Shandong study tour 24-30 April 2023

Exploring the impacts of digitalization on Chinese agriculture

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DCZ Report

Disclaimer

About the author

Michaela Boehme is an expert in agri-food studies with an area focus on China. Her work covers China's agricultural transformation and its implications for the global agri-food system, including issues related to food security, agricultural trade, and overseas investment. Long-term field research has taken her to China on multiple occasions. Michaela holds a PhD in Global Studies from the University of Leipzig and has worked as an agricultural consultant and China analyst. Since April 2022, she has been with the Sino-German Agricultural Centre (DCZ).

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Study tour itinerary

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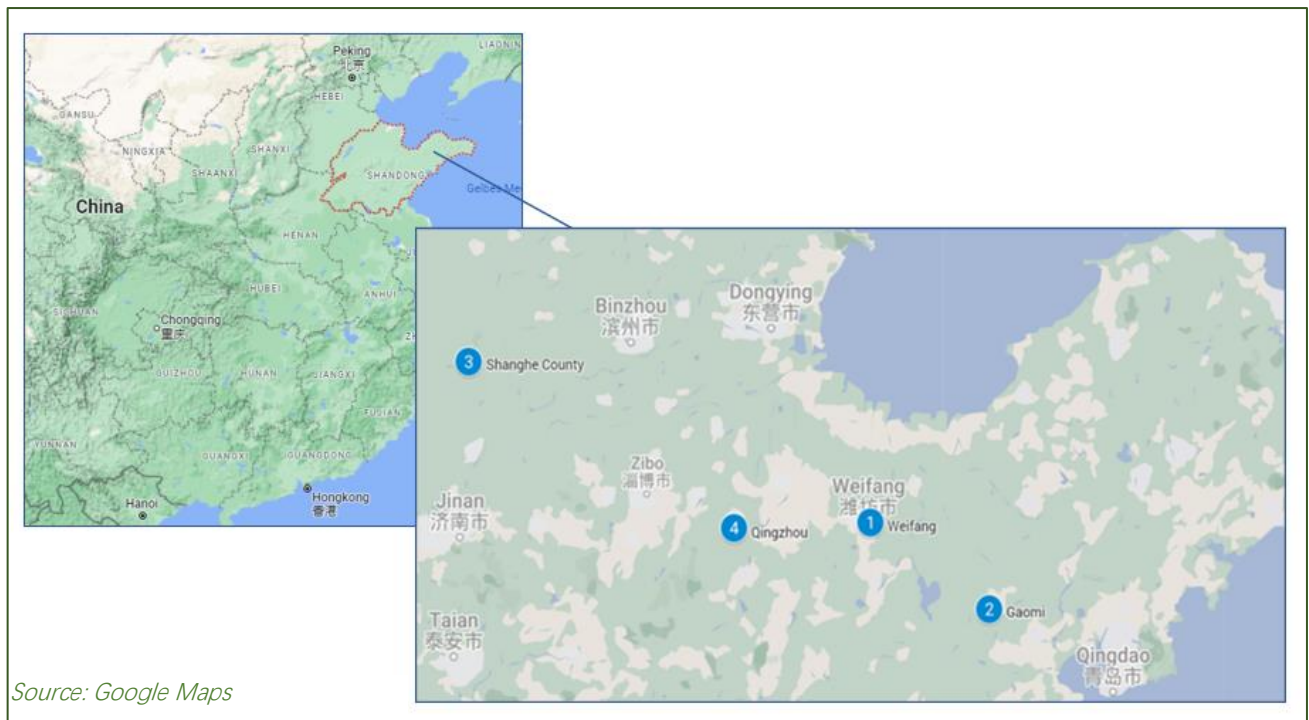
From 24-30 April 2023, the DCZ team went on a study tour through Shandong province to explore how digitalization is transforming agriculture and rural areas in China. Located in the lower reaches of the Yellow River, Shandong is a major agricultural province, accounting for 8% of China's grain and 12% of its vegetable output. The tour included [1] a visit to the World Expo on Digital Agriculture (WEDA) in Weifang city, where DCZ managing director Jürgen Ritter and Michaela Boehme contributed as speakers to the Sino-German Entrepreneurs' Forum on Smart Agriculture; [2] a day at the workshops and training centers of German agricultural machinery manufacturer CLAAS in Gaomi city; [3] a two-day field event in Shanghe county in the north of Jinan city; [4] and a visit of village collective Nanzhanglou near Qingzhou city. The first three stages of the study tour were organized by DCZ partner FECC (Foreign Economic Cooperation Center) of the Chinese Ministry of Agriculture and Rural Affairs (MARA), while the visit to Qingzhou was coordinated by the Shandong office of Hanns Seidel Foundation.

The trip provided unique opportunities to talk to Chinese policymakers, local and foreign companies, as well as practitioners on the ground and gain first-hand insights into the ways in which national policies shape the development of digital agriculture at the local level. Based on our observations from the trip, this report explores China's drive towards digital agriculture from the national, county, and village level. It aims to compare national policy goals and practical implementation on the ground and assess the ways in which digitalization is transforming China's agricultural sector and rural areas.

Weifang city: World Expo on Digital Agriculture showcases national policy goals
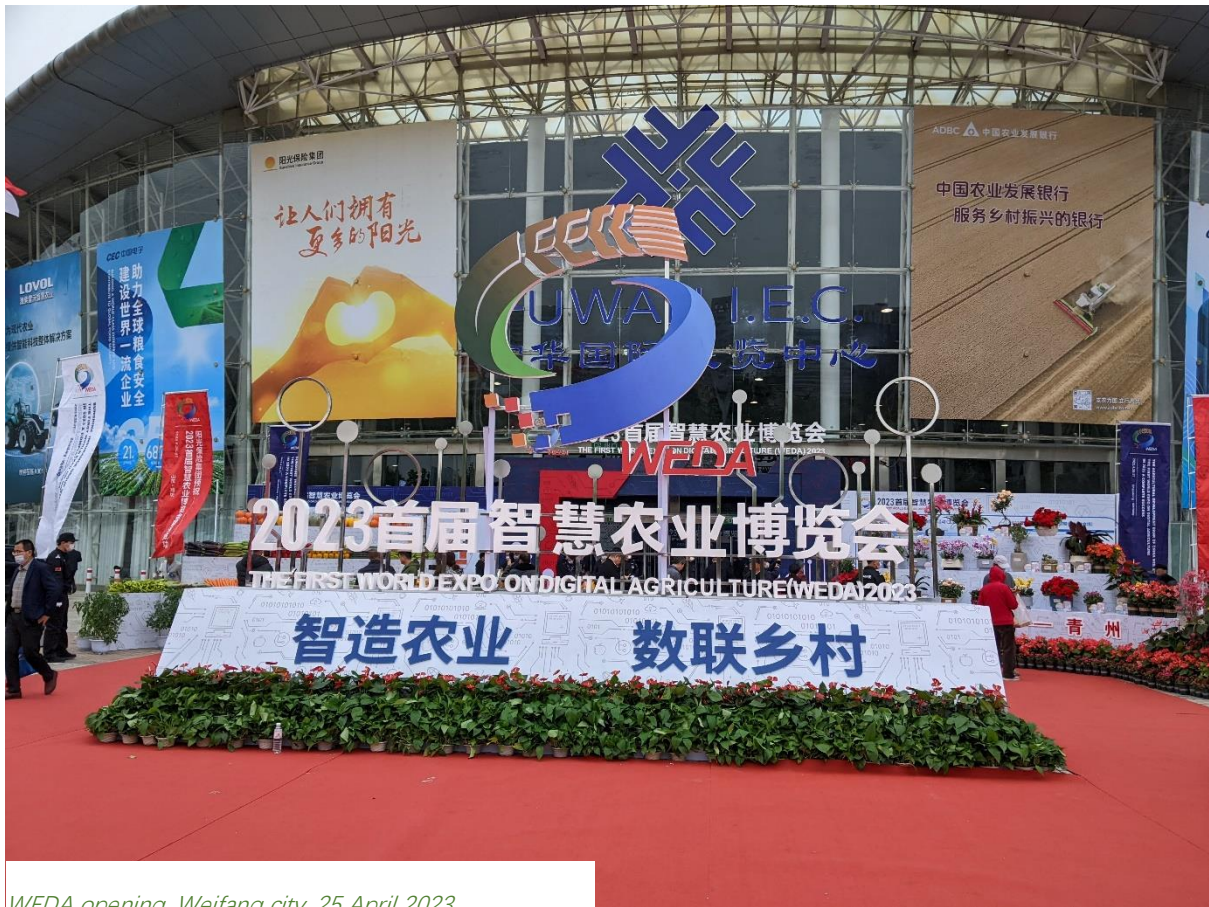
WEDA opening, Weifang city, 25 April 2023

Sponsored by the Foreign Economic Cooperation Center of MARA, the World Expo on Digital Agriculture (WEDA) from 25-27 April in Weifang city was the first exhibition in China exclusively dedicated to digital agriculture. Since 2020, Chinese authorities have issued several planning documents focused on agricultural digitalization, including the Digital Agriculture and Rural Development Plan (2019–2025) and a Digital Village Development Guideline. WEDA further underscored the importance Chinese policymakers attach to digitalization as a tool of agricultural and rural transformation.

Expectations in the potential of digital technologies are high and cover a wide range of areas, as was illustrated by WANG Xiaobing, Director General at the Information Center of MARA, who gave the opening speech at the Sino-German Smart Agriculture Forum taking place at WEDA. For Chinese policymakers, digitalization constitutes another step towards modernizing China's agricultural sector and achieving its goal of becoming a strong agricultural country (*nongye qiangguo* 农业强国).[1] If rolled out successfully, digital technologies will not only strengthen

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[1] The term nongye qiangguo (农业强国), varyingly translated as "strong agricultural country" or "agricultural power", has become a much cited buzzword in policy circles since the term was stressed by President Xi Jinping at the 20th Party Congress in October 2022, see DCZ analysis.

agricultural production but also attract more people to farming and make rural communities more attractive, Wang's speech made clear. Bigger yields, reduced input costs, higher farming incomes, and a narrowing of the urban-rural gap were mentioned by Wang as key goals.

The practical solutions towards achieving these goals could be explored at the exhibition center, where Chinese and international companies from Europe, the Americas, the Middle East, Central and Southeast Asia showcased a wide range of smart farming innovations. **Labor-saving** technologies featured prominently. For example, Beidahuang, one of China's largest state farms with an area of 800,000 ha under production in China's north-eastern Heilongjiang province, presented an unmanned farm system that uses multiple types of robots and autonomous agricultural machinery to manage the entire grain production process – from planting to harvesting and storage. According to a company representative, the system was introduced in 2020 and now covers two thirds of the company's total cropping area. The system, which has received political support from China's top leadership, uses 20,000 pieces of autonomous machinery, thereby drastically reducing Beidahuang's demand for rural labor. At the company's automated farms, one operator now replaces 30 workers.

Efforts at automation are a response to the widespread concern in China about "who will farm the land" as rural areas are faced with aging and shrinking populations. The drive towards establishing unmanned farm systems has likely received further impetus from the acute labor shortages rural areas experienced during the COVID-19 pandemic, when strict regulations left millions of migrant workers stranded in the cities and unable to return to their villages for spring planting and harvesting.

Improving **resource efficiency** was another issue tackled by some of the smart solutions presented at WEDA. Smart agricultural equipment manufacturers, including German companies Lemken and CLAAS, showcased solutions focused on reducing harvest losses, while others presented mobile apps, allowing farmers to remotely control plant nutrient and fertilizer levels. Efforts to use limited resources more efficiently have not only been driven by the growing costs of farm inputs, including fertilizer, energy, and labor, but also by concerns about the large environmental footprint of farming. Since 2015, a new policy has sought to keep fertilizer and pesticide growth at zero, while an action plan in December last year promises to increase the use of organic fertilizer and cut pesticides by 10% by 2025. This is driving demand for smart technologies that can help farmers use fertilizers, pesticides, and other inputs more efficiently.

Beyond agricultural production, digital technologies are also hoped to empower China's **rural revitalization** drive. A digital village platform developed by China Telekom feeds information on environmental pollution, weather forecasts, social services such as waste collection, street surveillance, and farming-related data on crop and livestock production into a central data management platform. Through a WeChat mini app, rural residents and farmers can obtain information, lodge complaints, and provide feedback to local authorities. The idea behind the platform

is to improve rural governance and energize rural development, a company representative told us. Currently, the system is being trialed in several counties in Jiangsu province, but collecting and synchronizing data across a wide range of different data sources still remains a challenge, we learned from the representative.

At the Sino-German Smart Agriculture Forum at WEDA

China Telekom representative explains digital village system

Gaomi city: spotlight on farmland size and data exchange

CLAAS factory, Gaomi city, 26 April 2023

Our insights into the latest smart agriculture innovations at WEDA were complemented by a visit of the workshops and training facilities of German agricultural machinery manufacturer CLAAS on 26 April in Gaomi city, together with a delegation of EU agricultural counsellors and Chinese cropping companies from Heilongjiang, Inner Mongolia, and Jilin. At its factory in Gaomi, CLAAS produces various types of harvesting machines, mainly for maize and wheat crops, and trains its service and after-sales workforce based on Germany's dual system of vocational training and education. Next to its CLAAS-branded machines, the company produces a smaller and cheaper model under the Chinese brand name Chunyu, resulting from a previous joint venture with local partner Jinyee.

"Today, data is the main source of innovation in mechanical engineering", CLAAS managing director ZHANG Jinwang told the delegation at a company presentation and discussion session. Several hundred sensors installed in the company's combine harvesters monitor the speed of all working components, measure the yield and quality of the harvested grain, and calibrate the ground speed to optimize harvesting quality and reduce fuel consumption, we learned during our visit. The data management system also allows several machines that are harvesting together to coordinate their settings and to feed the data recorded on the field into other digital systems used by the farmer.

WATCH VIDEO

But data is not just a driver of innovation but also a challenge. In 2020, Chinese top officials declared data a "factor of production" alongside land, labor, and capital, highlighting data's significance as an important resource for economic growth and national security.[2] As such, the circulation, storage, and processing of data is subject to strict regulations that can make it tricky for foreign companies to participate in China's booming data economy. To be compliant, software must be reconfigured to work with China's own navigation system Beidou, and data collected during the harvesting process must be stored domestically. This can make cross-border exchange and connectivity with other data systems more challenging, marketing manager Juergen Simon explained to us at the event.

Another issue coming into play when talking about smart agricultural machinery is land size. Advanced agricultural machinery of this type is most suited to flat or low-pitched fields of large size, meaning that machinery manufacturers such as CLAAS favor cooperating with the large-scale farms located in China's northeast. CLAAS has a significantly smaller presence in China's mountainous regions in the south and west, where efforts to consolidate scattered farmland plots into large, contiguous areas is defied by topography.

Tour around the factory premises of CLAAS, Gaomi city

CLAAS vocational school, Gaomi city

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[2] Interesse, Giulia (2023). *China has a new plan to strengthen its data economy*. In: China Briefing. https://www.china-briefing.com/news/china-has-a-new-plan-to-strengthen-its-data-economy/, last accessed on 10 May 2023.

Shanghe county: local lighthouse project for digital agriculture

Grain demonstration zone, Shanghe county, 27-28 April 2023

The need for large-scale areas of land has been taken up by government initiatives aimed at constructing "high-standard farmland". A National Overall Plan for the Construction of High-standard Farmland (2021-2030) proposes to build 800 million hectares of this type of land by 2030. During our two-day visit to Shanghe county north of Jinan, we could observe the local outcomes of the policy. Shanghe is located in the alluvial plains of the Yellow River and a leading agricultural county in Shandong province, accounting for one third of grain output in the greater Jinan city area. On an area of over 13,000 hectares, the county has invested into the construction of a high-efficiency grain demonstration zone and the conversion of its arable land into high-standard farmland. During a tour with local government officials and business representatives, we learn that the demonstration zone covers the area of five townships within the county and required an investment of over 440 million RMB (approx. 6 million EUR). According to WANG Peng, deputy head of Shanghe county, the construction of high- standard farmland does not only involve land consolidation to allow for more efficient use of modern ag machinery, but also other aspects such as roads, electricity, and irrigation infrastructure, as well as soil quality and modern farm management principles.
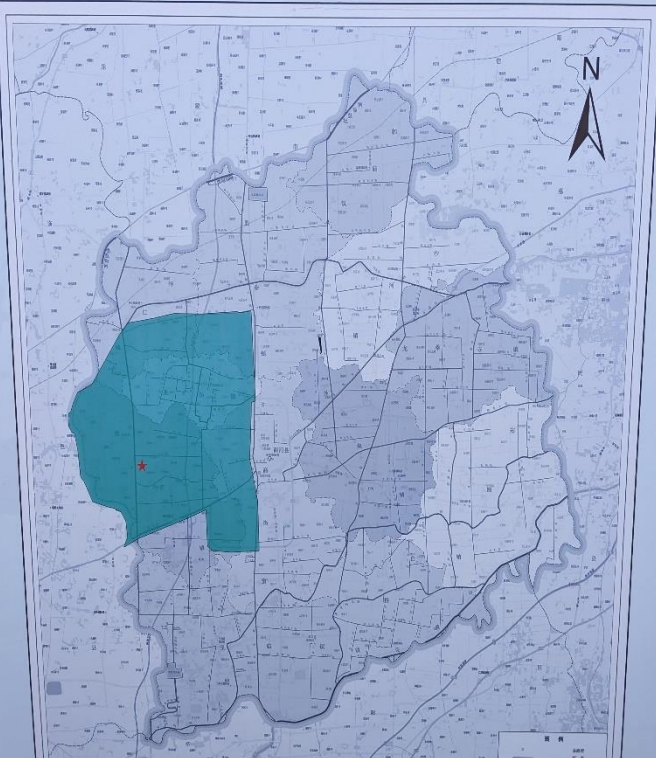
High-standard farmland area in Shanghe county

The grain demonstration zone is equipped with a smart irrigation system. The system is powered by energy from its solar panels and allows the farm managers to control irrigation and fertilization levels from their mobile devices. While a smart weather station collects meteorological data, sensors in the ground provide information on soil moisture and nutrient content. One of the farm managers shows us how on his mobile device climate parameters such as temperature and wind are displayed alongside data on soil humidity as well as nitrogen, phosphorus, and potassium contents, allowing the manager to decide when to irrigate the fields and how much fertilizer to use. In addition to the smart irrigation system, modern harvesters from CLAAS and its Chunyu brand help reduce losses during harvesting, the farm manager explains. We are also shown drone pesticide sprayers that are routinely used on the farm although it does not become clear from the demonstration if or what data points the drones collect to be able to apply pesticides in a targeted manner. Overall, we are told that the demonstration zone boasts an annual increase in grain output of 49,000 tons and saves 7.7 million cubic meters of water annually.

Digitalization progressing in lockstep with farmland consolidation does not only have impacts on agricultural productivity but also on farm structures, it becomes clear from our visit. The need for large-scale plots of land and high amounts of investment has spurred a trend towards larger farming cooperatives or other types of new agricultural business entities (*xinxing yingye zhuti* 新型营业主体). Individual farming households that have traditionally farmed very small plots of land either join these business entities as laborers or lease out their land use rights while taking up new occupations in Jinan or other surrounding cities. This process is accelerating a shift from smallholder to corporate farming. In addition, the growing use of smart agricultural machinery has seen the emergence of another type of business entity – so-called professional service organizations, which provide tilling, sowing, pest control, and harvesting services for a fee. Rather than owning the machinery themselves, farmers contract the services of these providers at critical times during the year. According to a local CLAAS representative, professional service teams are an important customer segment for the company and can cover thousands of hectares of farmland as they travel across the country to provide their services to farmers.

Smart irrigation system installed at high-efficiency grain demonstration zone in Shanghe county

Farm manager demonstrates how to control irrigation and fertilization levels

Operators demonstrate the use of drones for spraying pesticides

Nanzhanglou village: rural revitalization without digitalization

Nanzhanglou village near Qingzhou city, 29 April 2023

WATCH VIDEO

On 29 April, we finished our tour with a stopover at Nanzhanglou village, following an invitation from the Shandong office of Bavaria's Hanns Seidel Foundation (HSF), which has been active in the village since the early 1980s. As one of China's pioneers, in 1988, Nanzhanglou village commenced implementation of a land consolidation program based on German village renewal strategies. The program has helped Nanzhanglou to develop its agricultural sector. Combined with efforts to establish a vocational school and promote local industry, the village now boasts a high-yield agricultural area of 420 hectares and an integrated agricultural value chain, including several greenhouses with high value-added crops such as strawberries and dragon fruit, a seedling nursery, an agricultural plastics recycling company, as well as several food processing and manufacturing enterprises. These impressive changes have come with only modest levels of digitalization and no inflow of external funding, forming a stark contrast to the wheat demonstration zone we visited in Shanghe county. But Nanzhanglou's long-term mayor YUAN Xiangsheng is convinced of the benefits of the village's revitalization model. While the new land management principles introduced in the 1980s have made the village's agricultural economy much more productive, all 1,300 local households still hold on to their own land and there are no debts owed to outside investors, he informs us at a meeting in the town hall. Annual per capita income in the village is now well above

23,000 RMB (> 3,000 EUR), and, most importantly, Nanzhanglou is amongst the few villages whose number of inhabitants is showing an upwards trend.

Michael Klaus, chief representative of HSF Shandong, also sees Nanzhanglou village as a model for strengthening the capacities of rural communities and the agricultural sector. The land restructuring strategies employed by the village seek to bring social benefits to the entire community instead of solely adapting farmland to the needs of modern and smart agricultural machinery, he emphasizes. At the same time, digital technologies are indispensable for strengthening rural-urban linkages. For example, HSF is now exploring the use of digital marketing tools to broaden farmers' sales channels and increase rural incomes.

Local cooperative growing high-value crops in greenhouse in Nanzhanglou

Tree borders around consolidated farmland plots to promote biodiversity

China's digital transformation: areas for cooperation

China has ambitious policy goals for the expansion of digital agriculture. Digitalization is seen as an important tool to tackle the most pressing challenges affecting the country's agricultural and rural development: declining rural populations, growing production costs, as well as food security. Demonstration zones like the one we visited in Shanghe county function as lighthouse projects to drive the digital transformation of China's agricultural sector and act as a model for other localities to emulate. Yet, our visit to the village level in Nanzhanglou has also made clear that adoption rates are uneven, revealing large gaps between individual lighthouse projects and the wider countryside.

Three transformative aspects of digitalization have become evident on this trip, involving land, labor, and data. First, digitalization goes hand in hand with the construction of high-standard **farmland**. Scaling up scattered plots into larger areas is the basis for the effective use of smart agricultural machinery and digital tools. With an average farm size of less than one hectare[3], farmland upscaling is a gargantuan task that is receiving attention from the highest levels of government. Larger fields with better infrastructure promise higher agricultural productivity and higher efficiency. But there is also a risk of expanding monocultures, which are more vulnerable to climate change and exacerbate the loss of biodiversity. Learning from Germany's past mistakes, China and Germany should strengthen cooperation on digital solutions that help secure agricultural yields while simultaneously safeguarding biodiversity.

Second, digitalization is transforming rural **labor** by accelerating the shift from smallholder to corporate farming. The need for larger farmland areas and high levels of investment that come with the use of digital tools have spurred the emergence of larger farming entities such as cooperatives or farming corporations. The Chinese government promotes this shift as response to an aging and shrinking rural population – an issue encapsulated in the often-asked question of "who will farm the land" (*shei lai zhong di* 谁来种地). While population decline in rural communities is closely connected to a country's level of industrialization and urbanization, it should be recognized that the hollowing out of Chinese villages is also an outcome of uneven development policies that prioritize urban over rural development. Declining rural communities are no law of nature as the example of Nanzhanglou village demonstrates. Both Germany and China would benefit from developing ideas on how digitalization can respond to demographic trends while also ensuring that the countryside remains an attractive place to work and live. At the same time, it will be crucial for both countries to think about how to train a new type of agricultural labor force that will be required as digital tools become more widespread. Germany's dual education system might be a useful starting point.

Finally, agriculture's digital transformation has seen the role of **data** take center stage as a source of value creation. An emerging regulatory framework suggests

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[3]] OECD (2022). *Agricultural Policy Monitoring and Evaluation 2022: Reforming Agricultural Policies for Climate Change Mitigation*. OECD Publishing, Paris. https://doi.org/10.1787/7f4542bf-en.

that the Chinese state seeks to retain sovereignty over the use and control of such data, making cross-border data exchange more challenging, especially for foreign companies that develop parts of their technology outside of China. Clarifying rules and harmonizing standards wherever possible will be necessary for foreign and German smart ag companies to successfully operate in China.

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Sino-German Agricultural Centre (DCZ)