This is a preprint draft of a chapter that appeared in Naomi Oreskes and John Krige, eds. *Science and Technology in the Global Cold War* (MIT Press, 2014).

Self-Reliant Science: The Impact of the Cold War on Science in Socialist China

Sigrid Schmalzer[1]

At first blush, Chinese science in the Cold War appears to reflect the same move toward "gadgeteering" that Paul Forman has documented in the U.S. field of physics.[2] After the communist revolution of 1949, many Chinese scientists who had previously pursued research in basic science began working instead on topics with immediate and direct potential applications. Entomologists shifted their focus from insect classification to insect control.[3] Physicists turned from research on theoretical questions to work on fast-tracking China's weapons program.[4] When the political winds blew just right, influential scientists did manage to secure for basic science some level of state support, without which such research would have been impossible not only financially but also politically.[5] And some research areas had little hope for application but for other, ideological reasons nonetheless retained political favor even during the most anti-intellectual periods.[6] Over all, however, the move toward applied science in post-1949 China appears beyond dispute. Can we then say that the Cold War transformed science in China by causing a shift from basic to applied science? Only provisionally. More even than is generally the case in historical studies, the shift to applied science in China was profoundly overdetermined. Furthermore, "basic" and "applied" have a history that belies their deployment as naturalized categories. We know something of this history for the United States[7]; here I will speak to how it unfolded in socialist China, where what counted as "science" was even more subject to reinterpretation.

The relationship between basic and applied science emerged as an important concern in the revolutionary era as communist forces in the rural base areas struggled to develop necessary industrial and agricultural resources for use in the anti-Japanese and civil wars.[8] However, discourse on this relationship cannot be disentangled from myriad other concerns of the day. The decision to emphasize applied science was thoroughly intertwined with other, mutually reinforcing priorities, including the celebration of native techniques, mobilization of the masses, loyalty of scientists to the party-state, and achievement of self-reliance. By the time Mao declared victory in Beijing on 1 October 1949, applied science carried the cachet of eschewing the ivory tower and securing China's liberation from foreign domination and feudal tradition by harnessing the knowledge of China's own peasant masses. To capture this cluster of concerns, I would like to shift our focus away from the basic / applied dichotomy that informs our understanding of Cold War U.S. science and employ instead "self-reliant science" as the overarching category most relevant for the Cold War Chinese case.[9]

The definition of science found in the materials explored here may not fit our assumptions about distinctions between "science" and "technology." Indeed, "science vs. technology" was not nearly as important a contradiction in Mao-era discourse as were the contradictions between "foreign and native," "theory and practice," and by the late 1950s also "expert and red." I use the term "science" as an actors' category—that is, as it appears in the Chinese sources under investigation. As we will see, "science" in Mao-era China came to include activities far removed from our own understandings of the word. Even the collection and application of manure could count as "scientific farming," and horse breeding gained the noble appellation "scientific experiment." At the same time, we should not assume that the celebration of such practical activities as "science" arose from a purely utilitarian ideology. Rather, self-reliant science encompassed both an emphasis on practices of direct benefit to production and a decidedly non-utilitarian embrace of science as an agent of cultural revolution, i.e. a force capable of liberating society from oppressive old ways of thinking.

Returning to the problem of over-determination, the dominance of "self-reliant science" and its component parts cannot be explained solely through reference to geopolitical patterns: a quick series of counter-factual tests clearly demonstrates the limits of a Cold War explanation. Even without the U.S.-Soviet conflict, a focus on application would have been of obvious, practical importance for China as an impoverished "developing" country. Here China could readily be compared to any other country that faced immediate economic needs and had embraced a development ideology, whether socialist or capitalist.[10] Moreover, ideology—while significant everywhere—played a far more explicit role in shaping science policy in socialist-era China than in the United States or even the Soviet Union, which was by the 1950s more technocratic than revolutionary.[11] Applied science, mass mobilization, and related priorities would—Cold War or no Cold War—have carried ideological significance in China. Mao's influential essay "On Practice" would still have provided the needed inspiration (and intimidation) for scientists to frame their scientific work in practical terms.[12] At the same time, and perhaps even in the absence of Maoist ideology, China's experience suffering more than a century of imperialist aggression—from the first Opium War through the War to Resist America and Aid Korea—would still have offered more than sufficient nationalist ideological incentive to celebrate the virtues of self-reliance through the development of native technical resources.

All of these qualifications aside, Cold War geopolitics undoubtedly intensified such emphases. This chapter will thus examine the Cold War's effects on Chinese science within a web of related historical themes stretching back before the 1949 revolution and with attention to China's peculiar position in the Cold War.[13] Specifically, it will show that China's relative isolation during certain periods of the Cold War intensified the emphasis on self-reliance in science. Moreover, and despite the actual importance of transnational influences (as aptly recounted in Zuoyue Wang's contribution to the volume), the power of this representation fostered a belief in a uniquely socialist-Chinese approach to science.[14] With roots in the pre-1949 revolutionary period, this idea crystallized in 1958 and interestingly became even more sharply articulated through the international exchanges of the 1970s, as foreign scientists eager to bring home exotic epistemologies participated in the promotion of Chinese uniqueness. In a few cases at least, such claims to uniqueness went beyond shaping the way people talked about science to change the actual character of scientific knowledge produced in Cold War China. Because the emphasis on self-reliance arose from directives of the party center, we not surprisingly find references sprinkled regularly through the discourse of all scientific fields. For this reason, I will offer examples from a number of key areas explored in the secondary literature (including medicine, nuclear science, and bio-chemistry) in addition to a more thorough exploration of one area (agricultural science) that relates to my own current research.

Alternate Timelines

The Cold War in China did not follow the pattern suggested by the Cold War I and II timeline advanced by Fred Halliday and picked up by historians of science such as Paul Edwards and Peter Westwick.[15] Rather, at least two other timelines need to be taken into account to make sense of China's experience. The first follows China's changing position vis-á-vis the major Cold War powers: in the 1940s, the Chinese communists had uneasy relationships with both the U.S. and the Soviet Union; the 1949 revolution ushered in a period of "Soviet learning" that began falling apart in the late 1950s; following the Sino-Soviet split (c. 1960), and escalating with the Vietnam War, China maintained hostile relations with both major powers; beginning in 1971, China and the U.S. began cultivating a "friendship," culminating in normalization of relations in 1979; and in 1989, the first Soviet head-of-state visit to Beijing in thirty years was famously disrupted by the Tiananmen Square protests. The second timeline tracks China's internal political changes, especially the Great Leap Forward (1958-1960); post-Leap retreat of Mao and other radicals; Cultural Revolution (1966-1976); and then the 1978 rise of Deng Xiaoping, who developed a program of "modernization" (which had long been sought by other moderates) along with the new proposition of "market socialism," and whose 1989 crackdown on democratic protest signaled that Communist Party control in China would far outlast the celebrated "end" of the Cold War.

However, placing China in the greater international context of a Cold War chronology does present an important opportunity: it may help break China scholars of the habit of seeing everything through this latter internal Chinese political framework. Most critically for our purposes here, China scholars are not accustomed to thinking about science as a part of the radical politics of Mao-era China. Rather, the standard historical narrative follows a pendulum-like alternation between "radical" periods (the Great Leap and most of the Cultural Revolution) when political struggle stifled intellectual pursuits and economic development, making science virtually impossible, and "moderate" (or technocratic) periods when steadier minds (especially those of Zhou Enlai, Liu Shaoqi, and Deng Xiaoping) prevailed and more liberal policies rekindled the hopes of beleaguered scientists.[16]

David Zweig, for example, depicts Maoist "radical policies" on agriculture to have been "fueled by an anti-modernization mentality that saw economic development as the antithesis of revolution."[17] A former Maoist hopeful, Zweig became disillusioned after the death of Mao and fall of the "Gang of Four," and turned to modernization and rational choice theories to explain what went wrong.[18] Earlier analyses of Mao-era agricultural policy framed the history differently, and so found a great deal of continuity across radical and moderate periods. Writing in 1973, Benedict Stavis marked 1960-1962 as the key watershed when China embarked on a "technological transformation of agriculture" still going strong when he visited China in the early 1970s.[19] We now know much more about 1960s and 1970s China than Stavis was able to see; nonetheless, his conceptual frame helps make sense of the history of agricultural science in socialist China. Indeed, the move to develop "scientific farming" (*kexue zhongtian*) began circa 1961, during the heyday of the "moderate" technocrats, but came into its own amidst the intensifying radical politics of 1965, flourished throughout the Cultural Revolution, and remains relevant even today.[20] The "green revolution"—so much a part of U.S. engagement in the Cold War—thus progressed along much the same timeline in China as elsewhere, and it did so in the very middle of China's continually unfolding "red revolution."

In fact, Maoist radicals were deeply committed to modernization and science: they just defined these goals differently. The Cold War thus presented at least three competing development paradigms, constructed in conscious comparison and contrast with one another. First was the Leninist model of state-led economic development, based on a specific reading of Marxist philosophy of history and social development. The attractiveness of this model among Third World nations alarmed many academic and political leaders in the U.S., inspiring Walt Rostow's tremendously influential "non-communist manifesto," as he subtitled his 1959 book *The Stages of Economic Growth*. The parallels between Leninism and U.S. modernization theory are clear.[21] Both were committed to modernization through technological development, and both depended on deterministic expectations that development would proceed through specific "stages." Though he considered himself a Leninist, Mao's economic and political program—and the self-reliant "mass science" that went with it—departed in dramatic ways from modernization as pursued in the Soviet Union. Frustrated with the bureaucratic and technocratic structures of authority that formed in China during the period of Soviet learning, and with the rigid expectations of "stages" that slowed China's progress toward communism, Mao sought in the Great Leap Forward to abandon the determinism of staged growth and embrace instead a voluntarist faith in the power of the masses to channel their collective revolutionary will into rapid achievement of a truly communist economy.

My argument here is that acts of comparison and contrast similarly served as causal forces in transforming scientific practice. The Cold War created an expectation of ideological difference that was supposed to permeate even science. We see this clearly in several of the other contributions to this volume, for example Elena Aronova's treatment of Soviet philosophy of science and George Reisch's analysis of McCarthyism and the intelligent design movement in the U.S. In China, a specific approach to science based on a cluster of related values—self-reliance, application, mass mobilization, nativism—emerged in a context of perceived isolation from the world superpowers and then gained strength through repeated acts of contrast with U.S. and Soviet examples. In the context of the Cold War, Maoist "self-reliant science" was meant to bolster domestic confidence in Chinese socialist science and also to offer an alternative model for Third-World countries.

Revolutionary Roots

China's approach to science in the Cold War owed much to the experiences of the Chinese Communist Party during the 1940s as it struggled to mobilize people in the base areas to fight two wars: the War of Resistance against Japan and the Civil War against Chiang Kai-shek's Nationalist Party.[22] With the emerging leaders of the Cold War either outright supporting Chiang Kai-shek (in the case of the U.S.) or at least committed to a policy of non-aggression with him (in the case of the Soviets), Chinese communists determined that the only sure course lay in the development of indigenous resources—material, methodological, and human—to meet pressing economic and military needs. In the revolutionary "cradle" of Yan'an, the commitment to self-reliance, applied science, native methods, and mass mobilization became intertwined in ways that were to last throughout the Mao era (1949-1976).[23]

In 1939, Chinese communists responded to economic blockade by launching a movement for self-reliance in industry and defense.[24] Scientific knowledge had an obvious and important role to play in developing the means to produce material necessities like matches, soap, candles, and explosives. Despite the inevitable orientation toward practical applications that this situation implied, for several years the party maintained a commitment to basic scientific knowledge. This changed in mid-1942 with the major political upheaval of the

Party Rectification Movement. As Mao was consolidating his power through criticism of "bourgeois" intellectuals and party officials associated with the Soviet Union, the scientific leadership also underwent a profound shift.

The transformation centered on two figures: Xu Teli and Le Tianyu. Xu was the head of the Natural Science Institute in Yan'an. His approach was rooted in a belief that teaching and research in basic science formed a necessary foundation for the development of revolutionary China's science and economy. The commitment to following the masses and learning from practical experience that came with Rectification doomed Xu's program. The chairman of the biology department at the Natural Science Institute, Le Tianyu, had embraced an approach far more consistent with what was newly in vogue. His success in establishing a factory for producing beet-sugar entirely with local beets and handmade equipment had already made him something of a "local hero."[25] During the Rectification Campaign, Le took advantage of the political wind to argue for his own work as the model that the entire institute should follow. Le's criticisms focused on the institute's use of foreign textbooks, problematic in terms of both self-reliance and learning through practice. In contrast, under Le's direction, the biology department required students to go among the peasants, learning from them how to manufacture dyes and medicines from local plants. This was mass-based, applied science that made full use of local resources. Many faculty and students rallied to the defense of Xu and basic science as a whole, but by early

1943 Le's approach to science had won the day, and the Natural Science Institute became a part of Yan'an University, which was fully under party control.[26]

Beyond agriculture and industry, the intertwined themes of self-reliance and nativism also profoundly influenced the field of medicine in the revolutionary base areas. Acupuncture in particular emerged as an indigenous practice that served the need for a self-sufficient medical system: requiring only needles and knowledge, acupuncture helped reduce reliance on medicines made scarce by the blockades. Developing China's native medical practices was not a rejection of "western science"; in fact, Mao and others remained deeply committed to weeding out superstition, and in this sense the encouragement of native doctors—including so-called "witch doctors"—posed a potential problem. Thus the approach established in this early period, and which remained vitally important in later decades, centered on mobilizing local resources and adapting characteristically Chinese methods to achieve goals—modern science, public health, economic development—understood as universal.[27]

The Sino-Soviet Split and the Second Wave of Self-Reliant Science

In 1949, the victory of the Chinese Communist Party in the Civil War appeared to change everything. Gone were the blockades that cut the communists off from key industrial centers. Communist schools joined a substantial existing educational network—including Qinghua University and Peking Union Medical College, whose deep connections to the United States were now officially severed.[28] Perhaps most importantly, the Soviet Union moved from being a reluctant sponsor to an "elder brother," and China's foreign policy moved in response from "emphasizing self-reliance" and "depending on our own organizational power" (as Mao famously said in 1945) to "leaning to one side" (i.e., toward the Soviet Union).[29]

During the period of Soviet learning (1949-1960), China received guidance from resident Soviet technical advisors in almost every field of the natural and social sciences. In biology, the Soviets immediately and insistently promoted Lysenkoism, which in China was called "Michurinism" after the man whose experiments inspired Lysenko.[30] This was unsurprising: Lysenko had won his greatest battle in 1948, and in 1949 he was riding high on Stalin's support. Also unsurprisingly, Lysenko's chief Chinese proponent after the revolution was none other than Le Tianyu. Le's Yan'an-era ideas about science bore striking similarity to some of the more radical, peasant-based approaches underway in the Soviet Union since the 1920s, the very approaches that had given Lysenko his start.[31] To what extent these precedents had influenced Le is unclear, but in the early 1940s Le articulated his own peasant-based approach to science without highlighting Soviet examples. This is our third non-surprise: the Rectification Campaign was a key episode in Mao's struggle to chart a path away from Soviet leadership; reference to Soviet examples would hardly have served Le's purpose at that time. And as we will see, the other two highpoints for Maoist "mass science" (the Great Leap Forward and the Cultural Revolution) were similarly periods of rupture between Mao and the Soviets. Noticing this pattern, Laurence Schneider has concluded that "if Soviet Lysenkoism had not existed, the CCP would have invented something like it on its own."[32] I would add that it was important for Chinese radicals, no matter what the *actual* influence of foreign scientific models, to project an explicitly native, self-reliant form of mass science. (Here we see again the phenomenon of overdetermination.)

Despite the extraordinary level of Soviet assistance and the pervasive rhetoric about treating the Soviet Union as an "elder brother," Mao appears never to have fully lost his sense that ultimately China could rely on nobody but the Chinese people themselves. In 1955, prickling under Soviet unwillingness to share nuclear technology, Mao spoke of his commitment to developing nuclear energy "even if we have to do it on our own."[33] Sino-Soviet scientific collaboration continued until the final departure of the technical advisors in 1960, and the existence of 120 cooperative scientific agreements signed in 1957-8 indicates that some people at least continued to see a future in the alliance.[34] But by 1958, Mao had already clearly launched China on a different path.

The Great Leap Forward (1958-60) represented a bold departure from Soviet guidance; the rhetoric of self-reliance, application, nativism, and mass mobilization defined Mao's alternative vision. While political agendas shifted substantially on several occasions,[35] this "Maoist" approach to science exerted enormous influence from the Great Leap Forward through the Cultural Revolution. And, importantly for our purposes here, after the Sino-Soviet split state policy and propaganda materials consistently identified this approach to science as evidence of China's commitment to upholding true revolutionary values, specifically in contrast not only with the "imperialist" U.S., but also with the "revisionist" Soviet Union. (What Mao saw as "Soviet revisionism" may be seen clearly in the chapters contributed by Aronovoa, Schmidt, and Siddiqi.) Figures 1 and 2 chart the occurrence of key terms in *People's Daily*. As the major popular organ of the Chinese Communist Party, *People's Daily* offers a helpful indicator of state priorities—or more specifically, what the state wanted the people as a whole to view as priorities.[36] This admittedly crude methodology nonetheless offers an indication of the relationship between self-reliance and the Cold War timeline that would otherwise be difficult to capture. References to "self-reliance" (*zili gengsheng*) and "native methods" (*tubanfa*) both skyrocketed from 1958 to 1960 with the Great Leap Forward and Sino-Soviet split, and then peaked again with the mid-1960s escalation toward the Cultural Revolution and yet again beginning in 1969 with the worsening of Sino-Soviet relations.

Here it may be important to clarify that I am not seeking to argue that Mao-era scientific research was in fact utterly self-reliant. Given China's extensive connections to transnational science (again, see Zuoyue Wang's chapter), it would be hard to claim that any area of Mao-era scientific research arose independently: even acupuncture moved in new directions because of foreign influence.[37] Claims to "self-reliance" thus must be read critically. Even recent works of Chinese historians of science continue to display very clearly the nationalist stakes involved in debating the relative roles of foreign and Chinese in scientific achievements. Liu Jifeng, Liu Yanqiong, and Xie Haiyan, for example, devote an appendix in their book on Chinese nuclear science entirely to the question of Soviet assistance. After outlining precisely what types of personnel, training, and material support the Soviets provided, they conclude that the Soviets acted as a kind of guide pointing out the right direction, and so prevented the Chinese from wasting too much time on detours, but that it was the Chinese, through their own "gropings," who managed to resolve the crucial problems.[38] Yet self-reliance was not merely a rhetorical curtain obscuring dependency: the Chinese state really did face greater obstacles in pursuing scientific research because of its relatively isolated position during the Cold War. And the rhetoric crafted to turn that harsh reality into something ostensibly positive had tangible consequences for the approaches to science that the state supported.

The late-1950s shift back to emphasizing self-reliance in science took two somewhat different forms, which we may characterize as high-technology "big science" and low-technology "mass science." On one hand, the Great Leap-era fetishizing of "bigness" undergirded massive investment of resources into select projects, for example the manufacturing of synthetic insulin and the development of nuclear weapons. On the other hand, in such fields as medicine and agriculture, the emphasis was on large-scale mobilization of "the masses" (and especially the peasant masses), employing "local" (*tu*) methods to surpass the achievements of the world leaders in both capitalist and communist spheres. The term *tu* referred potently to self-reliance on several levels: it connoted not only the immediate vicinity, but also "native" (as opposed to *yang*, which meant "foreign") and also "earthy" or "crude" (thus associated with peasants in contrast with elite intellectuals).

The decision to make the synthesis of insulin a priority came in 1958, with victory pronounced in 1965. As described by Xiong and Wang, the project exemplified a specific Mao-era style of scientific research, which included a "military flavor," massive mobilization of human resources, influence of ideology, and heavy emphasis on planning and secrecy[39]—a kind of Cold War science with Chinese characteristics. Early in the project, the theme of self-reliance became prominent, with students in Beijing University's chemistry department following party
leadership to criticize their professors' "western slave mentality" among other faults.[40] When the team at Fudan University appeared to be on the verge of achieving synthesis of both the A and B amino acid chains that comprise insulin, a high-level political official declared, "Some people say that what foreigners can't

accomplish, Chinese people can never accomplish. Today we can say that Chinese people alone have accomplished something that foreigners have failed to do."[41]

In later years, China's success in manufacturing the world's first synthetic insulin became a shining example of self-reliance—for example, in a 1968 *People's Daily* article titled "Self-reliance, Overtaking Advanced World Levels: Ousting the Chinese Khrushchev's 'Western Slave Philosophy.'"[42] (The "Chinese Khrushchev" was Liu Shaoqi, the former president and most important early casualty of the Cultural Revolution, who had been targeted for his technocratic and internationalist political approach.) And in 1974, an article recounted the triumph of synthetic insulin even in the absence of the necessary raw materials of amino acids. "Researchers self-reliantly organized their own factory. With no foreign equipment available, they adopted native [*tu*] methods, and fighting bravely for several months were able to produce in the laboratory more than ten kinds of amino acids. With self-reliance and patriotic fervor, they ended in synthesizing the world's first entirely biologically active protein, crystalline bovine insulin."[43] Not emphasized in such articles was the continued significance of transnational connections: as Wang discusses in his chapter, many the key scientists had returned to China after receiving their degrees in the West.[44]

Nineteen fifty-eight also saw a profound shift in nuclear science. Already prepared to "do it on our own," Mao began talking more directly about developing a uniquely Chinese approach to the problem. In mid-1958, Mao approved eight guidelines for developing nuclear weapons: the fourth specifically warned against "imitating other countries" in the effort to "catch up to world levels." Here in a nutshell was the core concept: the goal was assumed to be universal, but the methods used to get there would be Chinese. In a speech to military officials, Mao critiqued the Soviet approach: "At present, the things worked out by the Soviet military advisers (such as operational plans and thinking) are all of an offensive nature, based on victory; no provision is made for the defensive and for defeat." Pointing to the strength of China's indigenous military strategies, Mao argued that "we don't have to learn from the Soviet Union."[45] The link between self-reliance and applied science was as tight then as it had been in 1942. In 1960 Chinese physicists working in the Soviet Union met to discuss Mao's call to embrace self-reliance. They wrote a joint letter to the State Council approving of the plan and pledging to "change their professions to meet China's need even at the cost of giving up research on basic theory in which they had been engaged."[46]

As with the synthesis of insulin, the development of nuclear weapons involved massive deployment of technical and human resources. Moreover, nuclear physics was also relatively insulated from political upheaval. The natural sciences in general suffered less than the humanities and social sciences, but nuclear physics—along with weapons research more generally—was especially privileged in this way. The combination of great state investment and shielding from political campaigns resulted in China's own version of "big science," which produced the "two bombs, one satellite" program, including Qian Xuesen's famous "silkworm missile."[47]

And yet, even in this biggest of big sciences, the local, the crude, and the masses played important roles. One of the key hurdles Chinese nuclear science had to overcome was a lack of uranium. Just as the state organized peasants in the Great Leap to create "backyard furnaces" in an attempt to surpass the British in steel production, it also assigned them to the collection and preparation of uranium. A *People's Daily* article on mass approaches to mining in general provides insight into what uranium mining probably looked like. In developing smelting facilities, Sichuan Province "sought out local methods [*tubanfa*] that fully relied on local folk technological power and were crude and simple, and so economically organized production." Local mudstone was used to make the furnaces, and the technicians were all local people.[48] Despite considerable waste of resources and pollution of local environments, scientific personnel remember the significant contribution such activities made in providing the nuclear program with needed uranium.[49] The spirit of self-reliance reportedly inspired technicians at the nuclear testing site as well: they sought to make the base itself self-sufficient by manufacturing monitoring instruments on site with available materials.[50]

In other branches of physical sciences too, native and crude methods gained ground. A *People's Daily* article from October, 1958 began with the common Great Leap expression "uniting native and foreign" (*tu yang jiehe*) and then argued that the "native" could replace and even create the "foreign," as was the case in Beijing University's physics department, where young professors and students used native smelting methods and native materials to manufacture an electrostatic particle accelerator. "If foreign experts [*yang zhuanjia*, meaning experts in 'foreign' types of knowledge] take frequent breaths of 'native' [*tu*] air, this will help break the fetters of dogmatism and prevent the ossification of thought."[51]

The local and crude side of self-reliance found far greater expression in other fields. During the Great Leap Forward, the renewed emphasis on self-reliance created unprecedented interest in Chinese herbal medicine and acupuncture, and even in the kind of "home-grown remedies" that Mao had once associated with witch-doctors and superstition. This was also the period when local people trained in primary care—known in the Cultural Revolution as "barefoot doctors"—became a critical component of the health delivery system.[52] Here again we find the tight interweaving of self-reliance, indigenous knowledge, "crude" (*tu*) methods, and mobilization of local peasants that emerged from the revolutionary experience and became the hallmark of "mass science" during the Cold War.

Just as the term *tu* acted multivalently to forge conceptual links among native, local, and crude, the nationalist rhetorical power of "self-reliance" simultaneously worked to encourage local economic independence. That is, the state used the slogan "self-reliance" to urge not just making it without foreign help, but also making it without assistance from the central state or other regions. When in 1970 the famous Red Flag Canal required maintenance, *People's Daily* reported that local revolutionary cadres struggled with representatives of the "traitor" Liu Shaoqi and class enemies, saying: "Are we moving forward or abandoning it? Are we self-reliant or depending on the nation-state? Are we using 'native' [*'tu'*] construction methods by making do with local materials, or are we using 'foreign' [*'yang'*] methods of reinforced concrete? Are we mobilizing the masses or blindly believing in a few 'experts'?"[53] Thus the isolating context of the Cold War lent a patriotic energy to the notion of self-reliance, which in turn served the Chinese state's domestic needs, both to spur scientific innovation and production and also to dissuade people from expecting too much from the central government.

<u>"Self-Reliance and Arduous Struggle": "In Agriculture, Learn from Dazhai"</u>

Agriculture offered perhaps the richest field for the growth of self-reliant mass science. Increasing dependence on agro-chemicals (*nongyao*) had caused demand to outstrip supply. A number of different approaches, involving not only scientists in research institutes but also rural political leaders and grassroots experiment teams, helped address this mounting problem. Scientists at key universities and institutes developed biological control regimens to reduce the need for chemical insecticides.[54] Experiments replacing "foreign chemicals" with "native chemicals" further uncovered a wide assortment of locally available materials useful in combating insect pests.[55] At agricultural conferences, local leaders trumpeted the success of "poor and lower-middle peasants" in demonstrating through scientific experiment the effectiveness of green-fertilizing crops like Chinese milk vetch (*ziyunying*) in resolving fertilizer problems and achieving self-reliance.[56] Labor-intensive observation of insect activity, often known as "insect pest forecasting," helped peasants time the application of chemicals for optimal efficiency and thus husbanding of this precious resource. Here the knowledge of "old peasants" sometimes proved invaluable (and was almost always said to be invaluable, whatever its actual worth).[57] The manual elimination of insect pests and their eggs was another technique consistent with a program of mass mobilization and self-reliance, as was the establishment of "local-method" (*tufa*—and here the meaning of "crude" is clearly indicated) factories for producing microbial agents to combat insect pests.[58] And throughout the 1960s and 1970s, rural experiment teams used simple, locally available resources to produce certain agro-chemicals, the most common being the plant hormone gibberellin, called 920 in Chinese, and a microbial fertilizer known as 5406.[59]

But in agriculture, perhaps more clearly than anywhere else, the call to be self-reliant meant not just socialist Chinese independence from untrustworthy world leaders, but still more the need for locales to make do without assistance from the central state. And so requests for funding the "mass movement for scientific experiment" highlighted plans to "organize the development and production of simple local [*tujian*] instruments" like light-traps for monitoring insects and soil analysis instruments.[60] In the other direction, memos announcing the distribution of funds for scientific experiment often included encouragements to realize the slogans of "self reliance, arduous struggle" and "practice thrift, using less to do more," or exhortations to be "self reliant, with the spirit of diligence and thrift, practicing meticulous planning and careful accounting, and being conscientious in management and use [of funds]."[61]

The slogan "self-reliance, arduous struggle," often associated with the "Yan'an spirit" and immortalized as a chapter title in the "little red book" of Mao quotations, gained its greatest currency with the policy "In agriculture, learn from Dazhai" (*nongye xue Dazhai*). Dazhai was a production brigade in the northern province of Shanxi celebrated especially for its success in building terraces to reclaim mountainous land for agriculture. Dazhai's influence took off in 1967, after which it remained the single most important agricultural model in China, until its leftist foundations were repudiated in the early Deng era. Countless local political and scientific leaders visited Dazhai to learn about mobilizing the masses and organizing agricultural production. Often they returned to their locales to impose Dazhai-like terracing programs or to institute the policy of "taking grain as the key link"—the growing of grain instead of other crops so as to achieve local self-sufficiency. And often these projects, ill-suited to local conditions, wreaked havoc on local environments and economies.[62] The bitter irony of this case was that Dazhai's remarkable success owed not just to local ingenuity and hard work, but also to generous state subsidies designed to create a glowing example for the rest of China and the world. However, it would be a mistake to emphasize the disastrous effects of the "Learn from Dazhai" movement without also noting the ways in which calls for self-reliance often helped in *resisting* inappropriate imposition of external models. Propaganda materials frequently highlighted the need for attention to the environmental conditions of specific places. One of the most common jobs local experiment teams undertook was the production of new hybrid strains or the testing of seeds from other places for local suitability. Local people breeding local plants using locally available resources: the epitome of self-reliance.[63]

The emphasis on creative use of limited resources was a repeated theme in propaganda designed to inspire the development of "scientific farming." Scientists, young peasants, and urban youth "sent down" to the countryside had to make do under crude working conditions. In a story published in 1966, a sentdown youth in 1958 hybridized two existing strains of rice, "Nation's Wealth" and "Atomic #2" (note the nuclear connection). He followed directions found in an agricultural textbook, but since he did not have access to a thermometer or a watch, he used his fingers to test the temperature and the school bell to measure the time.[64] A report delivered at a 1965 Beijing-area conference on rural scientific experiment groups named "self-reliance and arduous struggle" a "fundamental policy" in "mass scientific experiment activities," and called upon all participants to "conscientiously implement this policy and study and develop the spirit of Dazhai." Leaders should provide some necessary support, but otherwise they should "encourage group members to take initiative" in devising ways of producing "crude and simple" (*yinlou jiujian*) equipment and "replacing the foreign with the local" (*yi tu dai yang*). In some places, the scientific experiment groups were using test-tubes for levels, cooking pots for kilns, and ceramic plates for petri-dishes.[65]

The specific terminology used to discuss agricultural science was indicative of the revolutionary refiguring of scientific practice in Cold War China. According to Mao in 1963, "scientific experiment" was one of the "three great revolutionary movements" that would protect Chinese socialism from bureaucracy, revisionism, and dogmatism—a clear reference to China's split from the Soviet Union.[66] But scientific experiment did not necessarily mean scientists in ivory towers with lab coats, nor even always research in the pursuit of new generalizable knowledge. Despite significant interruptions from political campaigns, the kind of professional research we might readily recognize did continue in research centers around the country; the knowledge thus produced served agriculture in important ways. However, the notion of "scientific experiment" encompassed a much broader variety of activities.

For example, the production of plant hormones and microbial fertilizers counted as "scientific experiment." Such activities required basic laboratory skills, but they were not "experiments" in the conventional sense. The goal was not to produce new scientific knowledge, though certainly the participants themselves acquired new knowledge in the process of production, and the challenge of using only crude, locally available resources created a degree of unpredictability and thus an aura of "experiment." Some projects, such as the testing of new seed varieties and the production of new hybrids, were more clearly experimental. But others were perhaps less so: soil improvement through application of manure, weather prediction, pest observation and control, troubleshooting malfunctioning machinery, and animal husbandry. Claiming these often mundane practices as "scientific experiment" was itself a revolutionary act that brought science down from the ivory tower and into the realm of rural laborers.[67]

Science was also revolutionary when waged in defiance of traditional prejudice and class enemies. In 1971, a group of ten women of the minority Zhuang nationality established the March Eighth Agricultural Science Group (named after International Women's Day). Their average age was 19. According to an article in an agricultural science journal, the young women plowed and fertilized, braving inclement weather and the sexism of class enemies to get sand from the river, fertile mud from caves, and manure from the noisome "shit pit." Through such "scientific farming," they transformed the hardened clay fields into fertile land again.[68] Women who worked with livestock risked sexually charged verbal abuse. A report from a 1965 conference on rural youth in scientific experiment reported that in the early days of their work, some people scolded young women engaged in livestock breeding, saying, "You spend all day mating donkeys and horses."[69] Practicing scientific agriculture was thus said to be a way of overthrowing sexism and conservative thinking.

The vast majority of available materials documenting agricultural scientific work during the Mao era are state documents and propaganda: they are useful for understanding how the state sought to portray agricultural science. However, there is also evidence to show how fluently people on the ground spoke the state's language on science. The published diary of Shen Dianzhong, who was among the approximately fourteen million urban youth "sent down" to engage in agricultural work during the Cultural Revolution, contains detailed descriptions of his participation in "scientific experiments" on gibberellin and microbial fertilizer. On 13 June 1972, after more than a year of emotional hardship coping with the difficulties of the work and the frequent failure of the experiments, Shen wrote an extensive summary of his experiences. His second itemized point (after an initial reference to using Mao Zedong thought and uniting theory with practice) read, "920 [gibberellin] work brings into play the proletarian revolutionary spirit of using local methods, starting from scratch, self-reliance, hard work, not fearing failure, and overcoming hardships." He broke it down further: "Local methods and starting from scratch: you just have to look at the conditions, facilities, equipment, materials (*cailiao*), raw materials (*yuanliao*), operations, etc. over the course of one year [of experiments], and you will understand this point." As for "self-reliance and hard work," he noted that almost all the activities were accomplished during mid-day siesta or in the evening, which went to show that "a revolutionary spirit infused all the work."[70]

Sino-U.S. Rapprochement and the Production of Socialist-Chinese Uniqueness in Science

A world removed from Shen Dianzhong's rural laboratory, a major geopolitical shift was underway. In 1969, tensions between China and the Soviet Union came to a head, and Mao began to seek renewed relations with the United States. Rapprochement meant not just strategic partnerships but also opening doors to cultural and scientific exchange, and not just with the United States and other Western countries, but also through the United Nations: China's entry into the U.N. in 1971 allowed for participation in international scientific collaboration to a degree that its unique position in the Cold War had previously made impossible.

We might expect that this dramatic alteration of China's global position would have resulted in an equally dramatic fall in the emphasis on "self-reliance" in socialist Chinese science. Significantly, this was far from the case. Returning to Figure 1, we see that incidence of the term "self-reliance" shoots up in *People's Daily* articles in 1969 and remains high through 1977 before plummeting in 1979, after Deng Xiaoping took the reins. In Figure 3, we see a propaganda poster from 1975 articulating messages virtually indistinguishable from the discourse on self-reliance and scientific experiment ten years earlier. The reports of dozens of U.S. visitors —including scientific delegations along with journalists, activists, and others lucky enough to secure invitations—during what we might think of as the courtship period of the 1970s are filled with references to China's consistent emphasis on "self-reliance" in science as with everything else.[71] Figure 4 is an impressive example of the Chinese art of paper-cutting purchased by a U.S. visitor in 1978: it represents Maoist perspectives on rural production and scientific experiment. The palm trees suggest a southern locale, but the emphasis on terracing clearly indicates the movement to "Learn from Dazhai" in order to achieve self-reliance in agriculture.

Self-reliance thus remained a badge of honor for Chinese science; moreover, it was promoted as the basis for a uniquely socialist-Chinese style of science from which other countries could learn. This was the extension into the détente era of China's desire to present a "third way" to the world, an alternative —not only for the Third World, but also for potential European allies like Sweden —to the options offered by the two superpowers.[72] A perfect example is China's most ambitious technology transfer project: the TAZARA Railway that linked Tanzania and Zambia, bypassing apartheid South Africa. The project, initiated in 1967 and carried out between 1970 and 1975, exported not only China's scientific know-how but also its philosophy of self-reliance.[73] Similarly, in Liberia, Sierra Leone, and The Gambia, agricultural assistance from China emphasized this theme: the president of Sierra Leone returned from a visit to China inspired by the rhetoric on self-reliance, while Chinese experts on the ground in West Africa supervised the production of locally made rice threshers, demonstrated composting and use of animal manure for fertilizer, and raised chickens and pigs to feed themselves, all the while calling attention to these activities as examples of self-reliance. (As in China, West African political leaders recognized the usefulness of a philosophy that not only stoked anti-imperialist sentiment but also encouraged locales not to depend on aid from the central government.)[74] Maoist approaches to science had clear influence in Mozambique as well, where the revolutionary leader Samora Machel celebrated the wisdom of peasants and mechanics, and decried the "arrogance" of experts who kept themselves apart from the masses, making themselves into a "privileged class," but whose intelligence thus became "sterile, like those seeds locked in the drawer."[75]

The Chinese state deeply valued the propaganda opportunities afforded by technological assistance to Third-World countries. Visits from foreign delegations offered similar possibilities. In an internal serial publication *Reference Materials* *for Propaganda Directed at Foreigners* (Dui wai xuanchuan cankao ziliao), state officials tracked the published accounts of foreign visitors and commented on the degree to which they reflected the messages about Chinese socialism that the Chinese state intended to convey. For example, in 1973 the journal published a translation of a Japanese scientist's report on his recent visit. The editor's note explained, "The author examines rural changes in China with respect to politics. Although he is writing about agricultural science, he is able to conduct an analysis of our country's planning policies, and moreover is able to form a contrast with Soviet revisionism, in order to enlighten his audience."[76]

If Chinese political and scientific elites were excited to present the scientific achievements that Chinese socialism had fostered, foreign visitors were for their own diverse reasons often equally excited to bring such examples home. The passage from the Japanese report that inspired the Chinese propagandists' appreciative note compared Chinese and Soviet manufacture of herbicide. An herbicide factory at a commune the Japanese scientist visited had an annual output of 1,300 tons and was still under expansion.

> This situation, compared with the 2,000 tons of herbicide the Soviet Union purchased from Japan over the past several years, can offer such a deep awareness! The Soviet Union should be a very advanced socialist country, but in fact imports this kind of pesticide from foreign countries; on the other hand, in the so-called industrially backward China, peasants

> themselves are able to produce it. When I visited China in 1966, I saw the slogan "Class struggle, struggle for production, scientific experiment." China calls these the three great revolutionary movements. But at that time I did not understand why scientific experiment was called a revolution or what use peasants and workers could make of it. Now I've discovered the crux of the issue. This agro-chemical factory is a concrete reflection of China's pursuit of new-style scientific experiment through reliance on the masses.[77]

At the same time, foreign scientists had to reconcile their enthusiasm for the exotic with the uncomfortably obvious ways in which science in Cultural Revolution-era China departed from some of their own core scientific assumptions and values. One of the most critical of these involved the relative importance of basic research, technical application, and popularization. As Naomi Oreskes has argued (building on John Krige's work), the emphasis placed on basic science by U.S. scientists in particular reflected not only a belief in the necessity of basic research prior to technological development, but also a commitment to "fostering a form of science compatible with the American way of life."[78] Indeed, as early as the first decade of the twentieth century, U.S. efforts to promote scientific development in China had emphasized laboratory research and had presumed a clear connection between the ideal of research science and positive social transformation.[79] Traveling to China in 1974, the American Plant Studies

Delegation noted that some of the work they witnessed "though termed experimental, is actually demonstrational: for instance, plantings of improved seeds next to other varieties in order to show peasants the advantages of the new over the old."[80] A 1975 delegation of agricultural scientists from the United Nations Food and Agriculture Organization, committed to "leaving our mental luggage behind" in order to "learn from China," approached the issue from another angle: "The Chinese put it quite succinctly: 'In China, all agriculture is extension.'"[81] Defending Chinese agricultural science from the charge that research was too often neglected, a Chinese-American entomologist writing for a U.N. publication explained that in China scholarly publication tended to follow applications in the field and extension to farmers, while in the United States scholarly publication came first.[82] Writing in *Science*, he suggested, "Thus the image of Chinese entomology as ignoring basic research may be an oversimplification," while a more accurate assessment would acknowledge "the priority the Chinese give to putting scientific results into operation."[83]

For many foreign visitors China's experience appeared to offer something valuable that the West lacked. Many visitors with leftist or left-leaning politics specifically sought inspiration in China's socialist approach to medicine.[84] Others were drawn to Chinese medicine for different reasons. Western interest in "Traditional Chinese Medicine" (or "TCM," a term itself obviously created for foreign consumption) emerged along with the growth of the New Age movement.

Thus for many Westerners, TCM reflected China's long tradition of "holistic" philosophy and thus offered a powerful antidote to the overly specialized and reductionist medicine that had become "mainstream" in the West. But this was never how the Chinese state framed the role of Chinese medicine. Rather, the state selected acupuncture anesthesia as the exemplar of what China could uniquely *contribute to modern science*.[85] Based in indigenous knowledge, but rendered scientific, acupuncture anesthesia offered an effective and economical means of serving the people's medical needs. It was a perfect example of China's self-reliance: replacing scarce and costly "foreign medicines" with widely available materials embedded in an indigenous practice as useful on the operating table by high-level surgeons as in the fields by peasant paramedicals.[86]

The 1970s also saw rising environmentalism in the Western world. Insect scientists were anxious about the consequences of ever-increasing use of chemical pesticides, and many U.S. scientists in particular were angry about the power chemical corporations had in setting research agendas. Socialist China appeared to offer hope of a different way. In the absence of corporate capitalism, and making a virtue of the necessity of extreme thrift, Chinese insect scientists had succeeded in working with peasants to develop an "integrated" system of pest control that minimized use of toxic chemicals. The entomologists on the 1975 U.S. Insect Control Delegation reported, "Clearly, the Chinese have progressed beyond levels attained in the United States both in widespread enthusiasm for integrated control and, in many respects, in the application of the ecological principles fundamental to its development."[87] One British delegate reportedly told his Chinese hosts, "In Western countries people talk a lot about integrated control but do very little of it. You do so much work; you are our model."[88] The official report of the Swedish delegation similarly posited the relative backwardness of biological control in Sweden and suggested that knowledge should be sought in China, where biological methods and integrated pest control were more developed.[89] China's bag of insect-controlling tricks included light traps, parasitic wasps, mobilization of peasants for insect forecasting and manual elimination, and most popular of all, insect-eating ducks. Foreign delegations were treated to special demonstrations of this last method—and to roast duck in the cafeteria!—at a commune outside of Guangzhou, where the U.S.-trained entomologist Pu Zhelong had organized a number of biological control projects. So charming were these feathered representatives of Chinese ingenuity that the editors of *Environment* magazine ran an article by a U.S. insect control delegate with the title "China Unleashes Its Ducks."[90] Thus did foreign scientists participate in the construction of a uniquely socialist-Chinese vision of scientific practice.

Conclusion and Epilogue

What connects the humble bug-eating ducks of Guangzhou with Qian Xuesen's imposing silkworm missile? Self-reliance. While not the only factor, Cold War politics unquestionably contributed to the significance of self-reliance for science in Mao-era China: not only did the Cold War result in isolating China at key historical moments, it also produced an assumption of ideological difference and thus an expectation that science in socialist China would offer a distinct alternative to existing models. From 1958 to 1971, Mao's decision to part ways with both superpowers entailed a commitment to finding a Chinese path for Chinese science. After 1971, with the renaissance in international scientific exchange accompanying Sino-U.S. rapprochement, China no longer truly needed to go it alone; now Chinese political and scientific leaders sought to demonstrate what China had to contribute to international science.[91] During the 1970s, foreign and Chinese people alike contributed to the notion of a uniquely socialist-Chinese approach to science, though the two sides did not always share a common understanding of what this actually meant.

The rhetoric on self-reliance in socialist Chinese science was intense and pervasive, enough so to mask the actual, surprisingly transnational character of much scientific work in Mao-era China. And rhetoric is important. To what extent it actually represented significant epistemological differences and research results is more difficult to judge. In broad terms, we could hazard that Cold War pressures contributed to an experience, shared by most scientific fields in Mao-era China, of increased emphasis on application over basic research. Moreover, such pressures also helped produce in some areas—notably the synthesis of insulin and the development of nuclear technologies—a kind of "big science" approach comparable to that pursued by the Cold War superpowers.

A more fine-grained analysis creates a more complex picture. For example, despite the very different priorities Chinese proponents of Traditional Chinese Medicine held, the "holistic" approach that some Westerners derived from TCM certainly offered a profoundly "alternative" epistemology. But the axis of difference for these Westerners was less about Cold War ideologies and more about their perceptions of "Western materialism" and "Eastern spiritualism." The most we can say in this case is that Chinese commitments to self-reliance (which were strengthened by Cold War realities) drove Chinese medical practitioners and policy setters to promote TCM, and that this promotion helped fuel Western interest in TCM as an "alternative medicine." On the Chinese side, a Marxist commitment to seeing science and progress as universal combined with nationalist pride and the need for self-reliance to produce a desire to demonstrate the usefulness of Chinese practices like acupuncture in the service of modern medical science. Interest in this approach emerged during a period of geopolitical isolation in the revolutionary base area of Yan'an, accelerated during a second period of isolation from the superpowers (1958-1971), and then took on new meaning after China's reconciliation with the U.S., entrance into the U.N., and consequent emergence as a player in a larger international science community.

In agriculture, emphasis on self-reliance and the related concern for mass-based, practical approaches encouraged the development of some technologies that might not otherwise have emerged. Pest management based on close monitoring of insect populations and labor-intensive agricultural and biological control mechanisms is one example, recognized as such by Western participants in 1970s scientific exchange. In some cases, agricultural technologies developed during the Mao era have continued to be of scientific interest not only in China but in other parts of the world. This is true, for example, of microbial fertilizers like 5406, which played such a prominent role in Cultural Revolution-era rural-based youth experiment projects and served self-reliant science because they could be manufactured locally and so reduce the need for imported chemical fertilizer. 5406 now finds a place in the work of scientists at the International Nature Farming Research Center in Japan.[92] However, when scientists today turn to China for inspiration in agriculture, they are far less likely to highlight China's socialist experience, and more likely to revive the visions of F. H. King, the American soil scientist whose 1911 *Farmers of Forty Centuries, Or Permanent Agriculture in China, Korea, and Japan* extolled the ancient wisdom of Chinese farming practices and inspired the budding organic farming movement.[93]

The 1987 book *Learning from China? Development and Environment in Third-World Countries* may serve as a pivot-point in describing the changing international inclinations to see China as having something unique to offer to science. The volume originated in a 1983 conference in West Berlin, which brought together scientists and scholars from different countries to speak on subjects ranging from biogas technology to development policy. But by this time people around the world had begun to lose interest in socialist China as a model, which helps explain the question mark that the conference organizers felt obliged to include in the title. China had changed. The very real negative aspects of the Mao era—especially the political persecutions of many millions of people, including most of China's top scientists—had become harder to ignore in the post-Mao era, when the Chinese state was for its own political reasons increasingly calling attention to them. And if it was more difficult to draw unambiguous lessons from China's socialist past, it was also increasingly clear that China's new road differed little from that of any other developing country with its sights set on industrialization along typical Western lines. As Vaclav Smil wrote in his review of the volume, "At a time when China is busy emulating Taiwan and South Korea, what is one to learn from China's experience? Since the late 1970s many critical and courageous Chinese scientists and economists have documented the enormity of pre-1978 environmental degradation and economic mismanagement. They have been the driving force behind the current reforms and the spirit of learning from abroad." Smil went on to characterize biogas as "a large-scale failure" and biological pest control as "vastly exaggerated efforts while pesticide poisonings are common and traditional farming methods are disappearing fast."[94]

Though I would argue that Smil dismissed too readily and absolutely the agricultural innovations of the Mao era, he was undoubtedly right that by the 1980s the time for China to serve as a socialist model for other countries had passed. And with Deng Xiaoping's ascendancy in 1978, self-reliance had ceased to serve as an important inspiration for science within China—though it has been used in new ways to excuse the central state from responsibility for local economies. A study of science in China during the final decade of the Cold War would look very different. Interested readers could do no better than to consult Susan Greenhalgh's *Just One Child*, a fascinating study of the role of ballistic missile scientists in crafting Deng-era population science and policy. Where Mao had called for scientists to rely on China's masses, Deng called on scientists to control the numbers of those masses, now agreed to be entirely too massive, using theories and technologies with the clearest of connections to Cold War science.[95]

1 I thank Naomi Oreskes, Zuoyue Wang, John Krige, other participants in the workshop, and an anonymous reviewer for their helpful suggestions, and Charlotte Goor for her invaluable assistance. This research has been funded in part by a Franklin Research Grant from the American Philosophical Society and a Faculty Research Grant from the University of Massachusetts. All Chinese names, except for overseas Chinese, are rendered as pinyin, with family names first and given names second.

2 Paul Forman, "Behind Quantum Electronics: National Security as Basis for Physical Research in the United States, 1940-1960," *Historical Studies in Physical and Biological Sciences* 18, no. 1 (1987): 149-229.

3 Tien-Hsi Cheng, "Insect Control in Mainland China," *Science* 140, no. 3564 (19 April 1963): 269.

4 See note 46 below.

5 Zuoyue Wang, "Physics in China in the Context of the Cold War," in *Physics and Politics*, eds. Helmuth Trischler and Mark Walker (Berlin: Franz Steiner Verlag, 2010), 262.

6 Paleoanthropology is one example of such a field. Sigrid Schmalzer, *The People's Peking Man: Popular Science and Human Identity in Twentieth-Century China* (Chicago: University of Chicago Press, 2008).

7 See, for example, Ronald Kline, "Construing 'Technology' as 'Applied Science': Public Rhetoric of Scientists and Engineers in the United States, 1880-1945," *Isis* 86, no. 2 (June 1995): 194-221.

8 It was also already a key concern of the Guomindang, as thoughtfully analyzed by James Reardon-Anderson in *The Study of Change: Chemistry in China, 1840-1949* (Cambridge: Cambridge University Press, 1991).

9 Although the concept of self-reliant science was found widely in Cold War-era China, the use of this term as an overarching category to characterize the Maoist approach to science is my intervention. The concept of “self-reliance” itself is long overdue for an extensive transnational historical analysis. It is well known as a cornerstone of North Korean leader Kim Il-sung’s political philosophy; although the

broader concept is typically rendered *juche* in Korean, the Chinese term for self-reliance "*zili gengsheng*" also frequently appears in North Korean documents directly translated as *charyok kaengseng*. Scholars have typically traced the North Korean concept of self-reliance to the influence of Chinese Communists in the Yan'an area (see below), and we also know that many groups around the world (including the Black Panthers in the U.S.) were inspired by Mao's writings on self-reliance. However, evidence suggests that the term has a more complex history: in the 1930s, it was adopted also by the Chinese Nationalists (Guomindang) and by the Saito government in Japan. I am indebted to Bruce Cumings for sharing his leads on this subject. See also Gordon Mark Berger, *Parties Out of Power in Japan, 1931 -1941* (Princeton University Press, 1977), 69.

10 Note, however, the interesting counter-example in the case of post-1945 Europe, shaped by U.S. hegemonic science. John Krige, *American Hegemony and the Postwar Reconstruction of Science in Europe* (Cambridge, Mass.: M.I.T. Press, 2008).

11 On the relative importance of ideology to Mao's China as contrasted with the Soviet Union of the late 1940s and later, see Chen Jian, *Mao's China and the Cold War* (Chapel Hill, N.C.: University of North Carolina Press, 2001), 4. On the emphasis of ideology on science in socialist China, see Michael Gordin, Walter Grunden, Mark Walker, and Zuoyue Wang, "'Ideologically Correct' Science: French Revolution, Soviet Union, National Socialism, WWII Japan, McCarthyism, and People's Republic of China," in *Science and Ideology: A Comparative History*, ed. Mark Walker (New York: Routledge, 2002), 35-65. On technocracy in the Soviet Union, see Joel Andreas, *Rise of the Red Engineers: The Origins of China's New Class* (Stanford: Stanford University Press, 2009), 266; Kendall Bailes, *Technology and Society under Lenin and Stalin: Origins of the Soviet Technical Intelligentia, 1917-1941* (Princeton, NJ: Princeton University Press, 1978).

12 "On Practice" is usually said to have been written at Yan'an in 1937, but it was first published in 1950. For an overview of the debates surrounding the origins of "On Practice," see Joshua Fogel, *Ai Ssu-ch'i's Contribution to the Development of Chinese Marxism* (Cambridge, Mass.: The Council on

East Asian Studies, Harvard University, 1987), 64-71.

13 Odd Arne Westad offers an alternative way of analyzing the Cold War, whereby the "Third World" collectively forms a third force, disrupting the notion of a bipolar conflict. See his *The Global Cold War: Third World Interventions and the Making of Our Times* (Cambridge: Cambridge University Press, 2005).

14 My own research further supports Zuoyue Wang's conclusions. Sigrid Schmalzer, "Insect Control in Socialist China and Corporate U.S.: The Act of Comparison, The Tendency to Forget, and the Construction of Difference in 1970s U.S.-Chinese Scientific Exchange," *Isis* 104, no. 2 (June 2013): 303-29.

15 Fred Halliday, *The Making of the Second Cold War* (London: Verso, 1983); Paul Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge, Mass.: MIT Press, 1996); Peter Westwick, "The International History of the Strategic Defense Initiative: American Influence and Economic Competition in the Late Cold War," *Centaurus* 52, no. 4 (November 2010): 338-351.

16 This interpretation follows the "two-line" analysis advanced by Mao-era radicals themselves, the post-Mao anti-radical historiography reverses the signs and depoliticizes the rhetoric. My understanding of Liu Shaoqi, Deng Xiaoping, and others as "technocrats" follows Andreas, *Rise of the Red Engineers*.

17 David Zweig, *Agrarian Radicalism in China, 1968-1981* (Cambridge, Mass.: Harvard University Press, 1989), 192. Zweig sees peasants in Popkin's terms as economically rational actors, which he seems to equate with an interest in economic development / modernization, whereas the radicals were committed to ideology over material concerns and sought to impose these values on the peasants.

18 Ibid., ix, 3, 190-192.

19 Benedict Stavis, *Making Green Revolution: The Politics of Agricultural Development in China* (Ithaca: Rural Development Committee, Cornell University, 1974).

20 The first reference to "scientific farming" (*kexue zhongtian*) in *People's Daily* is from 22 July 1961; in 1965 there were 11 references.

21 Nils Gilman, "Modernization Theory, the Highest Stage of American Intellectual History," in *Staging Growth: Modernization, Development, and the Global Cold War*, ed. David C. Engerman et al. (Amherst: University of Massachusetts Press, 2003), 48-49.

22 Wu Heng, *Kang Ri zhanzheng shiqi jiefangqu kexue jishu fazhan shi ziliao* [Historical materials on scientific and technological development in the liberated areas during the War of Resistance], multiple volumes (Beijing : Zhongguo xue shu chu ban she, 1983-).

23 Stuart Schram cautions that the links between Yan'an and later Maoist perspectives on economic development represent "existential continuity" but "no intellectual continuity in terms of detailed policy formulations, and certainly no unbroken chain of development in Mao's own thinking." I do not seek to argue this point beyond the level of "existential continuity"; it is sufficient, I think, to recognize the lasting impact of both the experience of Yan'an and the heroic narrative woven around the "Yan'an Way." Stuart Schram, *The Thought of Mao Tse-tung* (Cambridge: Cambridge University Press, 1989), 93; Mark Selden, *The Yenan Way in Revolutionar China* (Cambridge, Mass: Harvard University Press), 1971.

24 Reardon-Anderson, *The Study of Change*, 323.

25 Laurence Schneider, *Biology and Revolution in Twentieth-Century China* (Lanham, Md.: Rowman & Littlefield, 2005), 105. Note that Le Tianyu's family name has previously been incorrectly Romanized as "Luo" (in pinyin) and "Lo" (in Wade-Giles) by a number of scholars, including me.

26 Two excellent discussions of this episode can be found in Reardon-Anderson, *The Study of Change*, 352-59 and Schneider, *Biology and Revolution*, 104-108.

27 Kim Taylor, *Chinese Medicine* in *Early Communist China 1945-1963: A Medicine of Revolution* (London: Routledge Curzon, 2005), 24.

28 These events effectively relieved People's University of its responsibilities for science in the new era. Andreas, *Rise of the Red Engineers*; Mary Brown Bullock, *An American Transplant: The Rockefeller Foundation and Peking Union Medical College* (Berkeley: University of California Press, 1980).

29 Mao Zedong, "Kangri zhanzheng shengli hou de shiju he women de fangzhen" [The Situation and Our Policy After the Victory in the War of Resistance against Japan], 13 August 1945.

30 On the early emphasis on Lysenkoism in the PRC, see Schneider, *Biology and Revolution*, 120-134.

31 For an utterly unsympathetic account, see David Joravsky, *The Lysenko Affair* (Cambridge: Harvard University Press, 1970), 54ff.

32 Schneider, *Biology and Revolution*, 177.

33 Wang, "Physics in China," 259.

34 Ibid., 263.

35 Richard P. Suttmeier, *Research and Revolution: Science Policy and Societal Change in China* (Lexington, Mass.: Lexington Books, 1974).

36 The availability of a full-text-searchable database of the entire run of the paper makes possible analysis that is far more difficult and less reliable using other sources (e.g., scientific journals).

37 The most striking example is the emergence during the Great Leap Forward of "ear acupuncure," which did not exist in Chinese traditions and owed directly and explicitly to French innovation. Elisabeth Hsu, "Innovations in Acumoxa: Acupuncture Analgesia, Scalp and Ear Acupuncture in the People's Republic of China," *Social Science and Medicine* 42, no. 3 (February 1996): 421-30.

38 Jifeng Liu, Yanqiong Liu, and Haiyan Xie, *Liang dan yi xing gong cheng yu da ke xue* [The project of "two bombs, one satellite": A model of the big science] (Jinan: Shandong jiaoyu chubanshe , 2004), 195.

39 Xiong Weimin and Wang Kedi, *Hecheng yi ge danbaizhi: Jiejing niuyi daosu de rengong quan hecheng* [Synthesize a protein: The story of total synthesis of crystalline insulin project in China] (Jinan: Shandong jiaoyu chubanshe, 2005), 56-66.

40 Ibid., 31.

41 Ibid., *Hecheng*, 37.

42 "Zili gengsheng, ganchao shijie xianjin shuiping" [Self-reliance, overtaking advanced world levels], *Renmin ribao*, 18 August 1968, 5.

43 "Duli zizhu, gaoge mengjin" [Independent self-governance, triumphant advance], *Renmin ribao*, 17 October, 1974, 1.

44 Xiong and Wang, *Hecheng*, 17, 21.

45 John Wilson Lewis and Xue Litai, *China Builds the Bomb* (Stanford, Calif.: Stanford University Press, 1988), 70-71.

46 Ibid., 123. The quoted material appeared in a *People's Daily* article from 1984: it is unclear how closely it represented the original statement as expressed in the 1960 letter. Gu Mainan, "Shiwan fen zhi yi: Ji Zhongguo kexue yuan xin ren fuyuanzhang Zhou Guangzhao," *Renmin ribao*, 23 July 1984, 3.

47 Liu, Liu, and Xie, *Liang dan yi xing*; Iris Chang, *Thread of the Silkworm* (New York: Basic Books, 1996). The “two bombs” referred to the two distinct technological projects of nuclear bombs and missiles.

48 "Quanmin jian tulu" [The entire population builds local furnaces], *Renmin ribao*, 30 August 1958, 1.

49 Lewis and Xue, *China Builds*, 87-88.

50 Ibid., 205.

51 "Yi tu dai yang, yi tu sheng yang" [Using the local to replace the foreign, using the local to create the foreign], *Renmin ribao*, 17 October 1958. *Yang zhuanjia* could refer broadly to people whose knowledge came from foreign sources (including foreign publications, hence by extension the

professional research establishment), but could also more specifically refer to intellectuals who had returned from abroad or to Soviet advisors.

52 Taylor, *Chinese Medicine*, 116-18.

53 "Yi ke hongxin, liang zhi shou" [A red heart and two hands], *Renmin ribao*, 7 September 1970, 2.

54 See Schmalzer, "Insect Control."

55 See, for example, "Tu nongyao fangzhi daowen xiaoguo hao" [Native agricultural chemicals show good results in controlling rice paddy diseases], *Nongye kexue tongxun* 1958, no. 9: 503. Note that producing native plant-based pesticides was of interest already in the Republican era. Yun-pei Sun and Ming-tao Jen conducted research in this area at the University of Minnesota, and Ting Wu (Mrs. T. Shen) applied for a fellowship from the China Foundation (funded by the Boxer Indemnity) to conduct similar research (I am unsure whether she was successful). Letter from H. H. Shepard to the China Foundation for the Promotion of Education and Culture, dated 22 December 1939. UMN archives. Collection 938: Division of Entomology and Economic Zoology. Box 10. Folder: "China—Miscellaneous, 1937-1945."

56 Chen Qinde, "Pinxia zhongnong shi nongye kexue shiyan de jianbing" [The poor and lower-middle peasants are the vanguard of agricultural scientific experiment], Eleventh speech at the Guangdong Provincial Conference for Representatives of the Poor and Lower-Middle Peasants and Advanced Work-Units, 1965, Guangdong Provincial Archives, 235-1-365-034~036.

57 See, for example, Heilongjiang sheng Binxian Xinlisi dui keyan xiaozu, "Bai ying dadou wang de xuanyu" [The selection of "white-breast soybean king" (variety of soybean)], *Nongye keji tongxun* 1973, no. 12, 4.

58 Guangdong sheng kejizu, "Zazhong youshi liyong he shengwu fangzhi liangxiang huizhan jinzhan qingkuang" [Progress in the two campaigns of utilizing superior hybrids and biological control], 28 May 1972, Guangdong Provincial Archives, 306-A0.02-41-85; "Sihui xian Dasha gongshe shuidao bingchonghai zonghe fangzhi qingkuang huibao" [Report on the integrated control of rice-paddy

diseases and insect pests in Dasha Commune, Sihui County], Guangdong Provincial Archives, 306-A0.06-12-42~47.

59 See, among many other examples, *Nongcun zhishi qingnian kexue shiyan jingyan xuanbian* (Beijing: Beijing renmin chubanshe, 1974), 31, 35, 66.

60 Guangdong kejizu, "Guanyu shenqing kexue shiyan qunzhong yundong jingfei de baogao" [Report on applying for funds for the mass movement for scientific experiment], 15 October 1974, Guangdong Provincial Archives, 306-A0.05-22-16.

61 Sheng nonglinshui zhanxian weiyuanhui, "Xiada 1970 nian kexue shiyan buzhu fei" [1970 allocation of supplementary funds for scientific experiment], 10 July 1970, Guangdong Provincial Archives, 277－2－22－1～1; Zhongkeyuan, Caizhengbu, "Zeng bo qunzhongxing kexue shiyan huodong buzhu jingfen de han" [Letter regarding the additional appropriation of supplemental funds for mass-scientific experiment activities], 31 October 1975, Guangdong Provincial Archives, 306-A0.05-22-91.

62 See, for example, Jacob Eyferth, *Eating Rice from Bamboo Roots: The Social History of a Community of Handicraft Papermakers in Rural Sichuan, 1920–2000* (Cambridge: Harvard University Press, 2009).

63 *Nongcun zhishi qingnian*, 37-39. For another example in which local needs trumped the call to prioritize grain production, see Peter Ho, "Mao's War Against Nature? The Environmental Impact of the Grain-first Campaign in China," *The China Journal* 50 (July 2003): 37-59.

64 *Kexue zhongtian de nianqing ren* [Youth involved in scientific farming] (Beijing: Zhongguo qingnian chuban she, 1966), 33.

65 "Gaoju Mao Zedong sixiang hongqi gengjia guangfan shenru de kaizhan nongcun qunzhongxing kexue shiyan yundong (cao)" [Hold high the red flag of Mao Zedong Thought in order to increase, broaden, and deepen the development of the rural mass-scientific experiment movement (draft)," 15 November 1965, Documents on the Beijing Municipal Rural Scientific Experiment Group Positive

Elements Conference, Beijing Municipal Archives, 002-022-00031, pp. 1-15.

66 Mao Tse-tung, *Quotations from Chairman Mao*, second edition (Peking: Foreign Languages Press, 1966), 40.

67 The broad and politically potent significance of "experiment" was related to its relevance within Chinese communist political philosophy, with origins in the revolutionary period. See Sebastian Heilmann, "From Local Experiments to National Policy: The Origins of China's Distinctive Policy Process," *The China Journal* 59 (2008): 1-30.

68 "Zhuangzu guniang xue Dazhai: Kexue zhongtian duo gaochan" [Zhuangzu girls study Dazhai: Scientific farming reaps bumper harvests], *Guangxi nongye kexue* 1975, no. 7, 32-35.

69 Gongqingtuan zhongyang qingnong bu, ed., *Wei geming gao nongye kexue shiyan* [Agricultural scientific experiment for the revolution] (Beijing: Zhongguo qingnian chubanshe, 1966), 8.

70 Shen Dianzhong, *Sixiang chenfu lu* (Shenyang: Liaoning renmin chubanshe, 1998), 286-89. Shen Dianzhong later became the director of the Institute of Sociology at the Liaoning (Province) Academy of Social Sciences.

71 Sigrid Schmalzer, "Speaking about China, Learning from China: Amateur China Experts in 1970s America," *Journal of American-East Asian Relations* 16, no. 4 (Winter 2009): 313-52.

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74 Deborah Bräutigam, *Chinese Aid and African Development: Exporting Green Revolution* (New York: St. Martin's Press, 1998), 1-2, 176-9.

75 Michael Mahoney, "Estado Novo, Homem Novo (New State, New Man): Colonial and Anticolonial Development Ideologies in Mozambique, 1930-1977," in Engerman, *Staging Growth*, 191.

76 "Wenhua da geming hou de Zhongguo: Nongye kexue jianwen" [China since the Cultural Revolution: The view from agricultural science], *Duiwai xuanchuan cankao ziliao* 13 (25 June 1973): 1-4. I thank Michael Schoenhals for sharing this extraordinary source.

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90 Robert L. Metcalf, "China Unleashes Its Ducks," *Environment* 18, no. 9 (November 1976): 14-17. Some of the material in this paragraph is taken from Schmalzer, "Insect Control."

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