

Opportunities for US-China Investments in Agricultural Innovation and New Technologies

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Kimle has worked in a variety of capacities in agriculture. His professional experiences range from helping to launch three start-up companies, work in the seed industry, involvement with venture capital and futures markets, and expertise in agricultural and trade policy. He has worked extensively in agriculture-related electronic commerce, as well as commodity price risk management.

Kimle earned his master's degree in agricultural economics at Iowa State in 1991. He then worked for Pioneer Hi-Bred International in business development and marketing, before co-founding E-Markets, Inc., in 1996. In 2002, Kimle founded Decision Commodities, LLC, which provides commodity sellers and buyers innovative risk management contracts.

Cover Photo: Reuters/Carlos Barria

Executive Summary

The United States has in many ways set the global standard for agricultural innovation. And China, for its part, has made significant strides in agricultural productivity as well. China continues to rapidly integrate innovations from abroad, while also developing homegrown innovations. But is the rate of agricultural innovation adoption sufficiently rapid to meet the growing food needs of a huge and increasingly wealthy population?

The average family in the United States today spends about 10 percent of its income on food, and that figure is double in China. Both of these figures have declined over time—in the United States over an extended period, and in China more dramatically in the last 30 years. When families spend less of their income on food, it represents a relative gain in prosperity as disposable income can then be spent on other necessities, leisure, or luxury items.

This decline in food prices is directly related to the rise of agricultural productivity over the last 30 years. And the main factor responsible for such significant gains is innovation, not just previous gains from input intensification and crop-area expansion. It takes significantly fewer resources today to produce one calorie of food than it did in the past, with much of the credit for that improvement attributable to agricultural innovation.

For this reason, investment in agricultural research and development (R&D) will be important. But while both the US and Chinese public sectors invest in such R&D, it is private sector investment that will determine the ultimate effect of future agricultural innovations, especially in the United States, which remains an innovation and commercial leader.

This raises an important question for both countries: Are there opportunities to link private sector investment activity in agricultural innovation and thereby connect the US and Chinese agricultural innovation engines?

This paper suggests four models that could link US and Chinese investment and yield productive new avenues for commercial collaboration. All four models focus on animal protein supply chain technologies. That is because agricultural innovation in this realm is of particular importance to demand-side developments and to rapidly changing consumption patterns in China.

These four models focus on early-stage agricultural innovation and business development. In the United States, funding for such opportunities, especially as new technology moves to commercialization, is provided largely by *private* capital. The public sector certainly plays a role in American agricultural innovation by funding basic

research, universities, and a host of federal and state-level programs that support early-stage business development, but private capital and financial markets fuel most technology commercialization in US agriculture, as well as other markets.

In China, of course, public capital plays a considerably greater role than in the United States, and agriculture is no exception. But domestic financial markets are evolving quickly in China, so there are new opportunities to leverage private capital for outbound investment—or public-private partnerships among Chinese market and corporate players in agriculture.

In short, the opportunities highlighted in this paper emphasize private capital, but various configurations could be appropriate for US-China collaboration in the four models.

Model One: Joint Agriculture Opportunities Fund

Such a fund, backed by US and Chinese equity partners, would have an explicit focus on investing in businesses with technology relevant to both the US and Chinese animal protein supply chains. Chinese investors would be limited partners in the fund itself, but personnel with deep experience in, and perspective on, Chinese agriculture would help bring unique capacity to the fund's portfolio companies. The goal would be to help

them scale portfolio businesses in both the United States and China.

Model Two: Joint Agriculture Accelerator

In this model, Chinese investors would partner with a US-based organization to start a US-China agriculture accelerator. Such an accelerator would provide participating businesses with office, laboratory, and/or engineering space, as well as access to mentors, skills training, a support network, and ultimately connections to investors and customers. The joint accelerator would, as is customary, often take an equity stake in businesses that participate in the program.

Model Three: University Student Incubators

In this model, US and Chinese investors would help create student incubators at US universities, with the explicit goal of supporting development of startup businesses created by teams of both US and Chinese university students. Startup businesses that emerge from the incubator would have market potential in both countries.

Model Four: Emerging Africa Agriculture Fund

This model would bring Chinese and US investors (and potentially third-country investors) together as

partners, as well as agribusinesses from both countries, that are active in third countries where agricultural development is a pressing need. One opportunity that stands out is the prospect of investment in greenfield agriculture projects in Sub-Saharan

Africa. Such a fund would aim to discover projects where mutual participation would benefit the Africa-based project but also build opportunities for participating US and Chinese agribusiness partners.

Introduction

The average American family today spends about 10 percent of its income on food, down from 25 percent in 1930. The proportion of income spent by Chinese families has also fallen, from an average of over 50 percent in the early 1990s to about 20 percent today.¹

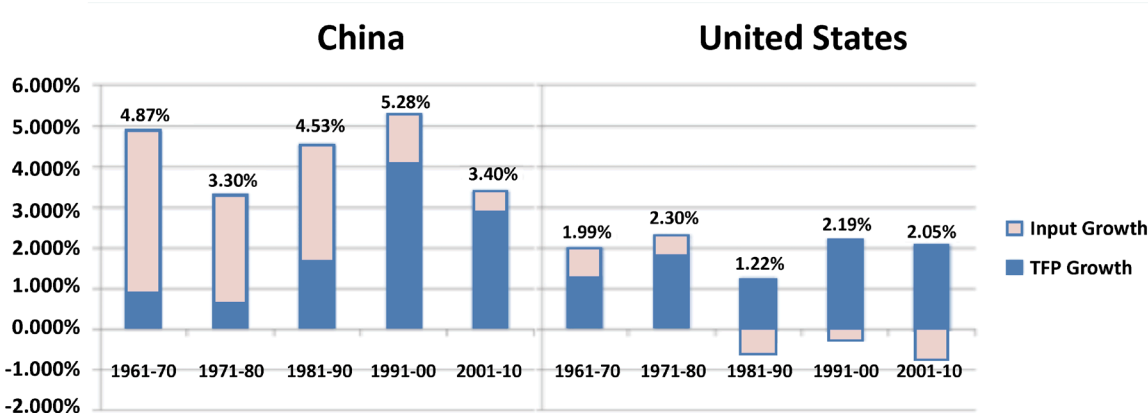
Rising overall income and food consumption patterns all have an effect on average food expenditure, but they are also inherently tied to agricultural productivity. In general, if agricultural productivity rises, all other things being constant, food expenditures as a proportion of income will fall. Increased agricultural output can arise from two sources: (1) utilization of more inputs, such as land and fertilizer, to increase output, or (2) higher productivity

obtained from each unit of input used. Innovation plays a central role in the second source, since new products, services, and business methods drive productivity higher.

In China and across other emerging markets, gains in agricultural productivity after the 1960s were driven by input intensification and crop-area expansion. But during the last twenty-five years, the pattern shifted in China because agricultural productivity gains came to be driven largely by input efficiency from innovation.

Economists measure this efficiency through Total Factor Productivity (TFP)—the ratio of total output to total inputs in a production process. Unsurprisingly, China, starting from a much lower base,

Figure 1. Average Annual Agricultural Output Growth by Decade



Sources: USDA, Economic Research Service, International Agricultural Productivity data product.

has significantly outpaced the United States in agricultural output growth on a percentage basis (see Figure 1).

The majority of agricultural output growth in China before the 1990s was driven by higher input use, such as the use of land, fertilizer, pesticides, and irrigation. Since 1990, however, China has driven the majority of its agricultural output expansion through improved efficiencies as measured by TFP. The United States again offers a contrast: over the past three decades, it has derived all of its growth in agricultural output from higher efficiency and has actually decreased its input use. This trend reflects the shift away from reliance on fertilizer and pesticide inputs to investments in genetic engineering and other high-tech improvements that have increased yields and productivity with fewer units of input.

China's TFP growth in agriculture has arisen primarily from technical progress rather than from efficiency improvement.² In other words, adoption of newer technologies has improved production, but those technologies have not been used to their full potential. Early adopters of technology may lack experience in exploiting its full potential and achieving high levels of efficiency with the new technology. For instance, an improved seed variety may increase crop yield, but the full yield potential of that seed will not be realized without proper agronomic practices.

What is Innovation?

Innovation is a new method or new product that becomes a new practice somewhere in the world. The idea or the technology is a necessary but not sufficient condition to achieve innovation with broad effects. Innovation is about both the idea and how it becomes a commercial reality. The gap between an idea, invention, or technology and a commercially viable product is huge. Innovation is a process that carries something from conception to development and from commercialization to market penetration.

Three ideas to consider regarding innovation include the following:

1. Entrepreneurial creativity and innovation is not usually about something that is entirely new to the world. Rather, innovation and invention is most typically about a re-combination of ideas, a melding of old things into some kind of new combination.
2. Innovation cannot be foreseen with significant clarity, and is usually not predictable. Transformative innovations are most often surprises that have arisen from an unlikely journey of single or small group of entrepreneurial people.
3. Innovation results from a collective intelligence, the cumulative ideas and knowledge of many people that have combined in unique ways over time. People exchange ideas and become specialists in increasingly complex trades and arts. This idea-sharing between people over the course of time results in a store of knowledge that can be iterated to drive further innovation.

But that is not all. Productivity growth in Chinese agriculture is also highly divergent by geography. Wealthier provinces tend to have experienced more prolonged and sharper advances in agricultural production and efficiency than have poorer provinces.³ Scale efficiencies have, in fact, been flat or actually deteriorated in many parts of China, reflecting issues related to small landholdings. This poses a fundamental challenge for Chinese agriculture because agricultural technologies are often directly related to scale efficiencies.

In one sense, the United States has natural advantages in agricultural production: the country has a relative abundance of natural resources, namely land and water. For instance, the United States has more than twice the arable land area of China, yet China must feed more than four times the US population on that smaller land base. Having done so successfully is a remarkable achievement and speaks volumes about the resourcefulness of Chinese agriculture. Yet China's comparative disadvantage in the natural resources necessary to expand food production means that it has all the more reason to rely heavily on technology and innovation to address existing and latent challenges.

Viewed through this prism, a central question for China is whether the rate

of adoption of agricultural innovations is sufficient. Gazing into the future, as millions more Chinese join the urban middle class, significant pressures will inevitably be placed on agriculture to feed China's population. A shift to diets heavier in animal protein has already begun to create a dramatic rise in demand for feed ingredients, from grains to oilseeds. So, even assuming conservative estimates, growth in Chinese meat consumption over the next decade will affect agriculture by increasing *global* consumption of beef by 25 percent, chicken by 20 percent, and pork by 15 percent.⁴

This means that although China's degree of self sufficiency in meat and grain consumption remains controversial and

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hotly debated, the sheer magnitude of ongoing demand shifts in China will lead to an "all of the above" approach to securing

stable agricultural supply needs. Put simply, China needs rapidly increasing production, as well as increased production in other countries that export various agricultural commodities to China. Otherwise, China will not be able to meet this new demand and mitigate broader impacts on global prices.

Beyond China, other emerging economies, particularly those in Asia, are undergoing similar phenomena—rising incomes, urbanization, and the emergence of middle-class food

consumption habits. The United Nations Food and Agriculture Organization (FAO) projects that global food production must double over the next 40 years to satisfy increasing demand due to population growth and rising economic prosperity. These figures have framed the discussion of what is needed to feed a global population that is expected to balloon by another 36 percent to 9.5 billion in 2050.⁵

There is limited opportunity to expand the land used in agricultural production because it is fixed. So to sustainably increase food production, innovation in agricultural technologies will be required that both raises productivity

and improves the efficiency and resiliency of existing and emerging agri-food systems.

As two of the most important global agricultural powers, the United States and China will play an important role in shaping global agricultural production and demand patterns and tackling attendant challenges.

This paper explores innovation in agriculture. Specifically, its aim is to present distinctive opportunities for joint collaboration, based on investment and commercial solutions, to address the rising pressures on global agriculture.

Agricultural Innovation in the United States

The last two centuries have been marked by a global shift away from agrarian economies and toward the acceleration of economic exchange and specialization. This is generally considered to be the basic foundation upon which modern prosperity has been built. Such was possible because dramatic improvements in agricultural productivity and yield freed up labor to be deployed into other economic activities.

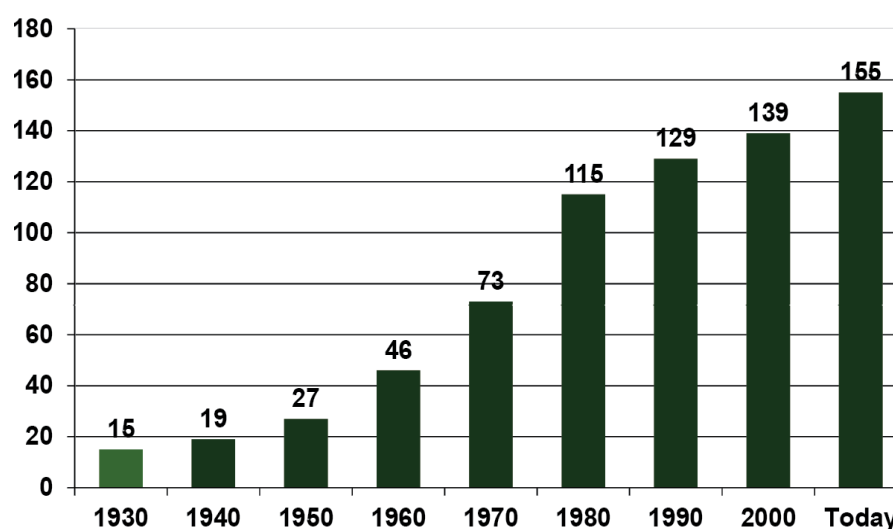
As recently as the nineteenth century, more than half of all human labor hours were dedicated to one task: weeding. Farming technology and pesticides have radically altered this, and keeping the stomach full is no longer an all-consuming

preoccupation. This has allowed the individual to divert his or her resources and time to other endeavors, including trade, business, and other worthwhile enterprises.

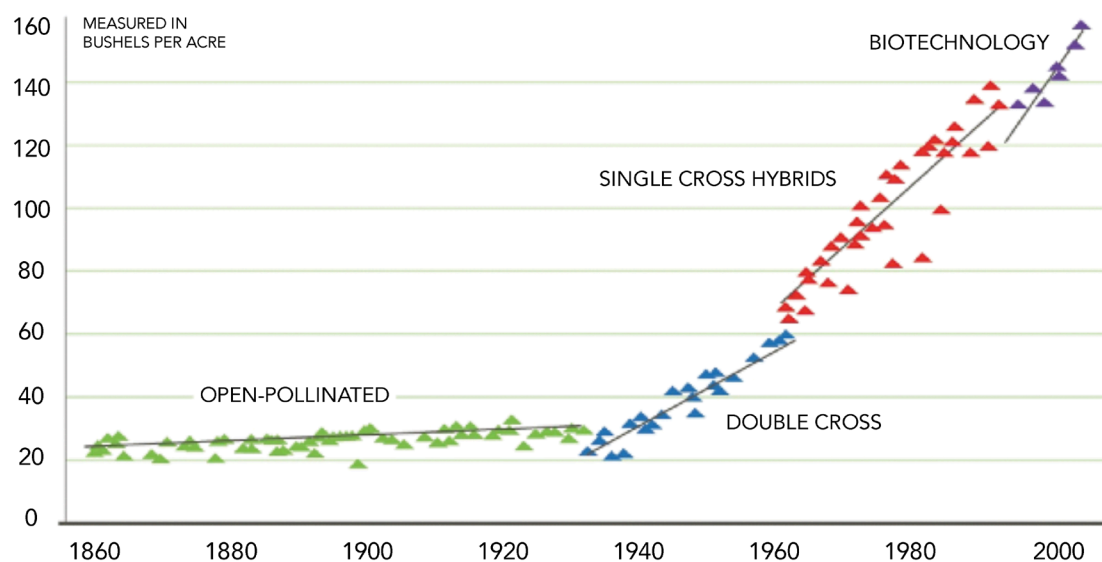
The United States has played an important role in this process of agricultural innovation. It is, to be sure, difficult to attribute any one innovation to a single person or place, but important categories of commercial advancements in agriculture that emerged largely from the United States include farm machinery, pesticides, hybrid seed, genetic modification and cloning, and precision agriculture, among others.

Using current US population and farm figures, the US Department of Agriculture

Figure 2. Number of People Fed by One US Farm



Source: USDA.

Figure 3. Historic US Corn Yields (bushels/acre)

Source: USDA.

(USDA) reports that each American farm feeds 155 people (using only US population, even though the country is a net agricultural exporter), a tenfold jump from 1930 (see Figure 2). Even this figure, however, underestimates the productivity gains made by most US farms. The 2012 Census shows that there are about 155,000 farms that sell \$500,000 or more annually, and these farms account for 80 percent of total farm sales. If 155,000 farms feed 80 percent of the US population, then each of these farms feeds, on average, 1,625 people, none of whom plays a direct role in the primary production of that food.

Corn is an agricultural commodity that well illustrates these tremendous American productivity gains and efficiencies derived from agricultural innovation.

Ideas about the potential yield gains from heterosis, or hybrid vigor, arose from Mendelian genetics in the late nineteenth and early twentieth centuries. Much research took place at US universities to further the notion. And in short order, agricultural entrepreneurs forged a new industry—seed—and then pushed these ideas into commercial reality with the introduction of double cross, and then eventually single cross, hybrids.

Adoption of hybrid corn by US farmers from 1930 to 1955 became a template for understanding and incorporating agricultural technology, using a model that stretched from early adopters, to early majority, to late majority and ultimately to adoption by laggards.⁶

More recently, the addition of molecular modification techniques (biotechnology) to traditional plant breeding has commercially introduced traits such as herbicide resistance, insect resistance, and drought tolerance. The net result of corn breeding innovation has been steadily rising yields (see Figure 3).

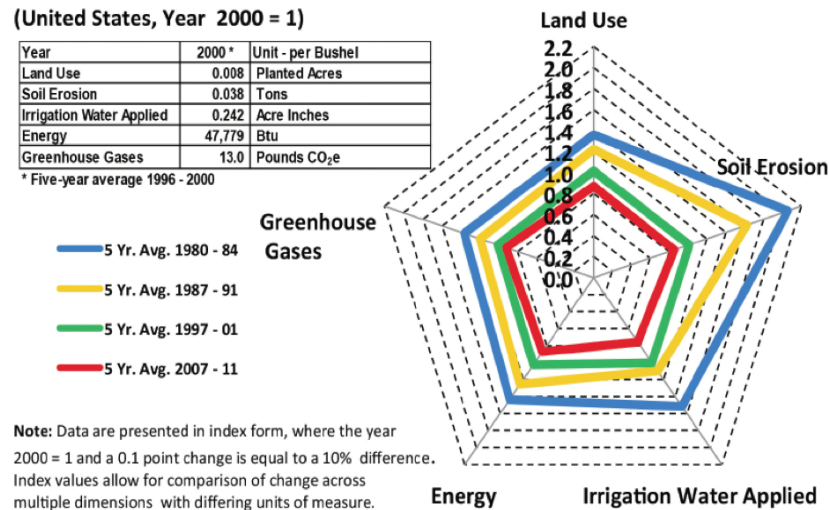
In addition, the resource efficiency of corn continues to improve. While yield has risen, the environmental impact of growing corn has decreased (see Figure 4). One study found that between 1980 and 2011, while US corn yield (bushels per acre) increased 64 percent, per bushel land use decreased 30 percent, per bushel soil erosion decreased 67 percent, per bushel irrigation water applied decreased 53 percent, per bushel energy use decreased 44 percent, and per bushel greenhouse gas emissions

decreased 36 percent.⁷ In other words, the United States managed, quite remarkably, to produce more with less.

US hybrid corn also illustrates how innovations result from the work of many people—and how collective knowledge can lead to dramatic impacts over time.

The success of hybrid corn through the decades rightfully owes credit to many influential people, with a leading example being Henry Wallace, an entrepreneur, two-time cabinet secretary, and Vice President of the United States during the third term of Franklin D. Roosevelt. Many others also played important roles, including university and government scientists, extension personnel, entrepreneurs, corporate scientists and business people, and foreigners.

Figure 4. Per Bushel Resource Impacts to Produce Corn for Grain, 1980-2011



Source: Field to Market 2012.

Agricultural Innovation in China

As in the United States, the story of agriculture is woven through China's history. But the development of modern agricultural practices and the adoption of innovations is a newer and still evolving phenomenon.

Change in Chinese agriculture has been driven by continued growth in consumer food markets. For example, the Chinese grocery sector is forecast to reach sales of almost \$1.5 trillion by 2015, having surpassed US grocery sales in 2011.⁸

Change in Chinese agriculture has been driven by continued growth in consumer food markets.

In 1980, at the beginning of the economic reform era, agriculture accounted for 40 percent of China's total economy and employed more than 70 percent of the labor force. Today, agriculture accounts for about 10 percent of China's economy and employs 35 percent of the labor force.⁹ This is a remarkable shift over a relatively short period of Chinese labor from agriculture to other industries and of people from rural areas to cities.

Yet despite these achievements, China still faces significant constraints in its agricultural land capacity, relative to its population size. China has 22 percent of the world's total population but only 7 percent of its arable land. To break the problem down further, China has

approximately 300 million acres of arable land, covering 13 percent of its territory. This amounts to 0.67 acres per capita and is less than 40 percent of the per capita world average, one-eighth the US level, and one half that of India.¹⁰ Resource availability for agriculture is a significant challenge, and one that makes innovation and the creative application of technology all the more important to China's future.

But over the last 30 years, China has defied these very considerable constraints and managed to make tremendous gains in agricultural production. Agricultural output grew at an annual rate of 4.5 percent from 1981 to 1990, 5.3 percent from 1991 to 2000, and 3.4 percent from 2001 to 2010, far exceeding the world average in agricultural output growth.¹¹ Chinese agriculture has seen the establishment of sizable homegrown agribusinesses, alongside the presence of multinational firms such as DuPont Pioneer, Monsanto, Syngenta, and Deere.

Integration of modern agricultural innovations into Chinese agriculture can be seen in the rising productivity of a number of commodities. A leading example of this success is rice, an important staple in the Chinese diet. Hybrid rice development in China

began in the 1960s, and has supported an increase in yields that enabled rice production to grow even as rice-planting area decreased. Chinese rice yields tripled as rice hybrids were improved. This has contributed significantly to overall agricultural productivity growth in China (see Figure 5).

Productivity in other agricultural commodities has increased in China as well, although it still lags leading yield levels globally in most commodities by a greater margin than for rice.

Here are a few examples:

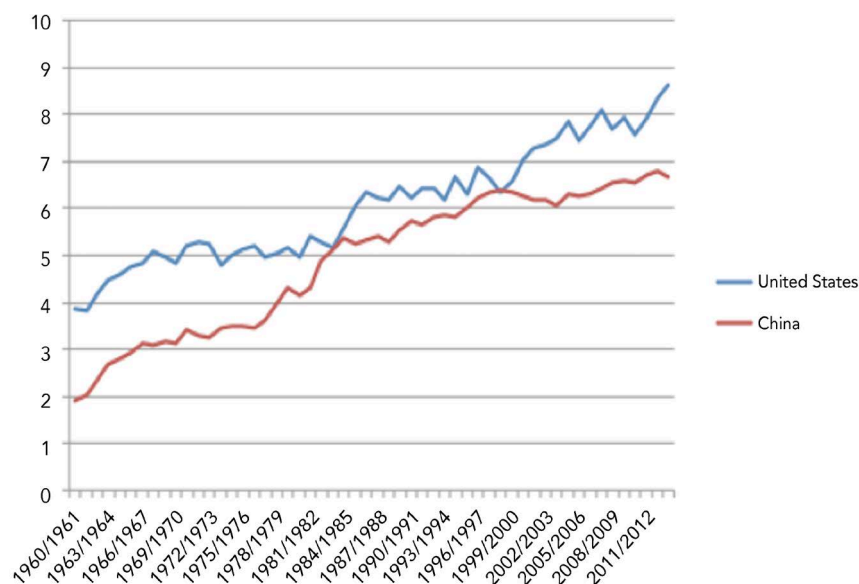
- Corn yields lag US levels by 40 to 50 percent but have continued to rise significantly, increasing from about

1 metric ton/hectare in 1960 to 6 tons/hectare today.

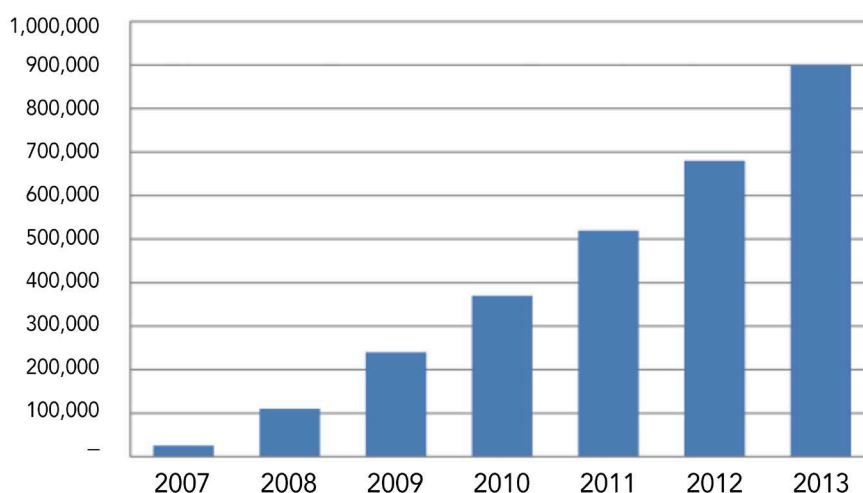
- Dairy yields per cow have increased in China from 0.4 metric tons/year in 1964 to about 4.2 metric tons/year today. By contrast, US dairy yields went from 3.67 metric tons/cow in 1964 to 10.1 metric tons/cow annually today.
- Soybean yields in China have increased from 0.8 metric tons/hectare in 1964 to 1.8 metric tons/hectare today. In 2013, US average soybean yields were 2.9 metric tons/hectare, having risen from 1.53 metric tons/hectare in 1964.

In spite of continued growth in agricultural output in China, some analysts do express concern about the

Figure 5. Rice Yields, 1960-2013 (metric tons/hectare)



Source: USDA-ERS.

Figure 6. Number of Farmer Professional Cooperatives in China

Source: Dr. Hongdong Guo, Zhejiang University, Hangzhou, China.

future. One USDA report, for example, observed that the rapid growth in agricultural production in China of the past few decades may not have been sustained in recent years.¹²

Indeed, an example of the recent challenges to agricultural productivity growth in China can be seen quite vividly in the swine industry. In 1996, the United States and China each produced almost 1.2 tons of pork for each sow in their respective inventories. By 2012, however, the United States had increased its production per sow to 1.8 tons, while China saw its output per sow fall by about 10 percent.¹³

Whether China now faces a structural slowdown in agricultural productivity remains unclear, but it is important to weigh the implications of such a slowdown because of ongoing and

future changes in food consumption. One-off events, such as animal disease and weather, may have cyclical impacts, but a larger concern Chinese leaders and planners must confront is whether gains from the previous era of reform and technology development and adoption have, at this point, been exhausted.

Some economists argue that countries like China (and others, for that matter) can grow up to a point by importing (or imitating) practices pioneered over decades in other economies, such as the United States.¹⁴ After having acquired technologies and innovations from other places, the challenge for China would be to continue agricultural output growth while also developing a greater indigenous innovation capacity.

Can the success story from rice technology, for example, be replicated

across a range of other agricultural products?

One indicator of recent Chinese agricultural innovation is the formation of farmer corporations, or farmer cooperatives (see Figure 6). These organizations have significant potential to play a role in the adoption and diffusion of agricultural technologies and innovations. Scholars have labeled these entities “farmer professional cooperatives,” which are similar to cooperatives elsewhere in the world and include organizations that supply inputs, manage production, promote technology, and sometimes even engage in marketing.¹⁵

The emergence of these newer farmer cooperatives has accelerated since 2006, when China passed a law providing further support for their formation. The number of farmer professional cooperatives in China is estimated to have increased to 900,000 in 2013 from none prior to the adoption of this law. Farmer professional cooperatives are playing a significant role in the formation of larger scale enterprises, which can access more substantial capital for agricultural production

and foster collaboration between agricultural entrepreneurs.

The influence of these cooperatives on production is seen in vegetable and fruit production in China, with production area growing from under five million hectares in the 1990s to almost 30 million hectares today. Between 2005 and 2012, fresh vegetable production has increased from 440 million tons to 574 million tons, up 30 percent.¹⁶ China has transitioned from a country that was barely visible in international markets to that of a leading exporter of vegetables and fruits, with farmer professional cooperatives playing an important role in that evolution.

In addition, technology has contributed substantially to the growth of Chinese vegetable and fruit production. For instance, greenhouse production has moved from less than 10,000 hectares in 1990 to about 3 million hectares today, with many greenhouse facilities integrating world-class technologies. The combination of strong domestic consumption growth and continued growth in exports is predicted to fuel increasing investment in vegetable and fruit production in coming years.¹⁷

Models for US-China Collaboration in Agricultural Innovation

As the above sections have shown, China and the United States have distinct differences with respect to agricultural innovation for a variety of reasons:

- China is a population dense but arable land scarce country; the United States is an arable land abundant but population sparse country. This means that labor versus capital decisions in agriculture are weighed much differently in the two countries.
- China is working to maximize limited agricultural resources for domestic consumption; US agriculture looks to develop capacity for other countries, especially China.
- China is adopting and integrating modern agricultural innovations but struggling to make full and efficient use of them; the United States tends to pull much efficiency from technologies, as well as developing follow-on innovations.
- Adoption of agricultural innovations in China has significantly affected agricultural production growth in the last 25 years; the impact of agricultural innovation in the United States has been spread over a longer time period.

But these differences should, in fact, lead to promising opportunities to connect

the US innovation engine to China's need for the fruits of that innovation. Ultimately, China needs to deploy innovations more effectively, and further develop its own agricultural innovations. China, perhaps more than any other country, has the ability to deploy US and indigenous agricultural innovations on an unprecedented scale.

Much US innovation in agricultural technology arises from early-stage businesses. And that means that identifying models of US-China innovation collaboration needs to begin with startups.

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Investing in early-stage agricultural technology businesses can be a means to solve two interrelated problems. First, it provides a pathway for Chinese investors to access promising technologies and the human capital behind them. Second, US funding mechanisms for early-stage agricultural technology businesses are relatively undeveloped, so there is room for Chinese venture capital. There may be a premium for first-movers willing to bear some risk. In contrast to sectors such as information technology or biotechnology that receive greater attention, agricultural innovation in the United States suffers from a lack of a deep reserve of funding options for early-stage ventures.

Indeed, the need for more investment activity in early-stage US agricultural technology businesses has been a focus of much discussion. For example, the Kauffman Foundation, a high-profile advocate of entrepreneurship in the United States, has recently called for higher levels of private investment in US agricultural technology.¹⁸ Such appeals are centered around the importance of setting agriculture on a path toward greater efficiency and sustainability, for both the United States and the world.

Agricultural technology innovation will be particularly important to China in animal protein supply chains. Dramatic increases in Chinese animal protein consumption over the next ten years will, as argued in earlier sections, put enormous pressure on animal and crop production, so the improvement and development of technologies that increase the efficiency and sustainability of such supply chains is vital.

Early-stage agricultural technology activity in the US Midwest is particularly relevant to such needs. The region is home to the greatest concentration of animal protein supply chain activity in the United States and centers on the production of corn, the country's biggest crop (see Figures 7a and 7b).

As of 2012, the US Midwest produces more than \$180 billion of raw

agricultural products annually and produces the majority of US corn, soybeans, swine, beef, and eggs. It is also the primary source of agricultural exports to China. In addition, the region has extensive processing and agriculture value-added activity, resulting in thousands of food, feed, fuel, and specialty products derived from raw commodities.

The Midwest region has a strong concentration of public and private entities focused on developing agricultural technology. It is home to land grant public universities that

Agricultural technology innovation will be particularly important to China in animal protein supply chains.

provide a unique network of cutting-edge basic and agricultural science platforms. There is, too, a concentration

of agricultural businesses engaged in technology development at many different levels. The Midwest is a catalyst of US agricultural innovation, knowledge transfer, and entrepreneurship development. And yet it has much untapped and undeveloped potential for further investment-related activity.

To illustrate, consider the geographic clusters of early-stage agricultural technology development in the Midwest. These include established public and private organizations that shape the environment for technology R&D and potential adoption:

Figure 7a. US Corn Production and Midwestern Agricultural Production Value

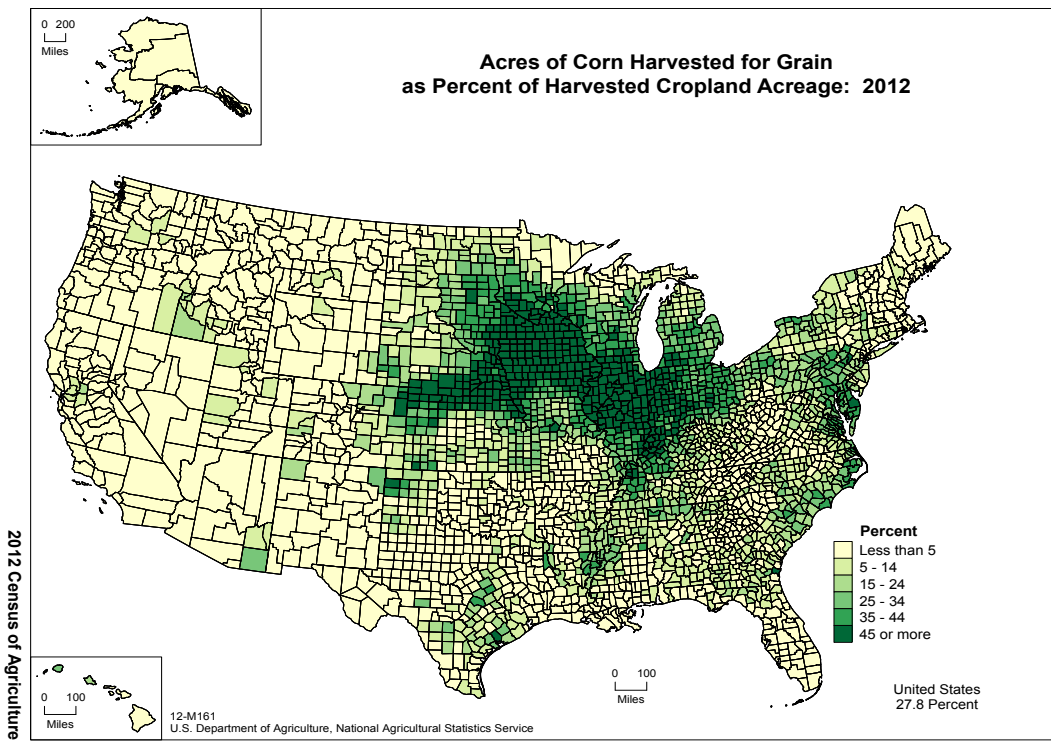
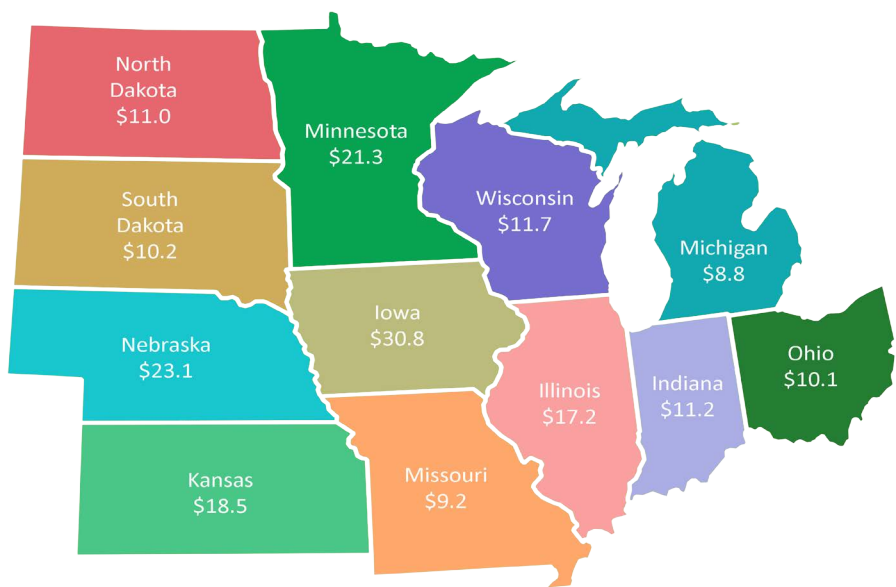


Figure 7b. Market Value of Agricultural Products Sold (2012), Midwestern States



Source: USDA.

- **Des Moines/Ames, Iowa**

- DuPont Pioneer: plant science agricultural business
- Iowa State University: land grant public university
- Iowa State University Research Park: assistance and accessibility for early stage businesses
- Iowa State University Agricultural Entrepreneurship Initiative: development program for agricultural entrepreneurs and agricultural innovation

- **Omaha/Lincoln, Nebraska**

- Valmont: infrastructure and irrigation equipment business
- University of Nebraska: land grant public university
- Nebraska Innovation Campus: support for early-stage companies
- Water for Food Institute: research institute for achieving food security with less pressure on water resources
- University of Nebraska Engler Agribusiness Entrepreneurship program: support and encourage entrepreneurship amongst students

- **St. Louis, Missouri**

- Monsanto: plant science agricultural business
- Bio-Research & Development Growth Park: bio-research facilities for emerging scientific enterprises
- Danforth Plant Science Center: nonprofit scientific facility to increase understanding of plant biology

- **Champaign/Chicago, Illinois**

- ADM: grain and oilseed processing agricultural business
- University of Illinois Urbana Champaign: land-grant public university
- University of Illinois Research Park: assistance and accessibility for early stage businesses.

By its nature, early-stage business activity is difficult to track. Inventors, entrepreneurs, and investors advance projects without extensive public disclosure, and personal networks are an important means of communication and development. To provide a proxy for the state of early-stage agricultural innovation activity in the Midwest, an analysis was conducted of business plans developed between 2012 and 2014 at the Agricultural Entrepreneurship Initiative at

**Table 1. Iowa State University
Agricultural Entrepreneurship Initiative
Business Plans**

	# of Plans	% of Total
Animal Health & Management	56	21.5
Machinery	22	8.5
Decision Support Technologies	21	8.1
Production Agriculture	20	7.7
Food Science	18	6.9
Urban Agriculture	15	5.8
Agri-Tourism	11	4.2
Energy Efficiency	11	4.2
Feed Efficiency	9	3.5
Sustainable Production Systems	9	3.5
Precision Agriculture	7	2.7
Aquaculture	6	2.3
Crop Nutrition	6	2.3
Crop Protection	6	2.3
Environmental Mitigation, Manure Management	6	2.3
Land Management	5	1.9
Horticulture	4	1.5
Seeds & Genetics	4	1.5
International Ag Development	3	1.2
Biological Pest Control	2	0.8
Bionutrition	2	0.8
Biotechnology	2	0.8
Fertilizer Efficiency	2	0.8
Information Systems	2	0.8
Irrigation Efficiency	2	0.8
Product Sourcing	2	0.8
Soil Health	2	0.8
Bioenergy	1	0.4
Biomaterials	1	0.4
Integrated Pest Management	1	0.4
Robotics	1	0.4
Water Quality & Preservation	1	0.4
TOTAL	260	100

Iowa State University. The dataset offered here is a snapshot of early-stage business development activity, much of it related to agricultural technology (see Table 1).

This analysis revealed a robust stream of innovation occurring across the agricultural value chain, with concentrations of activity in areas that should be of interest to Chinese agricultural entities, such as animal health and management, decision support technologies, food science, energy efficiency, feed efficiency, sustainable production systems, and environmental mitigation and manure management. Some startups have in fact emerged from these business plans, including Scout Pro, Agriculture Concepts, and AccuGrain.

Below are four models that have the potential to attract US and Chinese investment and commercial collaboration in these types of agricultural innovations in the Midwest and beyond. Each model focuses on early-stage agricultural business development activities and also contains a central element: human capital.

These four models are underpinned by the need to connect people to one another, but, most important, aim to do so in ways that assure that their collective knowledge and imagination is magnified and amplified. The opportunities encompassed by these four models would help to build US-China linkages but also lead to greater indigenous agricultural innovation over time in both countries.

Model One: Joint Agriculture Opportunities Fund

Relatively few venture capital (VC) or private equity (PE) funds in the United States are focused exclusively on agricultural technology. One means for Chinese investors to play a role in US agricultural innovation, then, is through the creation of a fund with an explicit focus on technologies relevant to both US and Chinese agriculture.

The central concept in this model is to pair Chinese investors with US investors in a relatively undeveloped segment of the US capital market.

Proprietary deal flow is one factor influencing early stage investment success, thus a fund with a clear investment thesis related to joint US and Chinese agricultural technology value and a geographic focus that aligns with that thesis is important. Such a fund would usefully focus on a region, for example by concentrating its investments in the Midwest.

There are 800 to 1,000 active VC funds in the United States, with an average fund size of about \$150 million. However, fund size varies considerably. In the most

recent years, US VC funds cumulatively invested between \$25 and \$30 billion a year in 3,500 to 4,000 deals.

VC deals in the United States have been most heavily concentrated in Silicon Valley, with up to 50 percent of total VC investment dollars in the country flowing to companies in northern California

during some quarters. In the same way, the bulk of venture deals in the United States have been geared toward computer and software technology, high growth sectors since the 1980s when the VC industry itself was in its formative stages.

In the Midwest, the prime agricultural region in the United States, VC investments have grown from under \$500 million in 1995 to \$1.1 billion in 2013, yet the region remains underdeveloped relative to other parts of the United States in attracting VC funding. For instance, VC investing averaged \$94.20 per capita in the United States in 2013, but was just \$17.02 per capita in the Midwest (see Table 2).¹⁹

Venture investing in agricultural technology is not even broken out as a category in industry statistics in the United States. A search of the vFinance.com database of more than 1,000 venture

Table 2. US VC Investments by Year

	Midwest (million)	US Total (million)	% of US
1995	\$470	\$8,022	5.9
1996	\$736	\$11,361	6.5
1997	\$913	\$15,097	6.1
1998	\$1,645	\$21,569	7.6
1999	\$2,631	\$54,908	4.8
2000	\$5,777	\$105,119	5.5
2001	\$2,185	\$40,967	5.3
2002	\$977	\$22,192	4.4
2003	\$914	\$19,626	4.7
2004	\$712	\$22,814	3.1
2005	\$916	\$23,554	3.9
2006	\$1,010	\$27,624	3.7
2007	\$1,159	\$32,003	3.6
2008	\$1,364	\$30,255	4.5
2009	\$966	\$20,336	4.8
2010	\$1,364	\$23,398	5.8
2011	\$1,554	\$29,764	5.2
2012	\$1,419	\$27,385	5.2
2013	\$1,112	\$29,580	3.8

Source: PricewaterhouseCoopers/
National Venture Capital

funds yielded just 54 with agriculture indicated as one of their investment areas, and only six of these are located in the Midwest. But though it is nascent, the activity of agriculture-related venture investors is much richer in the Midwest than 10 or 15 years ago.

Of course, VC is a subset of the larger PE asset class, which also includes buyouts and mezzanine investment activity. So there may be opportunities with some of these PE firms for investments from Chinese parties, although that would depend on the nature of the fund. For example, PE funds,

particularly foreign investors, focused on US farmland investment are legally restricted in some states. States such as Wisconsin, South Dakota, North Dakota, Minnesota, Missouri, Iowa, Nebraska and Oklahoma have laws that restrict foreign ownership of farmland.

Each state's laws are distinct, but many of them date to the 1970s and were rooted in fears of a Japanese takeover of US real estate.

A Joint Agriculture Fund may also be launched through an existing firm or by

Hypothetical Example of Early-Stage Investment by Joint Agriculture Fund

	Events	Issues
Problem	Porcine epidemic diarrhea virus (PEDV) is a coronavirus that infects the cells lining the small intestine of a pig, causing severe diarrhea and dehydration. Older hogs mostly get sick and lose weight after being infected, whereas newborn piglets usually die within five days of contracting the virus.	PEDV was first discovered in Europe, but has become increasingly problematic in China and now the United States. PEDV has killed more than eight million American hogs, resulting in significant losses to swine producers and higher pork prices for consumers.
Opportunity	An American scientist-entrepreneur has developed an assay to detect PEDV, and immunoassays to detect antibodies against PEDV in the blood of infected pigs. The idea is that laboratories using the technology will be able to more rapidly identify PEDV, enabling pork producers to limit losses.	Being able to rapidly diagnose a PEDV outbreak puts pork producers in a more powerful position. There are multiple causes of diarrhea, so fast confirmation of the PEDV enables appropriate action to be taken, including implementing strict biosecurity on affected swine farms.
Investment	The Joint Agriculture Fund invests money in a company formed to commercialize the PEDV assay and immunoassay technology.	The Joint Agricultural Fund is a preferred shareholder in the company, exchanging capital for an ownership stake. The fund also plays an active role on the Board of Directors and in mentoring and developing an effective management team.
Scale-Up	The company commercializes its first technologies, scales its sales and marketing capabilities and develops ongoing R&D for improvement of existing technologies and development of new ones.	The company works toward eventual cash-flow positive status while building an organization for both sales and operational execution and continued technology development in both countries. The Joint Agriculture Fund plays a key role in helping the company establish a market presence in China.
Returns	As the company provides value to the swine industry it increases enterprise value. The Joint Agriculture Fund's equity stake in the company increases in value. Return on investment comes in the form of a) dividends paid to investors and/or b) a sale of the company.	The Joint Agriculture Fund provides unique value-added service to the company beyond capital by helping the company develop its technology and organization to succeed in both countries. The US market is about six million sows, while the Chinese market is 50 million sows.

creating a new fund that uses the existing infrastructure of the firm. Alternatively, an entirely new firm could be formed. But in either case, a China-focused agricultural technology fund in the United States would need to have an explicit focus on technologies that have potential in both markets. Chinese investors should expect a return on investment consistent with early stage funds (25 percent annualized return or more), but should also leverage linkages to Chinese agriculture that will magnify returns.

One lesson from other similar joint funds is that management of the fund should integrate US and Chinese agricultural expertise. Chinese investors may be limited partners in the fund itself, but personnel with deep experience and perspective on Chinese agriculture will be needed to help bring unique capacity to the portfolio companies and help them scale in both the United States and China. This model of a Joint Agriculture Fund can target investments at early-stage businesses as one form of investment.

Depending on the business, such investments can take the form of “seed” capital (high potential, but unproven ideas or prototypes) or “series A” capital (proven business plans and core management teams).

The joint fund may also invest in roll-up opportunities, a term used by investors to describe a strategy of combining multiple small companies in the same market into a single entity. The goal of a roll-up

is to help a small firm achieve critical mass and/or to reduce cost through economies of scale. Creative mergers may also have the effect of increasing the valuation multiples of the roll-up business compared to the smaller pre-roll-up parts.

Midwestern VCs with demonstrated interest in agricultural technology

Advantage Capital Partners, St. Louis, Missouri: Invests in entrepreneurial small businesses in communities that are underserved by traditional sources of capital.

AgVenture Alliance, Mason City, Iowa: A business development organization for value-added agricultural ventures formed by a group of farmers and agriculture related individuals in northern Iowa.

Cultivian Ventures, Carmel, Indiana: Fund focused on high-tech opportunities in the food and agricultural sectors.

Iowa Farm Bureau Federation Rural Vitality Fund, West Des Moines, Iowa: Created as a part of the Iowa Farm Bureau Federation in partnership with other organizations to support the financing needs of rural businesses.

Linn Grove Ventures, Fargo, North Dakota: A VC fund focused on technology to feed nine billion people by 2050.

Nidus Partners, St. Louis, Missouri: Provides seed funding to commercialize promising technologies related to energy, including renewables, storage, and bioconversion.

Open Prairie Ventures, Effingham, Illinois: Provides early and growth stage VC, merchant banking, and strategic planning services to firms in industries including agriculture.

The underlying concept of this model is this: there are a plethora of early-stage companies in the United States and China that are working on analogous or similar ag-related products and technologies, operating in analogous markets but each in their own country, or are in possession of technologies, systems, and expertise that can be further leveraged in the other country. So a fund will need to identify opportunities to invest in two analogous companies—one in each country—and bring them together for scaling in a cross-border fashion. Early-stage companies rarely have this type of capacity to think about, much less execute, multinational strategies. The challenge of doing so is, at root, one of resource limitations, time constraints, lack of relationships, language barriers, and lack of experience or perspective.

Roll-ups by their nature are difficult and intensive to identify, difficult to put together, and challenging to execute over the long term. And that challenge is magnified when combining firms from two different countries. However, the opportunity in US ag-related technology for venture and equity investors is notable and significant. Building more direct ties and relationships across borders would afford the chance to build a truly transnational firm, and one that can grow with new and emerging opportunities for US-China agricultural collaboration, investment, and trade.

Indeed, there are few richer environments through which Chinese investors can dive into the US culture of innovation and entrepreneurship than through early-stage capital. However, the combination of new ideas, undeveloped markets, and entrepreneurs with limited experience means that there will be high rates of failure. Still, this constant churn of failure, mixed with occasional and spectacular success, has been an important part of the dynamic system of US innovation, including in agricultural technology.

Discussions with an assortment of ag-focused venture and PE fund professionals by the author revealed a generally positive reception to the idea of investors from China. The nature of investing in the United States and elsewhere is heavily relationship-oriented, so there is typically some caution to introducing a new potential business relationship. However, there is a considerable understanding in US agriculture of the potential cross-border benefits of building a bridge between markets and investors in the two countries. But while state-owned enterprises (SOEs) have partnerships with many in US agriculture, the preference among US venture and PE professionals, at least, is to develop relationships with individual Chinese investors, as opposed to funds linked to sovereign vehicles or SOEs.

Model Two: US-China Agriculture Accelerator

An emerging trend in early stage investing in the United States is the formation of accelerators. Accelerators offer entrepreneurs various combinations of mentorship, work space, and funding. They may be housed at universities, community-oriented organizations, or private development and funding entities.

The purpose of an accelerator is to immerse an entrepreneur in a fertile environment for early-stage companies. Companies that do so gain access to a robust network, other entrepreneurs working through similar challenges, quality mentors, and potentially even seed capital.

As with so many VC and PE funds, today's US accelerators are heavily concentrated in the information technology (IT) sector and cluster around a few geographies where firms in that sector are concentrated. Accelerators that have garnered attention through success and profile include Idealab, Techstars, and Y Combinator, but accelerators are now emerging in geographies outside the major IT hubs.

Future accelerators will become much more focused on distinct niches; agriculture cannot be far behind, although there are currently no accelerators with an explicit agriculture focus. Such entities will likely serve verticals for which they can help the entrepreneur

through specialization. In this context, an accelerator with a focus on agriculture and joint US-China opportunities is a clear example of the next generation development of accelerators in the United States.

This model suggests that Chinese investors would partner with a US-based organization to launch a US-China Agriculture Accelerator—again, for example in the Midwest. The accelerator would offer office/lab/engineering space, access to mentors, skills training, a network of support, and connections to ag-related investors and customers in both countries but with an emphasis on the China market. The US and Chinese partners in the accelerator may take an equity stake in participating startups, charge ongoing participation fees, or charge success fees depending on the nature of participants in the program. The budget (three to five years) for an accelerator can be as low as \$3 million or as high as \$20 million, depending on the scope of the program and overhead expense structure. The ideal arrangement will encompass funding from both US and Chinese agricultural investors.

Similar to the IT accelerators highlighted above, the joint ag-focused accelerator would work with early-stage businesses. The staff, mentor, and investor network that will be at the core of the accelerator should have a unique combination of US and Chinese agriculturalists and focus on opportunities that are scalable in both countries.

In addition to early-stage businesses, the accelerator would also accept businesses that are formed to portage existing US agricultural technologies to China. This concept involves helping to leverage Chinese agricultural knowledge into new opportunities for existing US agricultural technology via the accelerator. The accelerator can enable entrepreneurs to tap into larger opportunities through its perspective on technology in both countries.

The distinctive elements of this model involve a combination of a US organization that brings connections to early-stage agricultural entrepreneurs and innovative agribusinesses alongside Chinese investors with an interest in agricultural innovation and experience in Chinese agribusiness.

Potential US entities as partners for the accelerator could be the following:

- Midwest (or other) universities with colleges of agriculture and incubation

Hypothetical Example of Projects by a US-China Agriculture Accelerator

	Early Stage Business	Existing US Agricultural Technology
0 Months	A US entrepreneur has developed a technology that significantly reduces the risk and incidence of e. coli and salmonella bacteria contamination during meat processing. The technology has potential in the US market, but also in China as a means of improving food safety for processed meat products. The entrepreneur applies to the US-China Agriculture Accelerator and is accepted.	An established mid-sized US agribusiness has an animal feed ingredient technology for increased poultry feed efficiency. The patented ingredient has gained US industry acceptance, with a 30 percent market share in the egg laying chicken industry and 25 percent market share in the broiler chicken industry. The US company thinks the product has potential in China but doesn't know how to approach the opportunity so it applies to the US-China Agriculture Accelerator and is accepted.
0 to 6 Months	The entrepreneur moves into the accelerator office and gets \$100,000 in seed funding in exchange for a 10 percent equity stake in the company by the accelerator. Accelerator staff works intensively with him on commercialization strategy and engineering. Staff also works closely with him to identify potential customers in both markets.	The US agribusiness assigns an employee to lead the spin-off business at the accelerator. Patent rights to the technology for China are assigned to the spin-off business. The agribusiness contributes \$50,000 to the project as does the accelerator. The accelerator receives a 10 percent equity stake in the new business. Accelerator staff works closely with the business to identify Chinese staff, connect it with potential customers in China, develop a commercialization strategy, and identify potential Chinese partners.
7 to 12 Months	The entrepreneur completes a business plan, and accelerator staff assists with connections to interested investors. A coalition of Chinese and US investors invests \$5 million in the business. Ownership of the business is 50 percent investors, 45 percent founder, and 5 percent accelerator.	The staff of the spin-off business, now one American and one Chinese professional, completes the business plan. Accelerator staff continues to assist with connections to potential investors and partners. Ultimately, a Chinese meat processing equipment company becomes the investor and partner for the business. Ownership in the business is 47.5 percent US agribusiness, 47.5 percent Chinese meat processing equipment business, and 5 percent accelerator.

High Profile Accelerators in the United States

- Idealab: An early template for accelerators was this Pasadena, California-based accelerator started by Bill Gross in 1996. Idealab itself usually comes up with the ideas for new businesses then recruits outside people to bring them to fruition. Idealab takes a significant equity stake of participating companies, but also invests significant capital. Idealab has started and operated more than 125 companies with 40 initial public offerings and acquisitions.
- Techstars: This accelerator provides \$118,000 in seed funding to entrepreneurial teams accepted into its program through a competitive application process, intensive mentorship, and a network of mentors and alumni. Locations include Austin, TX, Boston, MA, Boulder, CO, Chicago, IL, New York City, NY and Seattle, WA. In exchange, Techstars gets 7-10 percent equity ownership in the companies. Techstars reports that of the 292 participating companies, each average over \$2 million in follow-on investment, 228 are still active, and 35 have been acquired.
- Y Combinator: Y Combinator invests \$120,000 in a large number of startups (most recently 68) biannually. The startups move to Silicon Valley for three months, during which Y Combinator works intensively with them to get the company into the best possible shape and refine their pitch to investors. Each cycle culminates in Demo Day, when the startups present their companies to a carefully selected, invite-only investor audience. Since 2005, Y Combinator has funded more than 700 startups with a current valuation of over \$20 billion.

and technology commercialization activity and research parks.

- Regional initiatives with an agricultural focus. These include but are not limited to the Cultivation Corridor in Des Moines, Iowa and the Kansas City Animal Health Corridor in Kansas City, Missouri.
- Not-for-profit organizations with missions related to Chinese agricultural needs, such as the Danforth Plant Science Center in St. Louis, Missouri.

Universities are particularly interesting potential partners in such an accelerator because of the opportunity to pursue entrepreneurial projects with combinations of US and Chinese faculty or students.

Indeed, some universities, such as Purdue University in West Lafayette, Indiana, have even developed venture vehicles to commercialize university innovations. In addition, there are a number of latent patented agricultural technologies at US universities that are available for licensing. Entrepreneurs hosted by a prospective joint US-China accelerator could develop plans to license and commercialize these technologies in China.

Model Three: University Student Incubators

Another sensible and mutually beneficial opportunity for Chinese investment in US-based agricultural

innovation is the development and launch of student incubators at universities. There are nearly 500 such student incubators in the United States, a trend supported by the development of entrepreneurship classes, related programs, and subject majors at many universities.

Student incubators support the development of startup and fledgling companies by providing student entrepreneurs with an array of targeted resources and services. These services are usually developed or orchestrated by incubator management and offered both

in the student incubator and through its network of contacts, often alumni. A student incubator's main goal is to produce successful startup businesses that will leave the program financially viable.

Entrepreneurship activity at some US universities is, in fact, quite significant. A survey of Iowa State University graduates who had received bachelor's degrees between 1982 and 2006, for example, found that 15.1 percent of all graduates had started at least one for-profit company, and 20.1 percent of those who graduated from the College of Agriculture and Life Sciences had done so.²⁰

Hypothetical Example of a US-China Agriculture Student Incubator

	US-China Agriculture Student Incubator Activities
Founding	Chinese investor(s) receive proposals from universities for creating US-China Agriculture Student Incubators. Funding provides for five years and \$500,000 total investment per incubator. Universities are selected, including a university that will house the student incubator at its College of Agriculture. The university has existing student incubator activity for agricultural businesses, but this funding will enable further development of those activities with a focus on teams of Chinese and US students with prospective business potential in both countries. The university designates two faculty members to direct the program as well as alumni entrepreneurs to provide mentoring and support.
Fall Academic Term	A competitive application process results in three student entrepreneur teams being selected. One of the teams consists of a) a US agriculture student, b) a Chinese agriculture student, and c) a Chinese software engineering student. The student team wants to develop an application for a tablet computer that enables crop scouts to identify pests (insects, weeds, plant diseases) and record scouting data that can be shared with agronomists and farmers for more effective pest diagnosis and treatment. The student team has a prototype for US corn that is being tested, but funds from the incubator will support further development with the support of university plant pathologists. In addition, the funds will support development of a version appropriate for China, involving collaboration with plant pathologists from a Chinese university.
Spring Academic Term	The student team has collaborated with US and Chinese university plant pathologists to create the alpha version of the corn scouting application. In addition, the student team has worked closely with Incubator mentors to define its value proposition, articulate its initial business model, and develop a marketing and sales strategy. The application is launched in time for spring planting of corn in both China and the United States with 20 professional crop scouting organizations signing up for the pilot release.
Next Year	The pilot release of the corn scouting application is a success, with the startup company demonstrating value and generating revenue. The startup completes a business plan and a proposal for \$2 million in equity capital to scale the company, develop applications for other crops, and build the organization.

In fact, the early cohort of graduates from the agriculture college included more than 30 percent of graduates who were now entrepreneurs. And these alumni entrepreneurs from this time period created companies that collectively did \$64 billion in revenue annually and employed almost 225,000 people.

This is precisely why building ties to aspiring entrepreneurs at American universities by funding a student incubator is a means for Chinese investors to tap into developments in US-based agricultural innovation. Such an investment model differs from Models One and Two in that it would involve an indirect investment. The goal of funding a university-based student incubator is the creation of proprietary deal flow, and also the identification and development of entrepreneurial talent. If done properly, university-based student incubators dedicated to US-China agriculture startups will generate investment-ready businesses at a relatively low cost.

Midwest land grant universities are a target-rich environment because of the opportunity to pursue incubation projects with both US and Chinese agriculture students. Many of them, as the Iowa State University survey demonstrates, are also aspiring entrepreneurs. This model calls for creating a student incubator with an explicit goal of supporting development of startup businesses created by teams of American and Chinese students.

Universities with the most potential as partners will likely be those with a combination of entrepreneurship, business, and agribusiness programs, which also have a record of business incubation and technology commercialization. In addition, those US universities with faculty and students from China with an interest and expertise in agriculture and related fields will be strong potential partners. Depending on the relationship, there is the longer term potential of establishing cross-border student incubators on both US and Chinese campuses.

Model Four: Emerging Africa Agriculture Fund

In team sports, the term “home field advantage” describes the advantage that the home team is said to have over the visiting team as a result of playing in familiar facilities and in front of supportive fans. The alternative to playing on the team’s home field is to pick a neutral field, where neither team has an obvious advantage. One can apply this neutral field metaphor to a fourth model of US-China investment in agricultural innovation—namely, investing in third-party agriculture projects, for instance in Africa.

Agriculture in Africa is currently seizing the attention of its own and other governments, local and international business leaders, communities, and development partners such as bilateral and multilateral donors. In recent years,

many have called Africa the world's "last agricultural frontier." Significant economic growth in many parts of Africa over the last five to ten years has yielded rising urban middle classes and increased demand for more and better locally sourced foods, energy, water, infrastructure, housing, and sanitation.

This rapidly emerging opportunity for agribusiness investors in Africa has been a focus of Rabobank, a leading international agricultural bank. Take this assessment from Piet Moerland, chairman of Rabobank's board:

No region of the world offers more excitement, complexity, and opportunity [for] global food and agriculture than Sub-Saharan Africa. Over the past decade, the hidden food and agriculture potential of this region has become better understood, but the challenge of achieving sustained growth and development in African food and agriculture remains unmet. Sub-Saharan Africa possesses the natural resources advantages needed to build effective food and agriculture industries, but in some instances lacks the know-how, experience, and the enabling environment to get it done.²¹

There is tremendous underdeveloped agricultural production capacity in Africa, but that capacity needs to be put onto a pathway of sustained growth and more rapid productivity increases. Agriculture—more than any other industry—has the potential to reinforce Africa's transition toward global economic relevance at the

macro level, and to drive income growth and reduce poverty at the individual level. The World Bank estimates that by 2030, agriculture could be a \$1 trillion industry in sub-Saharan Africa.²² The possibility of shifting parts of Africa from net food importers to exporters is not outside the realm of possibility.

Now is a unique moment for Chinese and American agriculturalists and investors to jointly explore ways to be involved in developing Africa's private agribusiness sector. Indeed, in many ways, everything in Africa has been tried already except for the development of a sustainable private sector, particularly beyond primary agricultural production. This should include creating local agribusinesses that support farmers (inputs and services) as well as those that improve and develop markets through processing and value-added activities.

There are an increasing number of business plans that have been developed by US agricultural entrepreneurs for farming and agribusiness investments in various countries in Africa. And Africa has very quietly built up a capacity for billions in agriculture-related investment. A proper and effective model would combine Chinese capital, US agribusiness and technology know-how, and local African agriculture partners to more rapidly increase the rate of productivity gains in commercial agriculture. US-China relationships, sharing of expertise, and investment history could thus be leveraged on a neutral field.

Clusters and Parks in Action

One US business championing farm and agribusiness clusters and business parks is Heartland Global, Inc. in Johnston, Iowa. For example, the company is already working with a Ghanaian local food company, the Ministry of Food and Agriculture, the Irrigation Development Authority, and other local and global agribusinesses to develop an agricultural business park in the Volta region of the country (see Figure 8). The investment opportunity, currently in the design phase, aims to convert a 63,000 acre former government ranch property that has fallen into disuse into a hub of modern farming and agricultural processing. The design includes local food value chains and production and processing for export. American, South American and Ghanaian farm and agribusiness investors are engaged in this development. Heartland Global seeks to develop “economic zone” or “inland port” status to ease the movement of products and inputs in and out of the cluster. In addition, the company is engaged in discussions of analogous projects in DRC, Malawi, and elsewhere on the continent.

This model could, for example, take the form of a US-China Emerging Africa Agriculture Fund, focused on early-stage projects in the \$5 to \$15 million equity capital range. There are a variety of funds appropriate for larger, more developed agriculture projects but few, if any, geared toward early-stage, greenfield projects at this time. Most countries in Africa have relatively undeveloped agriculture economies and agribusiness sectors, so greenfield projects are necessary but occupy the high risk/high reward part of the investment spectrum.

Broad parameters for an Emerging Africa Agriculture Fund include:

- Involvement of both Chinese and US agriculturalists as investors. It could be set up as a new firm, or a new fund for an existing firm.
- Leveraging investment from both the African and Asian development banks and, where appropriate, position for later stage investment from
- The World Bank/International Finance

Figure 8: Agricultural Business Park Schematic in Ghana (Tongu Ranch)



Source: Heartland Global, Inc.

Corporation and possibly even from the nascent BRICS Bank.

- Initial capitalization of \$50 to \$100 million, targeting investment in 10 to 15 projects.
- Targeting businesses where management can include a mix of African, American, and Chinese members, and where linkages to US and Chinese agricultural businesses are important. (For example, a US or Chinese equipment supplier may be important or a US or Chinese company may be a customer for an export product from Africa.)
- Support by in-house or contracted commercial agribusiness advisors with extensive practical experience in adapting agricultural technologies in emerging markets and in Africa's agriculture-related regulatory, policy, and stakeholder engagement.

The Emerging Africa Agriculture Fund might target high potential projects without a particular focus. Alternatively, the fund may develop a focus on a region or a particular industry segment. Africa is an enormous continent with a diverse and large agricultural opportunity set, and the convergence of those opportunities with the interests and expertise of a US-China combination may require a narrower focus and scope for the fund at the outset.

One example of a potential focus is “farm and agribusiness clusters” or “business parks,” which are a relatively new agricultural development concept in Sub-

Excluded Model: Mergers and Acquisitions (M&A)

In 2013, Chinese Shuanghui Group acquired Smithfield Foods, the largest pork producer in the United States. With this \$7 billion deal, Shuanghui increased its US pig production from zero to almost 16 million animals a year. Pork can be sold in the US domestic market or be sold in China, leveraging the knowledge and infrastructure of a company in China to get it done. Shuanghui, through the deal, gained a US management team with tremendous expertise and a company that had developed scale economies in pork production, slaughter, and delivery over the course of decades.

This is an example of an M&A model that some expect to become more common between large agribusiness companies in China and the United States. While this may well be true, this paper omits such a model.

Multi-billion dollar deals like that between Shuanghui and Smithfield tend to abide by a complex logic particular to each deal. It is difficult to point to transactions of this nature and magnitude as a complete solution to either China's need for agricultural innovation or US agriculture's need for capital. In addition, the US agricultural innovation engine is fueled by a complex network of people and organizations. And much of the truly ground-breaking innovation occurs at a grassroots level. Large agricultural businesses in both countries will continue to play an important role in agricultural innovation, but in all likelihood their role will be heavier in the adaptation and commercialization of innovation rather than early-stage development.

This is why some larger businesses also have their own venture funds, or make a habit of acquiring early-stage companies and their breakthrough innovations. Major and mature players naturally gravitate toward excellence in execution than focus on the messy business of developing the next disruptive technology.

Saharan African countries such as Ghana, Kenya, and the Democratic Republic of Congo. The concept of an agricultural business park is to cluster a mix of agricultural input, production, conversion, and processing activities together in a contiguous geographic space.

An analogy is an urban or suburban real estate development, but, in this case, geared toward accelerated development of entire agricultural value chains where small farmers, large farmers, and agribusinesses can co-locate and have the advantage of pre-developed infrastructure such as roads, rail, and power. Other relevant analogies are manufacturing clusters or industrial parks in the United States or special economic zones in China.

Agricultural clusters or business parks are often designed, at least initially, as public-private partnerships (PPPs) because they need to align with national priorities. The government tends to play a pivotal role in the designation of appropriate land for development, leads dialogue with local communities, commit to finance infrastructure and, where appropriate, creates investment incentives. There is a project or site manager that plays the role of general contractor and developer to design the site, build infrastructure, recruit early tenants for “crowding-in” farm investors, processors, input suppliers, and others.

The agricultural business park can evolve as a pod of modern agriculture

for a mix of foreign and local commercial farmers, agriculturalists, and agribusinesses. Investors in the park may achieve returns through ongoing profits from the development, as well as via trade opportunities.

There may also be opportunities to leverage private sector investment with public funds and projects. Infrastructure projects for roads, power, and irrigation may be aligned with fund activities. Projects funded by the World Bank or the recently formed BRICS Bank may be attractive PPP opportunities, for example. US government initiatives, such as Feed the Future Initiative, supported by GrowAfrica, and the New Alliance with GEF, aim to increase agricultural production and private sector participation in targeted countries, including eleven in Africa. This is another example of a PPP that can be leveraged by the fund.

At the US-Africa Leadership Summit in summer 2014, the US public and private sectors committed over \$37 billion to the African continent, in an effort viewed by some as an attempt to “catch up” to Chinese investments. The second 10 years of the Comprehensive Africa Agriculture Development Program and the renewed UN Millennium Development goals will also continue to ensure ongoing government support for sustainable agricultural intensification in various African countries.

Conclusion

The rise of the Chinese consumer has been one of the most important drivers of change in global agriculture in the last 25 years, and that process is only starting. Combined with the emergence of middle-class food consumption habits across emerging markets, this trend has yielded new demands on agricultural production systems that represent one of the most important economic and environmental challenges of the next 50 years.

Agricultural technology and innovation have been and will continue to be the principal means to meet these challenges. Producing more food with fewer resources, while mitigating natural resource degradation, will not occur without a virtuous cycle of creating and adopting new technologies, methods, and systems.

This paper has suggested four models, or opportunities, that have the potential to attract US-China investment and commercial collaboration. These models focus on early-stage agricultural business development activities, representing a new element of US-China engagement, especially by (but not necessarily limited to) the private sector. While M&A activity between US and Chinese agribusiness and food companies may continue to be an important part of strengthening agricultural ties, collaborative early-stage commercial activity promises to deliver more enduring impact. Connecting investors, business people, and entrepreneurs from both countries will build collective knowledge and imagination, resulting in greater indigenous agricultural innovation over time in both countries. If successful and sustainable, this kind of collaboration will be the world's gain.

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The Paulson Institute's Program on Cross-Border Investment

There are compelling incentives for the United States and China to increase direct investment in both directions. US FDI stock in China was roughly \$60 billion in 2010, yet a variety of obstacles and barriers to further American investment remain. Meanwhile, Chinese FDI stock in the United States has hovered at around just \$5 billion. For China, investing in the United States offers the opportunity to diversify risk from domestic markets while moving up the value-chain into higher-margin industries. And for the United States, leveraging Chinese capital could, in some sectors, help to create and sustain American jobs.

As a nonprofit institution, The Paulson Institute does not participate in any investments. But by taking a sector-by-sector look at opportunities and constraints, the Institute has begun to highlight commercially promising opportunities—and to convene relevant players from industry, the capital markets, government, and academia around economically rational and politically realistic investment ideas.

The Institute's goal is to focus on specific and promising sectors rather than treating the question of investment abstractly. We currently have two such sectoral efforts—on agribusiness and manufacturing.

The Institute's aim is to help develop sensible investment models that reflect economic and political realities in both countries.

The Paulson Institute currently has four investment-related programs:

US-China Agribusiness Program

The Institute's agribusiness programs aim to support America's dynamic agriculture sector, which needs new sources of investment to spur innovation and create jobs. These programs include:

- A US-China Agricultural Investment Experts Group comprised of some of the leading names in American agribusiness. The group brainstorms ideas and helps in the Institute's effort to develop innovative investment models that reflect economic and technological changes in global agriculture.
- Periodic agribusiness-related investment workshops, bringing key players and companies together. The Institute held the first workshop in Beijing in December 2012, whose attendees included numerous CEOs and experts. It has since held

smaller, sessions in the United States focused on specific technologies or aspects of agribusiness.

- Commissioned studies that propose specific investment models, including for commodities, such as pork, or value chain opportunities, such as collaborative research and development (R&D).

US-China Manufacturing Program

In June 2013, the Institute launched a program on trends that will determine the future of global manufacturing and manufacturing-related capital flows. We aim to identify mutually beneficial manufacturing partnerships that would help support job growth in the United States. The Institute's principal manufacturing programs include:

- Investment papers that the Institute is co-developing with private sector and academic partners.
- Periodic workshops in Beijing and Chicago with Chinese, American and global CEOs and executives, focused on technological change, sectoral trends, and investment opportunities.

Case Study Program

The Institute publishes in-depth historical case studies of past Chinese direct investments in the United States, examining investment structures and economic, political, and business rationales. These detailed studies are based on public sources but also first-hand interviews with deal participants on all sides. They aim to reconstruct motivations and actions, and then to draw lessons learned.

State-Level Competitiveness Program

The Institute works closely with several US governors to help them hone their teams' approach to attracting job-creating foreign direct investment. Our core competitiveness program is a partnership with states in the Great Lakes region, but we work with other governors as around the United States as well.

- Paulson Institute-Great Lakes Governors Partnership: Working closely with the Council of Great Lakes Governors, the Institute is honing pilot strategies to help match the "right" investors and recipients to the "right" sectoral opportunities. Work is also focusing on how to connect Great Lakes/St. Lawrence-based R&D and innovation to foreign deployment opportunities while opening markets in China. The Council includes the governors of Illinois, Indiana, Michigan, Minnesota, New York,

Ohio, Pennsylvania, and Wisconsin, as well as the Canadian premiers of Ontario and Quebec.

- **American Competitiveness Dialogues:** The Institute convenes an ongoing series of competitiveness forums around the United States. These aim to address the implications of the changing global economy for US competitiveness, opportunities and challenges associated with foreign direct investment.
- **R&D+Deployment (“R&D+D”):** Working with partners, including McKinsey & Company and a small number of universities, the Institute is exploring new models that would link Chinese investors to the US innovation engine, especially in areas linked to demand-side needs in the China market. The aim is to design fresh models that capture value in both countries but do not sacrifice America’s innovation edge or intellectual property protection. Our dialogue in this area aims, ultimately, to lead to a pilot initiative.

About The Paulson Institute

The Paulson Institute, an independent center located at the University of Chicago, is a non-partisan institution that promotes sustainable economic growth and a cleaner environment around the world. Established in 2011 by Henry M. Paulson, Jr., former US Secretary of the Treasury and chairman and chief executive of Goldman Sachs, the Institute is committed to the principle that today's most pressing economic and environmental challenges can be solved only if leading countries work in complementary ways.

For this reason, the Institute's initial focus is the United States and China—the world's largest economies, energy consumers, and carbon emitters. Major economic and environmental challenges can be dealt with more efficiently and effectively if the United States and China work in tandem.

Our Objectives

Specifically, The Paulson Institute fosters international engagement to achieve three objectives:

- To increase economic activity—including Chinese investment in the United States—that leads to the creation of jobs.
- To support urban growth, including the promotion of better environmental policies.
- To encourage responsible executive leadership and best business practices on issues of international concern.

Our Programs

The Institute's programs foster engagement among government policymakers, corporate executives, and leading international experts on economics, business, energy, and the environment. We are both a think and "do" tank that facilitates the sharing of real-world experiences and the implementation of practical solutions.

Institute programs and initiatives are focused in five areas: sustainable urbanization, cross-border investment, climate change and air quality, conservation, and economic policy research and outreach. The Institute also provides fellowships for students at the University of Chicago and works with the university to provide a platform for distinguished thinkers from around the world to convey their ideas.

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