the Making of Egypt's Wheat

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Wheat is one of the world's most important crops, source of almost a fifth of the world's calories.¹ The Rockefeller Foundation has played a major role in wheat development, through its agricultural program of research, technical assistance, and educational extension. This work began with the foundation's support for the Mexican Agricultural Program in 1943, which later developed into the International Maize and Wheat Improvement Center (CIMMYT). Over the following two decades, the foundation expanded its wheat program in South America, South Asia, and the Middle East.² Yet while a number of scholars have examined the impacts of this work on wheat cultivation in Mexico and South Asia,³ little scholarship has looked at how this influence spread to the Middle East (with the exception of some work on Turkey.)⁴

My current book project, *Precarious Staples: Wheat, Bread, and the Taste of Security in Egypt*, explores the political dynamics of wheat and bread in Egypt from 1952 through to the present. As the source of Egypt's staple food – bread – wheat holds profound significance to the Egyptian population. Securing the supply of wheat to meet the population's high bread consumption needs is thus central to the stability of the state. A significant amount of this wheat is grown by Egyptian small-scale farmers.⁵ Over the last 50 years, the amount of wheat these farmers have been able to produce on a limited area of agricultural land has increased markedly as yields have grown from 3.5 tons per hectare in the 1960s to an average of 6.8 tons per hectare today.⁶ While this growth in yields is a function of multiple factors, including agricultural practices and fertilizer use, new varieties of wheat have played a key role. But how have these new varieties emerged? What practices of scientific breeding have led to the development of wheat seeds that produce some of the highest yields in the world? Drawing on material from the Rockefeller Archive Center, this paper examines how the development of high yielding varieties of wheat in Egypt has been linked to transnational flows of expertise and seed.⁷ I focus on the 1960s and 1970s, a period of transformation in Egypt's wheat breeding program during which

breeders started working with a wide range of germplasm and developing high yielding varieties that were quite different from their predecessors.⁸

Expertise

In 1960, Norman Borlaug, head of the Mexican Wheat Program, traveled through the Middle East with Jose Vallega, from the Food and Agricultural Organization of the United Nations (FAO). The purpose of the FAO-sponsored mission was to examine the status of wheat production in the region. Another prominent wheat scientist, Elvin Stakman, recounts how during this trip, Borlaug and Vallega “visualized ... wheat fields for the Near East such as both of them had seen in Mexico” and asked themselves, “how could this vision be realized?” The answer they came up with was that “by sending men from the Near East to study in Mexico for a long enough time to really absorb information and to capture the spirit – that might be the best way.”⁹ Mexico was judged, by FAO staff, to be the ideal location for wheat breeders from the Near East to train, due to the similarity of the problems the two regions faced in spring wheat improvement and production, linked to soil and water management, disease, and lodging.¹⁰ With a grant from the Rockefeller Foundation, in 1960 the FAO initiated a program to send Near Eastern scientists for training in wheat breeding at CIMMYT.¹¹ Over the following decade, 57 Near Eastern trainees traveled to Mexico to hone their expertise in wheat breeding.¹²

The emphasis of the eight-month program was on practical training.¹³ As Borlaug explained, “They were to work with us in learning by doing, largely, right out in the plots and out on farmers’ fields, supplementing this with seminars and rounding it out as best we could in an informal sort of way... And they were to know from the outset that this was, in part, working physically, in the dust and the mud and the dirt and the sweat and all that goes with this kind of operation.”

¹⁴ To Borlaug, this kind of in-field training was of particular significance for agricultural scientists from the Near East, whom, he noted, typically come from “privileged classes.”¹⁵ Borlaug saw this experience as vital for wheat breeders. He stated, “We feel that we do serve a useful purpose from a down-to-earth, practical

training standpoint to give them a feeling for what agriculture really is and that there can be dignity in sweat when it's done by a scientist as well as when it's done by that peasant farmer. And until they learn this lesson, no matter how much science they learn, they're never going to be worth a darn to their own society.”¹⁶ The Rockefeller Foundation also funded scholarships for students from the Near East to study in the United States. This was part of a shift in the foundation's focus in the 1950s and 1960s from its earlier emphasis on supporting fellows from Western Europe who were studying medicine to supporting scholars from Central America, Africa, and India in agriculture and public health fields.¹⁷ The following two examples are illustrative of how this training, both in Mexico and the US, helped shape the expertise of key individuals within Egypt's wheat breeding program.

Elham Talaat was born in Tanta, Egypt, in 1926. After graduating with a BS in Agriculture from Cairo University, he started to work as a wheat breeder at the Giza Agricultural Station (with two stints working on wheat in Libya in 1954-55 and 1956-59). In 1960 he transferred to the Sakha Agricultural Station and the following year, began studying for his Master's degree at Ain Shams University. In his first year of the Master's program (in 1961), he attended the wheat breeding training program in Mexico.¹⁸ There, he made a strong impression. Borlaug commented that Talaat was “certainly one of the outstanding scientists to study under a FAO scholarship program here in Mexico.” He added as a handwritten note on the copy of this recommendation letter that was sent to Robert Osler at the Rockefeller Foundation offices in New York: “Bob, this guy is a human dynamo – perhaps a little too nervous but outstandingly promising.”¹⁹ After the course, Talaat returned to the Sakha Agricultural Station to develop what Borlaug described as a “vigorous wheat breeding program.”²⁰ This work also received endorsement from the director of the FAO's regional project on wheat breeding, which was based out of Cairo, who described Talaat as “a very enthusiastic worker.” He went on to elaborate that Talaat “has done very good breeding work at Sakha and has got some very promising lines which are in advanced stages of testing and are expected to replace the Giza varieties in the near future.”²¹ While working at Sakha, Talaat completed his MSc in Agricultural Genetics from Ain Shams, writing a thesis on resistance to leaf rust in wheat.

In 1966, Talaat received a Rockefeller Foundation scholarship to study for his PhD in the US at North Dakota State University. His research was on hybrid wheat. This was a topical issue at this time. Breeders around the world were keen to exploit *heterosis* (hybrid vigor) in wheat as they had done in other crops like maize. But wheat's propensity to self-fertilize (its flowers have both male and female parts) presented a problem for breeders seeking to cross two pure wheat lines to produce a hybrid. Much research was therefore devoted to various techniques through which some wheat plants could be rendered sterile, to prevent this self-fertilization from taking place, and then restored, to ensure that offspring would be able to reproduce. Talaat's research looked at the latter part of this challenge – the genes through which fertility could be restored once the hybrid was produced.²² North Dakota was not necessarily the best place in which to conduct this research, since as Talaat's advisor explained, "its sterility-favoring environment often masks the expression of fertility restorer genes."²³ So Talaat also grew some of his research in Mexico. He completed his PhD in 1969 and on the way home, broke his trip in the UK and the Netherlands, to visit and discuss his results with scientists in plant breeding institutes at Cambridge and Wageningen.²⁴ Back in Egypt, he returned to work at the Sakha Station.

The second example is Abdel Salam Gomaa, who came to be known in Egypt as "The Father of Wheat" (*abu al-qamh*).²⁵ Born in 1935 in Mansoura, Egypt, Gomaa graduated with a BA from Alexandria University in 1956. After graduation, he worked as a wheat breeder at the Giza Agricultural Station (with a year-long secondment to the Syrian government as a wheat breeder in 1961). He participated in breeding wheat varieties for Egypt, such as Giza 155.²⁶ He completed a MSc (in 1964) in Genetics at Ain Shams University, studying the inheritance of leaf rust resistance in wheat crosses. In 1962, the year after Talaat, he attended the wheat training program in Mexico. There he, too, excelled. Borlaug commented that he was among the better of the trainees and that he has "good motivation."²⁷ The deputy of director of CIMMYT judged that Gomaa was "excellent Ph.D. 'Timber'."²⁸ In 1969, Gomaa received a Rockefeller Foundation fellowship to study for a PhD in the US. After some confusion about the admissions process to several universities, he, too, ended up at North Dakota State.²⁹ Gomaa's research, also, was focused on developing an improved system

for producing hybrid wheat.³⁰ After completing his PhD, he returned to Egypt in 1973, where he continued to work on wheat breeding.

These two scientists' research on hybrid wheat did not ultimately lead to hybrid wheat programs in Egypt.³¹ Indeed while there have been hybrid wheat programs operating in a number of countries for decades, to date hybrid systems have remained impractical and difficult to use. Only a very small fraction of the total area sown with wheat is sown with hybrids.³² Yet the expertise Talaat and Gomaa developed over the course of their doctoral studies no doubt informed their subsequent work on Egypt's wheat breeding program.

The translation of this knowledge back home was not always, however, seamless. In some cases, these experts' newfound knowledge generated conflicts with higher-level bureaucrats within the wheat-breeding program. When Talaat returned from his training in Mexico in 1961, for example, he brought with him seeds of some Mexican dwarf varieties and started incorporating them in his breeding efforts.³³ But this proved to be controversial. These so-called "Mexican dwarfs" were short-statured varieties developed in Mexico from germplasm (Norin 10) originally sourced in Japan and further developed in the US.³⁴ Scientists associated with the Rockefeller Foundation saw these varieties as the way to unlock Egypt's potential. When Charles Krull, a wheat breeder from CIMMYT, visited Egypt in 1965, he commented on the "great opportunity" he saw. He wrote that he could see Egypt doubling its wheat production in 5 years, as had been done in Pakistan. "What is needed," he wrote, "is the right people in the right places who decide that they are going to do the same sort of thing." He went on to clarify what the "right" thing would be. "I am quite sure that using the [dwarf] variety we call 8156 here, that is being multiplied under the name Mexipak in Pakistan, could do exactly the same thing in Egypt that it is doing presently in Pakistan."³⁵

One reason why foreign experts judged these dwarf varieties to be vital was because of the problem of lodging (plants falling over because their stems are unable to support the weight of the grain). During Krull's visit, for example, he made a day trip from Cairo to the Sakha research station. Passing through the

“rich Nile delta” Krull observed, “the majority of the wheat fields seen between Cairo and Sakha had considerable lodging.”³⁶

Lodging was a particular concern given that with increasing fertilizer applications, which these scientists were advocating, the crop’s head would only become heavier. As Krull described, “None of the present varieties including Giza 155 have adequate straw strength for even the presently used fertilizer levels and the situation will rapidly deteriorate as fertilizer applications are increased. It is essential that this be done, or wheat will not be able to retain its present place in U.A.R. agriculture.”³⁷ The available varieties were thus limited because they constrained fertilizer applications. As Krull elaborated, “Farmers are already accustomed to using some chemical fertilizer with wheat and would undoubtedly begin using much more if stronger strawed varieties were available.”³⁸ Borlaug noted something similar. Egyptian breeders, he said, were “told that they could not fertilize with more than 50 pounds of nitrogen. Why? ... Because above 50 pounds of nitrogen, all of their own breeding material is flat on its back on the ground, lodged, and no matter how much more fertilizer, no matter what you do to the crop from there on out, you get no additional yield.”³⁹ The dwarf varieties would solve this problem, allowing farmers to use much more fertilizer and obtain higher yields. As Borlaug noted, “These small wheats – short ones – could be fertilized 100 pounds, 120 pounds, 130 pounds and still pay big dividends with the yield going up progressively as a result of this.”⁴⁰ Krull voiced a similar perspective: “The Mexican dwarfs are in general well adapted in the UAR. Their straw strength is definitely what is needed in the breeding program now.”⁴¹

But some Egyptian bureaucrats were wary of these dwarf Mexican varieties. Indeed, at one stage, the Minister of Agriculture proposed converting all the wheat in Egypt to a locally developed variety, Giza 155.⁴² What was the reason for this resistance? At root, first, was a contrasting way of seeing the wheat plant. To a scientist like Borlaug, the grain was the central focus of breeding efforts. Recounting what happens if you plant wheat too close together in poor agricultural conditions, he remarked “you’ll just get straw. They say it goes to straw.”⁴³ In other words, to him, straw epitomized failure. But in Egypt, where the straw is an important fodder source, the perspective was different. Egyptian agriculturalists saw wheat not just in terms of its grain but also its stalk, thus

valuing tall varieties regardless of their grain yields. This value was not just cultural but also economic. In fact, at times wheat straw has actually been worth as much or even more than the grain in Egypt.⁴⁴ While foreign scientists countered that dwarfs could produce as much straw as tall varieties because of their increased tillering, and possibly even more with higher fertilizer rates,⁴⁵ the perception that smaller varieties would have less straw was persistent.

But there was also more going on. Take, for instance, the resistance expressed by Said Dessouki, who was Head of the Wheat Section at the Ministry of Agriculture. Dessouki, too, had trained in the US (receiving his PhD from the University of Minnesota). He questioned whether the Mexican varieties would actually yield more than local varieties, like Giza 155.⁴⁶ Furthermore, one foreign specialist stationed in Egypt suggested that Dessouki was wary of Mexican varieties “since the dwarfs are not of Egyptian origin.”⁴⁷ As another foundation officer noted after his visit, “Egyptian workers are extremely proud of their varieties, ones which they have bred for high yield and for resistance to rust diseases.” He called this the “cult of the variety.”⁴⁸ That these breeders should feel a sense of pride in the fruits of their labor is not altogether surprising. Other work has indicated how breeders often develop a relationship with their varieties.⁴⁹

Nor was this resistance from higher-level bureaucrats a surprise to the foreign wheat breeders. In his oral history, Borlaug commented how “One of the biggest roadblocks to progress...is the scientists who control the programs and control policy” who are “ultra-conservative.” He saw them as being often concerned about losing control to scientists trained overseas and also fearful and even jealous of them.⁵⁰ Thus, part of being a good breeder, Borlaug said, was learning how to “become a bull fighter and try to evade as much as possible all of the bureaucrats that are knocking you down and tripping you up and poking your mouth full of paper when you’ve got so darn much work to do that you can do only half of what you want to do in the first place.”⁵¹ Such obstacles were particularly pronounced, Borlaug thought, when working in an area that is a center of origin of a plant. “When you deal with trying to transform an agriculture in the region of origin of the crop plant,” Borlaug noted, “you need to be a better showman than when you are introducing a change in culture into an introduced crop.” This, he said, was

another reason why he advocated for high fertilizer use in Egypt and other Near Eastern countries from the outset – in order to make sure there was a clear yields advantage.

You have to deal with attitudes like – well, we’ve survived on it like it is for all these thousands of years, let’s not rock the boat too much. I want the difference in yield to be so big that everything they’ve believed in – that has been basic to their very survival – comes down in shambles all around them.⁵²

In the face of the skepticism among some of these higher level officials, foreign experts thought the solution would be to bring these higher level officials to Mexico. We need to “retrain Dessouki,” one stated.⁵³ Another commented of Dessouki that “if he can see what they are doing for Mexican agriculture he would be more receptive to let the young men trained in Mexico make use of the dwarf lines.”⁵⁴ Charles Krull had the same opinion after his visit to Egypt. After commenting on how there had only been limited work with dwarf Mexican material in Egypt, he noted in his trip diary, “It would seem advisable to bring Dessouki and probably Hak (Director of Plant Pathology, also closely involved in the wheat breeding program and also with a PhD from the University of Minnesota) to Sonora next year for a month or so to give them a chance to see first-hand what is needed.”⁵⁵ He elaborated, “Such visits give us a good opportunity to influence the orientation of their programs by showing them (rather than just telling them) some of the things that have worked well in our wheat programs.”⁵⁶

Based on these recommendations, the Rockefeller Foundation paid for Hak and Dessouki to take a two-month long trip in 1967 to visit wheat research stations in Mexico, the US, Canada, and Sweden. By some accounts, this was a great success. Stakman recalls meeting with Hak and Dessouki after their visit to Mexico, on their way home, and said “they were tremendously enthusiastic about what they had seen and about the possibilities of capitalizing on some of the potential values that they have seen in these programs.”⁵⁷ The Egyptians were keen, he said, “to get into the streams of international flow of improved materials” – including those coming from CIMMYT.⁵⁸ Sure enough, the following year, in 1968, a program of “extensive exchange of wheat material” between Egypt and CIMMYT began.⁵⁹ In

a 1969 conference, Dessouki heralded a “new era in wheat breeding” referring to a “number of promising dwarf lines.”⁶⁰ Over the following decades, Egyptian breeders worked to incorporate these dwarf lines into their crossing program and released a series of high-yielding dwarf varieties. As I discuss in the next section, part of what made these changes possible was the breeders’ increasing access to new forms of germplasm within Egypt.

Seeds

A survey of wheat-producing developing countries in the early 2000s found that 64 percent of the land was cultivated with wheat varieties containing CIMMYT-related germplasm.⁶¹ But how did this material make its way around the world? How did it arrive in Egypt and become part of what Egypt’s wheat is today?⁶²

The first mode of circulation was in the luggage of breeders as they traveled around the world. Participants in the Mexican training program took back with them to their home countries, not only their knowledge, but also “a great mass of material” – a variety of seeds for them to experiment with on their own research stations.⁶³ All trainees were allowed to select 10g samples of seed from any of the Mexican breeding plots that they were interested in.⁶⁴ As noted above, this was the mechanism by which the controversial Mexican dwarf varieties arrived in Egypt – Talaat brought some home with him after he completed the course in Mexico. In addition, at the end of his doctoral program in the US, Talaat traveled to Mexico, once again to help prepare seed materials for use in Egypt.⁶⁵

The second mode was through shipment, either by boat or plane, on request. CIMMYT’s approach has been to make seed freely available to those who ask for it.⁶⁶ However this transportation of seeds has not always been straightforward. An interesting account by Borlaug of one particular transfer of seeds to South Asia is illustrative of some of the challenges of shipping seed around the world. In 1965, a freighter carrying 600 tons of seed for Pakistan and India set sail from Mexico just four days before the Pakistan-Indian war broke out. A number of delays ensued. When the seed finally arrived and could be planted, its germination rate

was poor. Further investigation revealed that the seed had been treated with three times as much disinfectant than was recommended before leaving Mexico.⁶⁷

The third mode of disbursement was via the international yield nurseries. In 1961-2, Abdul-Hafiz of the FAO and Borlaug organized the first Near East-American Spring Wheat Yield Nurseries. The idea of these nurseries was to plant the same package of seeds in different locations and compare yields and other criteria in the contrasting sites.⁶⁸ This nursery included all the main commercial varieties of the Near East as well as Mexican and Colombian varieties, which they knew to have flexibility and adaptability. They also included one or two less well-adapted varieties from Canada and the US as a point of comparison.⁶⁹ Judged to be a success, the program was expanded into an international yield nursery. Scientists working at CIMMYT dispatched sets of seed, each comprising 25 (and later 50) varieties to 70 breeding stations around the world. These were referred to as “nurseries” (i.e. the nursery was the set of seed not the location in which it was planted). If any wheat breeder around the world submitted 50g of seed, CIMMYT agreed to multiply the seed in Mexico and include it in the nursery. This allowed the breeder to immediately get a large volume of data on that variety’s success around the world, which could be helpful in deciding whether to multiply the line.⁷⁰ Reproducing this seed, measuring it out, and labeling seed envelopes took a considerable amount of work; analyzing the data that came back from the experimental plantings around the world was even more time consuming.⁷¹ Yet this was not only a way of distributing germplasm, but also of maintaining the network of Mexican-trained wheat breeders – described by Stakman as “alumni of the School of Wheat Apostles” – around the world. The international nurseries were, Stakman said, “one way of keeping up their zeal and strengthening their faith that even if they haven’t got too good facilities now, they may get better ones in the future.”⁷²

Notably, however, this was not just a one-way transfer of seeds from Mexico to the Egypt and the Near East. Near Eastern seeds crossed with Mexican varieties, and with materials from Europe and Latin America, were also disseminated around the world.⁷³ In addition, there was an active exchange of seeds within the region, for instance between Egypt and Turkey.⁷⁴

As the seeds moved across borders and breeders incorporated them into their national breeding programs, their names shifted. Different research programs have different naming conventions. Take, for example, the red-seeded strain of wheat that came from a particular cross and was known as Super X in Mexico. In 1967, Borlaug noted that he had tried several times to get this variety “baptized” (ie. its name changed) but “all of the built-in jealousies in government have not permitted this to happen.”⁷⁵ Thus, the seed left Mexico as Super X. Arriving in India, wheat breeders renamed the variety PV18 (Punjab, variety 18); in Pakistan, they renamed it Indus 66 (after the river). A white-seeded strain of the same wheat cross, called Siete Cerros in Mexico (meaning seven hills) was transported overseas under the name S-227. In India, it was renamed Kalyan 227 (Punjabi name for “freedom from hunger”), although it remained known as S-227 in other parts of India. In Pakistan, it was known as Mexipak 65 (from the names of the two countries).⁷⁶ Krull, who was working out of Pakistan, noted how in India breeders were multiplying that variety (Mexipak) under the name S-227. He added, “This variety will probably have at least half a dozen names at the rate it’s going...It’s all essentially the same variety. Some of them are repurifications and reselections, but it’s essentially the same thing.”⁷⁷ In Egypt, the typical practice has been to name varieties after the research stations in which they are developed (Giza or Sakha) followed by a number.

This renaming had occasionally led to some confusion. In a letter from J. Prescott, a wheat pathologist based in Turkey to a pathologist in Egypt, he commented that when looking through the results from one of their nurseries, he noticed a mistake regarding an entry listed as “Bluebird #4, II-23584-203M-oY-20L.” Prescott wrote, “Bluebird #4 has been renamed as Cajeme 71”. The pedigree of this variety is “II-23584-26Y-2M-3Y-2M-oY.” He noted that perhaps Kamel had only used “a selection of Bb#4 and not the original line” but that he wanted to let him know this just for his information.⁷⁸ On other occasions, the names stayed the same but pronunciation changed. In a discussion of the variety Penjamo, for instance, Borlaug commented how the Pakistanis:

...say Pen-jah-mo. This gets to be a real corruption. When the Mexicans hear these Pakistanis and Indians coming over and calling Penjamo, which is the name of a little town in the old

central part of Mexico, when they hear them calling it Pen-jah-mo, they almost have a stroke. It's so curious now to hear Narvaez over there in Pakistan talking about Pen-jah-mo. A real Mexican distorting and corrupting a good Mexican name. I have nothing against it, but it's a curious insight into how this labeling gets twisted a bit.⁷⁹

Names mattered. They had a symbolic role. They could, for instance, be used to honor a breeder, as in the Miramar variety developed in Colombia, which means “look at the sea” but was actually named to honor an old-time Colombian wheat breeder, Miranda Martinez.⁸⁰ There was also an element of national identity in the naming of varieties. One foundation officer after visiting Egypt noted, for instance, “It is not likely that the Egyptians will accept foreign varieties of wheat bearing foreign designations, however much more they may yield than local varieties. If Egypt is to advance on the basis of better varieties of wheat, such varieties will have to come up through local programs and local names.”⁸¹

Conclusion

This discussion demonstrates how the making of Egypt's wheat has been tied to transnational circulations of expertise and seeds. These flows of knowledge and germplasm must be placed in a broader political context. The period in question – the 1960s and 1970s – was a time of turbulent relations between the US and Egypt. In the late 1950s, after the Suez crisis, Egypt was not very interested in having many foreign experts, especially from the US or England. This eased in the early 1960s, though, with an increasing openness from Egypt to foreign expertise – hence the reason why a number of Rockefeller Foundation officers visited Egypt at this time.⁸² Still some tensions remained. In 1968, in a discussion over whether the Rockefeller Foundation might be able to further support research on wheat in Egypt as requested by Talaat, the foundation officer explained “at the moment the relationships of the US and Egypt were such that it would be difficult for the Rockefeller Foundation to be further involved.”⁸³ In correspondence over Gomaa as a potential scholarship recipient, a foundation officer noted, “there may be opposition here to a scholarship to a UAR national, given the civil situation.”⁸⁴

Borlaug responded with his endorsement of Gomaa noting that he is “apolitical, and a very conscientious worker”⁸⁵

Finally, this work on wheat has to be understood in the context of wheat trade between the US and Egypt. In 1966, the US cut off the supply of highly-subsidized wheat to Egypt, which it had been exporting to Egypt since 1954. In an interesting take on this, a foundation officer circulated an article from the *New York Times* about the pending US cut of sale of wheat to Cairo, along with a memo noting that “the world grain situation is tightening up” and that more countries would be having to “take even more seriously programs to speed grain production at least to a point of self-sufficiency.”⁸⁶ Thus so long as the American wheat grain was not flowing, all the more reason for the seed – either materially or in terms of related expertise – to keep flowing.

¹ Mitchell, D. and M. Mielke (2005). Wheat: The Global Market, Policies, and Priorities. In: *Global Agricultural Trade and Developing Countries*. A. Aksoy and J. Beghin (eds.). Washington, D.C., The World Bank: 195-214., p196.

² “Agriculture” in 100 Years: The Rockefeller Foundation Online Exhibit. <http://www.rockefeller100.org/exhibits/show/agriculture>, last accessed 2/13/17.

³ Fitzgerald, D. (1986). Exporting American Agriculture: The Rockefeller Foundation in Mexico, 1943-53. *Social Studies of Science* 16: 457-483; Perkins, J. (1997). *Geopolitics and the Green Revolution: Wheat, Genes and the Cold War*. New York, Oxford University Press; Goldsmith, A. (1997). The Rockefeller Foundation Indian Agricultural Program: Why It Worked. *Philanthropy and Cultural Context: Western Philanthropy in South, East, and Southeast Asia in the Twentieth Century*. S. Hewa and P. Hove (eds.). Lanham, Maryland, University Press of America: 85-114; Cullather, N. (2013). *The Hungry World: America's Cold War Battle Against Poverty in Asia*. Cambridge, Harvard University Press.

⁴ Baranski M. (2015) *The Wide Adaptation of Green Revolution Wheat*, PhD Dissertation, Arizona State University.

⁵ The exact proportion of domestically grown versus imported wheat has varied over time. Egypt currently produces around 50% of its wheat, but in the past this proportion has been both higher (in the 1940s Egypt was self-sufficient in wheat) and lower (in the 1980s the self-sufficiency ratio fell to about 20%). This shifting balance between domestic and foreign wheat is part of what I am exploring in the book.

⁶ ICARDA. (2013) Egypt Wheat Improvement Program Review: ICARDA-Agricultural Research Council.

⁷ I would like to thank Lee Hiltzik for his extremely helpful advice and support in navigating the Rockefeller Foundation archives and locating materials. I abbreviate the

archival citations as follows: F (folder), B (box), S (series), RG (record group), RF (Rockefeller Foundation records), RAC (Rockefeller Archive Center).

⁸ As I discuss in the longer chapter on seeds in my book manuscript, the development of these new high-yielding varieties did not translate into a dramatic increase in average yields within Egypt until the 1980s and 1990s, largely because of the time it took to disseminate the seeds of these new varieties and to convince farmers to start planting them.

⁹ Elvin C. Stakman Oral History, p. 242, Box 24, RG 13, RF, RAC.

¹⁰ “Training Programme under FAO Cereal Improvement and Production Project in the Near East as a Model Framework for Other Regions,” p.2, Plant Production and Protection Division, FAO, Rome, 1973, F114, B20, S105, RG1.3-1.8, RF, RAC.

¹¹ For ease, I will refer to the center of the Mexican wheat program as CIMMYT, even though the program was not actually named this until 1966. It is also important to note that the Mexican training program was not the only training initiative. There were other opportunities for expertise development, for instance through a series of FAO and Rockefeller Foundation sponsored wheat seminars in the Middle East.

¹² “A proposal for Regional Coordination of the Mediterranean and Near East Cereal Programs,” CIMMYT, 1971, p. 55-56, F111, B20, S105, RG1.3-1.8, RF, RAC.

¹³ At first the training course was envisaged as a year-long (non-degree) training program, but this timeframe was later revised it to 8 months to allow more people to benefit.

¹⁴ Norman Borlaug Oral History, p. 16, B15, RG13, RF, RAC.

¹⁵ Norman Borlaug Oral History, p. 16, B15, RG13, RF, RAC.

¹⁶ Norman Borlaug Oral History, p. 273-274, B15, RG13, RF, RAC.

¹⁷ As noted in a number of RF archival collections at RAC.

¹⁸ “Rockefeller Foundation Application for a Fellowship or Scholarship, Elham Talaat,” 1966. F7287, B490, S812E, RG10.1, RF, RAC.

¹⁹ Letter from Borlaug to Abdul Hafiz, copied to Robert Osler, July 9, 1965, F7287, B490, S812E, RG10.1, RF, RAC.

²⁰ Letter from Borlaug to Abdul Hafiz, copied to Robert Osler, July 9, 1965, F7287, B490, S812E, RG10.1, RF, RAC.

²¹ Letter from Abdul Hafiz (FAO, Cairo) to Robert Osler (RF, New York), July 20, 1965, F7287, B490, S812E, RG10.1, RF, RAC.

²² Letter, Karl Lucken (ND State) to Jesse Perry (Fellowship Officer, RF, New York), Aug 24, 1967, F7287, B490, S812E, RG10.1, RF, RAC.

²³ Letter, Karl Lucken (ND State) to Jesse Perry (Fellowship Officer, RF, New York), Aug 24, 1967, F7287, B490, S812E, RG10.1, RF, RAC.

²⁴ Letter, Karl Lucken (ND State) to Jesse Perry (Fellowship Officer, RF, New York), Aug 21, 1969, F7287, B490, S812E, RG10.1, RF, RAC.

²⁵ “The Wheat Mafia killed Abu Alqamh: Obituary for Abdel Salam Gomaa,” by Abbas Altarabeely. *Al-wafd*, Jan 19, 2016. <http://alwafd.org/essay/5547>

²⁶ Letter Karl Lucken to Ahmed El-Kosheri (Embassy of India-Egyptian Interest Section), Feb 15, 1973. F5, B1, S812E, RG1.2, RF, RAC.

²⁷ Letter Borlaug to Ralph Cummings (RF), March 8, 1967. F5, B1, S812E, RG1.2, RF, RAC.

²⁸ Letter R. Osler (deputy director, CIMMYT) to John McKelvey (RF, NY), May 7, 1969. F5, B1, S812E, RG1.2, RF, RAC.

²⁹ Gomaa’s wife (referred to in the records as “Mrs Gomaa”), who also held a MSc in plant breeding from Cairo University, accompanied him to North Dakota. After her arrival, she requested that the Rockefeller Foundation also fund her studies at North Dakota State. After some deliberation, the foundation agreed. However, when Mrs Gomaa had a baby and decided to shift to the Master’s program, the foundation withdrew the funding as Mrs Gomaa already had a Master’s degree. Upon intervention from Mrs Gomaa’s advisor and assurance that Mrs Gomaa had decided to pursue her PhD, the foundation agreed to pay her tuition again. This was a subject of much back-and-forth communications. One handwritten memo (with no addressee and an unclear signature) notes “If Mrs G is just going through the motions of taking courses just because she is there it’s not very exciting. If she is really good researcher with a future ahead (can’t imagine what that would be as a housewife in UAR) then I would be inclined to continue to pay her fees.” In the end, Mrs

Gomaa decided not to stay on for her PhD after her husband completed his, and the foundation paid for some of her courses but not others. (See multiple letters in F5, B1, S812, RG1.2, RF, RAC.)

³⁰ Interview by JRB with Gomaa, July 13, 1971, F5, B1, S812E, RG1.2, RF, RAC.

³¹ I use the term “hybrid” in the scientific sense of a cross between two pure lines, rather than in the more colloquial sense of any mix between different things (in which case any variety might be termed a hybrid).

³² Whitford, R., et al. (2013). Hybrid Breeding in Wheat: Technologies to Improve Hybrid Wheat Seed Production. *Journal of Experimental Botany* 64(18): 5411-5428.

³³ Charles Krull Diary, Near East and Middle East Trip, April-May 1966, p.3, B250, RG12, RF, RAC.

³⁴ Perkins, J. (1997). *Geopolitics and the Green Revolution: Wheat, Genes and the Cold War*. New York, Oxford University Press.

³⁵ Charles F. Krull, Oral History, 1966, p. 52. B17, RG13, RF, RAC.

³⁶ Charles Krull Diary, Near East and Middle East Trip, April-May 1966, p.2, B250, RG12, RF, RAC.

³⁷ Charles Krull Diary, Near East and Middle East Trip, April-May 1966, p.2, B250, RG12, RF, RAC.

³⁸ Letter, Charles Krull to L.M Roberts (FF, New York), Sept 5, 1966, F4, B1, S812, RG1.2, RF, RAC.

³⁹ Norman Borlaug Oral History, p. 22, B15, RG13, RF, RAC.

⁴⁰ Norman Borlaug Oral History, p. 22, B15, RG13, RF, RAC.

⁴¹ Charles Krull Diary, Near East and Middle East Trip, April-May 1966, p.3, B250, RG12, RF, RAC.

⁴² Interview by JRB with Gomaa, Dec 6, 1973, F5, B1, S812E, RG1.2, RF, RAC.

⁴³ Norman Borlaug Oral History, p. 9, B15, RG13, RF, RAC.

⁴⁴ Report on the CIMMYT Trustees Program Committee, El Batan, Mexico, April 11, 1978, p.11. Folder “Board of Directors 1977-79”, BR1998, S105, RG1.9, RF, RAC; Charles Krull Diary, Near East and Middle East Trip, April-May 1966, p.2, B250, RG12, RF, RAC.

⁴⁵ Charles Krull Diary, Near East and Middle East Trip, April-May 1966, p.2, B250, RG12, RF, RAC.

⁴⁶ Lewis M. Roberts Officer Diary, 1966, p320. Folder “Oct-Dec 1966”, B410, RG12, RF, RAC.

⁴⁷ Letter, John Gibler (resident rep, FF) to Borlaug, Dec 26, 1966, File “Wheat Improvement 1966”, BR2002, S105, RG1.9-1.15, RF, RAC.

⁴⁸ “Officer diary, John J. McKelvey, Trip to Egypt, Dec 1968.” 1968, Reel 68, RG2, RF, RAC.

⁴⁹ On this relationship between breeders and their objects of work, see also, Mendum, R. (2009). “Subjectivity and Plant Domestication: Decoding the Agency of Vegetable Food Crops.” *Subjectivity* 28: 316-333. Indeed, Borlaug referred to this relationship in terms of being “in love with a variety” that he has developed, assuring his oral history interviewer that he was not so much blinded by love for his variety as to ignore other considerations (Norman Borlaug Oral History, p. 25, B15, RG13, RF, RAC).

⁵⁰ Norman Borlaug Oral History, p. 19-21, B15, RG13, RF, RAC.

⁵¹ Norman Borlaug Oral History, p.336, B15, RG13, RF, RAC.

⁵² Norman Borlaug Oral History, p.255-256, B15, RG13, RF, RAC.

⁵³ Letter, John Gibler (resident representative, Ford Foundation) to Borlaug, Dec 26, 1966, File “Wheat Improvement 1966”, BR2002, S105, RG1.9-1.15, RF, RAC.

⁵⁴ Report on Travel Grant Application for Said Moustafa Dessouki, Oct 21, 1966, by John W. Gibler. F4, B1, S812D, RG1.2, RF, RAC.

⁵⁵ Charles Krull Diary, Near East and Middle East Trip, April-May 1966, p.2, B250, RG12, RF, RAC.

⁵⁶ Letter, Charles Krull to L.M Roberts (FF, New York), Sept 5, 1966, F4, B1, S812, RG1.2, RF, RAC.

⁵⁷ Elvin C. Stakman Oral History, p. 249, Box 24, RG 13, RF, RAC.

⁵⁸ Elvin C. Stakman Oral History, p. 249, Box 24, RG 13, RF, RAC.

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- ⁵⁹ El-Togby and Talaat, E. (1971). Wheat Improvement and Production in Egypt. Proceedings of the First Wheat Workshop, El Batan, Mexico, 1971. CIMMYT, p.26.
- ⁶⁰ Dessouki, 1969. Egypt Country Report. In Ninth Ad Hoc Conference on Wheat and Barley Improvement and Production in the Near East. Beirut, October 1969. FAO.
- ⁶¹ Lantican, M., et al. (2005). *Impacts of International Wheat Breeding Research in the Developing World, 1988-2002*. Mexico, CIMMYT, p. ix.
- ⁶² Notably the CIMMYT seeds were not the first foreign wheat material to enter Egypt. In the 1920s, some wheat was introduced from India; in the early 1940s some material was introduced from Kenya; and in the 1950s Egypt received seeds from the US and Europe through the USDA and FAO's international nursery program. El-Togby, Hassan and Talaat, Elham. 1971. "Wheat Improvement and Production in Egypt." Proceedings of the First Wheat Workshop, September 1971, El Batan, Mexico, edited by R. Fischer and Dean Bork. CIMMYT, p.25.
- ⁶³ Norman Borlaug Oral History, p. 22-23, B15, RG13, RF, RAC.
- ⁶⁴ Borlaug, N. (1993) The Political, Socioeconomic, and Institutional Obstacles to Empowering the Farmer with Improved Production Technology. Keynote Address to CIMMYT Workshop on Wheat, 1993, p.6-7.
- ⁶⁵ Letter from Joseph Bookmyer (RF Fellowship Associate) to Elham Talaat, Aug 12, 1969, F7287, B490, S812E, RG10.1, RF, RAC.
- ⁶⁶ Norman Borlaug Oral History, p.290, B15, RG13, RF, RAC.
- ⁶⁷ Norman Borlaug Oral History, p.26-32, B15, RG13, RF, RAC.
- ⁶⁸ There was a different set of nurseries focused on disease resistance (known as the disease trap nurseries).
- ⁶⁹ Norman Borlaug Oral History, p.282, B15, RG13, RF, RAC.
- ⁷⁰ Norman Borlaug Oral History, p.283, B15, RG13, RF, RAC.
- ⁷¹ Charles F. Krull, Oral History, 1966, p. 49-50. B17, RG13, RF, RAC.
- ⁷² Elvin C. Stakman Oral History, p. 245, Box 24, RG 13, RF, RAC.
- ⁷³ "A proposal for Regional Coordination of the Mediterranean and Near East Cereal Programs," CIMMYT, 1971, p. 57, F111, B20, S105, RG1.3-1.8, RF, RAC.
- ⁷⁴ See, for instance, letter, Arthur Klatt (wheat breeder, Turkey) to Abdul Hafiz (FAO, Cairo), March 15, 1973; letter, J Prescott (wheat pathologist, Turkey) to Mohamed Sadek (Ministry of Agriculture, Cairo) May 12, 1972; and letter Ahmet Demirlicakmat (Turkey) to Abdul Hafiz (FAO, Cairo), May 25, 1971. F40, B3, RG6.19, RF, RAC.
- ⁷⁵ Norman Borlaug Oral History, p.35, B15, RG13, RF, RAC.
- ⁷⁶ Norman Borlaug Oral History, p.34-35, B15, RG13, RF, RAC.
- ⁷⁷ Charles F. Krull, Oral History, 1966, p. 54. B17, RG13, RF, RAC.
- ⁷⁸ Letter, J Prescott (wheat pathologist, Turkey) to Kamel (M of Agriculture, Egypt), Dec 8, 1972. F40, B3, RG6.19, RF, RAC.
- ⁷⁹ Norman Borlaug Oral History, p.38, B15, RG13, RF, RAC.
- ⁸⁰ John W. Gibler Oral History, p.55. B16, RG13, RF, RAC.
- ⁸¹ "Officer diary, John J. McKelvey, Trip to Egypt, Dec 1968." 1968, Reel 68, RG2, RF, RAC.
- ⁸² Charles Krull Diary, Near East and Middle East Trip, April-May 1966, p.1, B250, RG12, RF, RAC.
- ⁸³ Interview with Elham Talaat by R.L.F, Aug 15, 1968. F7287, B490, S812E, RG10.1, RF, RAC.
- ⁸⁴ Memo, SW to NEB, Sept 12, 1969. F5, B1, S812E, RG1.2, RF, RAC.
- ⁸⁵ Memo, NEB to SW, Sept 12, 1969. F5, B1, S812E, RG1.2, RF, RAC.
- ⁸⁶ Memo, SW to Field Directors, Aug 8, 1966. F "Wheat improvement 1966", BR2002, S105, RG1.9, RF, RAC.