Agricultural Innovation in China: From Policy Ambition to Commercial Reality

and What It Means for Dutch Agri-food

Introduction

China is putting substantial policy, research and industrial resources behind the digitalisation and intelligent transformation of agriculture. Government plans increasingly refer to smart agriculture, intelligent breeding, agricultural AI and the ambition to build an "agricultural power" by 2035. Demonstration projects showcase agricultural drones, autonomous machinery, intelligent greenhouses, large agricultural models and robots for tasks ranging from pollination to harvesting.

For Dutch companies, researchers and policymakers with long-standing interests in China's horticulture, breeding and agricultural sectors, the important question is therefore not whether agricultural innovation is happening. It clearly is. The more useful question is how mature the technologies are, where they are actually being deployed, and what this means for future markets and cooperation.

A useful way to assess China's agricultural innovation landscape is to distinguish between six stages: research, prototype, pilot, early commercial, commercial and large-scale adoption. These stages are often blurred in media coverage. A robot demonstrated at a showcase farm may be technically impressive without being commercially viable. Conversely, a relatively simple technology can become transformative when a workable business model, service network and user base develop around it.

Viewed through this lens, China's agricultural innovation system shows a mixed but increasingly coherent picture. Policy and research capacity have strengthened substantially, while mechanisms for testing and scaling technologies are becoming more developed. Agricultural drones have clearly reached mass adoption, and satellite-guided machinery is moving into large-scale use. Digital agriculture platforms are also operating across large production areas. By contrast, many harvesting, pollination and fully autonomous-farm concepts remain in pilot or early-commercial stages. Agricultural large language models and AI decision systems are developing quickly, but evidence of broad farmer adoption and commercial returns remains limited.

For Dutch stakeholders, this distinction matters. It helps separate areas where Chinese technologies are already commercially relevant from those where the main development is still taking place in research institutes and demonstration projects. It also shows where cooperation remains attractive: not only in high-end hardware, but in genetics, crop management, controlled-environment agriculture, digital systems, water efficiency, AI, robotics and the adaptation of technologies to local production conditions.

1. Policy Developments and Trends in Agricultural Innovation in China

China's agricultural technology policy has evolved through several overlapping stages: agricultural modernization and mechanization, digitalization, smart agriculture, and increasingly the application of AI, robotics and intelligent breeding.

The idea of "smart agriculture" is not new. The term appeared in China's central agricultural policy documents during the 2010s and was subsequently linked to precision farming, information technology and the Internet of Things [1]. However, the inclusion of precision farming in China’s policy agenda should not be taken as evidence that China has closed the technological gap with leading international suppliers. In particular, Dutch companies retain strong expertise in high-end precision farming, integrated crop management and the integration of sensing, control and cultivation technologies. China more recent progress is therefore better understood as a rapid expansion of the application and deployment of precision technologies, rather than as unfiform technological leadership across the sector. What has changed is the degree of specificity. More recent policies increasingly identify particular technologies—

AI, drones, robots, sensors, intelligent machinery and agricultural foundation models—and connect them to implementation targets and application programs.

The foundation was laid partly through policies on agricultural mechanization and the seed sector. The 2021 No. 1 Central Document placed strong emphasis on strengthening China's seed industry, reflecting the strategic importance attached to seed security [2]. During the 14th Five-Year Plan period, agricultural mechanization and rural digital infrastructure were further expanded [3] [4]. These policies were not themselves an AI strategy, but they created important conditions for the current phase of intelligent agriculture.

The policy agenda became more explicit from 2024 onwards. In October 2024, the Ministry of Agriculture and Rural Affairs issued guidance and a four-year Smart Agriculture Action Plan for 2024–2028 [4]. The plan identifies technologies including sensors, intelligent equipment, agricultural robots and agricultural large models and sets targets for improving agricultural informatization [5]. This was followed in 2025 by a long-term plan for building an agricultural power by 2035 [6] and an implementation opinion aimed at strengthening China’s agricultural science-and-technology innovation system [7].

The State Council's August 2025 "AI+" policy further incorporated agriculture into the national AI agenda [8]. It called for applications of AI in areas including breeding, agricultural machinery and production management [8]. The policy direction was already visible in the 2025 No. 1 Central Document, which called for wider application of digital technologies, artificial intelligence and low-altitude technologies in agriculture [9]. The State Council's August 2025 “AI+” policy subsequently incorporated agriculture more explicitly into the national AI agenda [8].

The direction became even clearer in the 2026 No. 1 Central Document, which called for integrating artificial intelligence with agricultural development and expanding application scenarios for drones, the Internet of Things and robots [10]. Chinese state-media coverage highlighted this as an important symbolic step: drones and robots were presented as a new category of agricultural tools [11]. More importantly, the policy language was increasingly about application scenarios, rather than technology development alone.

The scale of agricultural drone use illustrates the point. At a January 2026 State Council Information Office press conference, China's Ministry of Agriculture and Rural Affairs reported that agricultural drones had exceeded 300,000 units in 2025, with annual operating area above 306.7 billion m² (460 million mu) [12]. The same briefing said that agricultural large models were being iterated and applied, while the ministry was expanding agricultural technology test bases and pilot-validation platforms [12].

Another important policy development is the stronger emphasis on the stage between laboratory research and commercial deployment. In 2025, MARA and the Ministry of Industry and Information Technology issued a joint policy on accelerating pilot validation and maturation/application of innovative agricultural machinery [13]. The policy sets a 2027 objective of establishing pilot-validation platforms and maturation/application centers, and a 2030 objective of substantially improving the industrialization of agricultural machinery innovations [13].

This is significant because one of China's longstanding challenges has been the transition from research achievement to practical deployment, commercially sustainable deployment. A technology can be technically successful in a university trial or government-supported demonstration, but still require several iterations before it can survive field conditions, meet farmers' cost expectations and be integrated into existing machinery and service systems.

The transition from demonstration to commercialization is also an area where Dutch companies continue to have an important advantage. The Netherlands ha s long track record of integrating agricultural technology into commercially viable production systems, supported by strong crop knowledge, specialized suppliers, service networks and close links between research and commercial horticulture. China's innovation system is becoming increasingly capable of testing and validating technologies at scale, but the ability to turn successful demonstrations into profitable, repeatable and widely adopted business models remains uneven.

For Dutch stakeholders, this distinction is critical: China's large number of pilot projects and demonstrations should not automatically be interpreted as evidence of market maturity. The key question is increasingly not whether a technology works under demonstration conditions, but whether it can deliver reliable performance, an attractive return on investment and sustainable adoption under commercial farming conditions.

The same application-oriented direction can be seen in China's wider smart-agriculture programs. During the 14th Five-Year Plan period, China expanded the development and demonstration of smart-agriculture technologies and intelligent agricultural equipment, while establishing national smart-agriculture innovation and application projects across different regions and production sectors [14]. This implies a substantial policy and demonstration effort, although they should not be interpreted as proof that all technologies have reached commercial maturity.

The regional picture is similarly important. Zhejiang has been selected to develop a national-level smart-agriculture leading zone, drawing on more than two decades of experience with digitalization. Under a province–ministry coordination mechanism, it is tasked with exploring approaches to smart-agriculture development that can provide lessons for other parts of China. The province has also set targets for developing digital agricultural factories and "future farms" [14]. Other provinces and municipalities are also translating the national agenda into dedicated local programs. Beijing, Jiangsu, Sichuan and many other provinces have adopted a dedicated implementation plan for smart agriculture [15][16][17]. These initiatives illustrate how national priorities are being translated into regional experimentation, demonstration and investment.

At the same time, official Chinese sources increasingly acknowledge the limits of current adoption. A July 2026 expert roundtable reported by the official agricultural portal noted that smart-agriculture applications remain concentrated among large enterprises and demonstration projects, while participation by small and medium-sized farmers remains limited and costs and business models remain challenges [18]. This is particularly important for interpreting China's policy targets: policy ambition is high, but implementation is uneven.

The emerging policy model can therefore be summarized less as a linear sequence than as a state-led, iterative chain with feedback loops:

policy priority → research funding → technology development and pilot testing → demonstration and validation → standards and data governance → business-model experimentation → service-based extension → commercial application and scaling.

In practice, these stages overlap and loop back: demonstration often reveals new research need, and scaling depends on standards, infrastructure, finance, and service organizations as much as on the technology itself.

China has built institutions and programs across this chain [10], but support has been relatively stronger in the earlier stage (research funding, piloting, and demonstration) and weaker in the later stage (commercialization, sustainable business models, and inclusive adoption). Whether these mechanisms can move beyond subsidized demonstrations to scalable, profitable, and inclusive service models—and systematically convert research into economically sustainable technologies and business models—will be one of the most important questions for the next phase of agricultural innovation, alongside data governance, standards, and small holder adoption.

2. Advanced Agri-tech Innovations in China

China's agricultural innovation landscape is increasingly characterized not only by a large number of pilot projects, but also by the emergence of technically sophisticated systems that combine artificial intelligence, sensors, robotics, remote sensing, automation and agricultural data. Some of these developments are comparable with advanced international technologies, while others are notable for their scale or degree of integration.

Four areas are particularly relevant for understanding China's technological capabilities: intelligent greenhouse control, plant factories, large-scale digital farm management, and agricultural foundation models. They illustrate different forms of technological advancement—and, importantly, different levels of commercial maturity.

Intelligent greenhouse control: increasingly capable domestic alternatives

China's greenhouse sector has traditionally relied heavily on imported technologies for environmental control and climate management, particularly in high-end horticulture. However, domestic engineering capabilities have developed rapidly, and Chinese research institutes and technology companies are increasingly developing their own greenhouse control systems.

A particularly illustrative recent case is Beijing's 294-day "horse-racing" validation program for domestically developed greenhouse control technologies. The program, conducted from September 2025 to July 2026, compared three Chinese-developed environmental control systems with a Priva system used as the imported reference. The four greenhouses used the same tomato variety, growing substrate, cultivation procedures, data-collection standards and evaluation criteria, allowing the systems to be tested under comparable production conditions [19].

The significance of this experiment is not that it proves Chinese systems have overtaken Dutch greenhouse technology. A single trial at one location and over one production cycle cannot support such a conclusion. Its importance is instead that Chinese technology developers are increasingly capable of benchmarking domestic systems against established international suppliers under real production conditions.

This represents a change in the competitive environment. China's greenhouse industry is moving beyond simply adopting imported equipment towards developing locally integrated control systems adapted to Chinese production conditions. For Dutch suppliers, this means that technological differentiation increasingly needs to come from system performance, crop knowledge, reliability and integration rather than from hardware alone.

Plant factories: technically advanced, but economics remain challenging

Plant factories provide a particularly interesting example of China's ability to combine advanced technologies at industrial scale. These facilities integrate LED lighting, environmental control, nutrient

management, sensors, automation and increasingly artificial intelligence and robotics. They represent one of the most technologically intensive forms of controlled-environment agriculture.

China entered the plant-factory sector later than Japan, Europe and the United States, but has expanded rapidly. A recent review by researchers from the Chinese Academy of Agricultural Sciences estimates that, by the end of 2023, China had more than 250 operational artificial-light plant factories of a certain scale, distributed across more than 20 provinces and regions [20]. The same review describes China as one of the world's largest plant-factory production countries and highlights rapid progress in vertical cultivation, LED lighting, intelligent environmental control, automation and unmanned production.

The technological sophistication is significant. Modern Chinese plant factories increasingly use sensor networks, intelligent LED lighting, automated environmental control and AI-based decision-making. The review notes that robots are already being developed for tasks such as seeding, transplanting, conveying and harvesting, while data fusion and AI algorithms are being incorporated into environmental and production management [20].

Yet plant factories also demonstrate why technological sophistication should not automatically be equated with commercial success. The same research identifies high construction and operating costs, particularly energy consumption, as major constraints on commercialization. Artificial lighting and climate control require substantial energy input, while technical standards and market acceptance remain further challenges [20].

The Chinese experience therefore illustrates an important distinction for assessing agricultural innovation: China has demonstrated the ability to deploy highly sophisticated controlled-environment production systems, but the economic sustainability of those systems remains dependent on energy efficiency, crop selection, capital costs, labor requirements and market prices.

Digital farm-management systems: China's advantage in scale and integration

One of China's more commercially relevant areas is the integration of digital technologies into large-scale agricultural production. This is particularly visible in large agricultural enterprises such as Beidahuang, where the combination of extensive farmland, centralized management, machinery fleets and digital infrastructure creates favorable conditions for deploying data-intensive systems.

Beidahuang Information Company has developed several platforms, including Zhi Rang COOMAP, the Lizhu intelligent remote-sensing cloud platform and the Yuntu large-scale farming management platform. According to Beidahuang, these platforms form an integrated "air–space–ground–human" agricultural data system. As of April 2026, the company's platforms reportedly contained 99 algorithms and nearly 3,000 datasets. Crop-growth analysis algorithms can be updated across the agricultural area within approximately five days, while UAV data can be integrated to automatically generate plant-protection prescription maps and provide dozens of customized remote-sensing reports [21].

A related Beidahuang application extends digital management from enterprise-level production management towards individual farmers and agricultural service providers. The company's reporting describes the use of digital tools across multiple stages of crop production, illustrating how digital agriculture is being incorporated into an existing large-scale agricultural service system [22].

The importance of this development lies less in the individual algorithms than in their integration with real production systems. Remote sensing, UAVs, machinery, farm records and production-management

platforms can be connected within a single organizational structure. This gives China an important environment for testing and scaling digital agriculture, particularly in large-scale grain production.

This is also an area where China's scale can become a technological asset. Large production bases generate substantial quantities of operational data and provide an environment in which new digital tools can be tested repeatedly across different crops, fields and production cycles. The result is potentially more significant than isolated AI demonstrations: it is the gradual construction of a data–AI–machinery–production ecosystem.

At the same time, most of the quantitative performance figures available for these systems are reported by the company itself. They should therefore be treated as evidence of deployment and technological development rather than as independently verified measures of productivity or return on investment [21][22].

Agricultural foundation models: rapid development of domain-specific AI

Agricultural AI is perhaps the fastest-moving area of China's current agri-tech ecosystem. Since 2024, Chinese universities, national laboratories and AI research institutions have increasingly moved beyond generic large language models towards agriculture-specific foundation models trained on specialized agricultural knowledge and data.

One of the clearest examples is Feng Deng (丰登, SeedLLM), jointly developed by Shanghai Artificial Intelligence Laboratory, Yazhou Bay National Laboratory and China Agricultural University. Launched in April 2024, it was presented as China's first large language model specifically developed for the seed industry. The model integrates agricultural and breeding literature, technical books, seed-company reports and historical promotion data, and was designed to support applications including variety selection, agronomic trait description, cultivation recommendations and analysis of historical cultivation areas [23].

The project subsequently moved beyond a general seed-industry knowledge model. In 2025, the team launched Feng Deng–Rice, a large language model specifically designed for rice biological breeding. The system integrates a rice biological knowledge graph and a large rice research corpus and is intended to support information retrieval and knowledge-based breeding decisions [24].

Another example is Shennong (神农), an agri cultural AI model developed at China Agricultural University. The university reports that the system combines a large agricultural knowledge graph with tens of millions of agricultural production records and has been used as a foundation for specialized applications covering areas such as crop production, livestock, fisheries and agricultural water management [25]. Its current public-facing version describes functions including crop-management advice, pest and disease identification, yield prediction, soil analysis and weather-risk alerts. The platform reports more than 1.2 million farmers served across 31 provinces and more than 3.3 billion m² (5 million mu) of farmland supported; these figures are developer-reported rather than independently verified and should therefore be interpreted cautiously [26].

The development of these models is significant because it demonstrates a shift from simply applying generic AI to agriculture towards building domain-specific AI systems around agricultural knowledge, production data and biological information. China's large agricultural research system and extensive production base provide a substantial environment in which such models can be trained, tested and refined.

The development is also extending into highly specialized agricultural fields. In August 2026, the Chinese Academy of Agricultural Sciences released CottonMind 1.0 ("棉芯 1.0"), described by the institute as the world's first specialized knowledge large language model for cotton. The system combines AI-assisted literature search and knowledge-graph functions for researchers with image-based diagnosis, AI question-answering and agricultural advisory functions for cotton farmers. It also supports Chinese, English, Uyghur and Uzbek, reflecting an effort to adapt the technology to cotton-producing regions in western China and beyond [27].

These examples suggest that China is developing a relatively broad ecosystem of sector-specific agricultural foundation models, ranging from general agricultural advisory systems to specialized models for breeding and individual crops.

However, the existence of such models should not be interpreted as proof of widespread commercial adoption. Many remain in research, demonstration or early deployment stages, and independently verified evidence on productivity gains, farmer willingness to pay and long-term commercial returns is still limited. The more defensible conclusion is that China is moving unusually quickly from general-purpose AI towards domain-specific agricultural AI, while the commercial value of these systems is still being tested.

What these cases tell us about China's technological position

Taken together, these cases point to a more nuanced picture than either "China is catching up" or "China is already ahead".

China has developed substantial technological and engineering capabilities in several areas that are strategically important for the future of agriculture. Its plant-factory sector demonstrates the ability to combine multiple advanced technologies at scale; its large agricultural enterprises provide unusually large environments for deploying digital production systems; and its AI ecosystem is rapidly producing specialized agricultural models for breeding, production and advisory services.

China's potential advantage is therefore not necessarily that every individual technology is more advanced than its European counterpart. Rather, it lies increasingly in the ability to combine AI, data, hardware and large-scale production environments and to test technologies rapidly in real agricultural settings.

At the same time, the cases also reinforce an important qualification for Dutch stakeholders: technological capability and commercial maturity are not the same thing. Plant factories remain economically challenging; domestic greenhouse systems still need to demonstrate performance over multiple locations and production cycles; and agricultural foundation models need stronger evidence of sustained farmer adoption and commercial returns.

For Dutch companies and research institutions, this suggests that China should be viewed neither simply as a technology market nor solely as a source of competitive pressure. It is increasingly both a large testing environment and an innovation ecosystem in its own right. The most relevant opportunities may therefore lie in areas where Dutch expertise in crop science, greenhouse production, genetics, resource efficiency and integrated cultivation can complement China's strengths in AI, data, engineering, manufacturing and large-scale deployment.

3. Applications of Artificial Intelligence in Agriculture

Chinese agricultural AI development is particularly interesting because it combines strong technology research with a very large potential user base. But the gap between technical demonstration and broad adoption remains important.

One early international example is Tencent AI Lab's iGrow team. In the 2018 WUR Autonomous Greenhouse Challenge, iGrow—combining Tencent AI researchers with agricultural experts and students from China and Wageningen University—finished second overall and first in the AI-strategy category [28]. The challenge required teams to remotely control greenhouse cucumber production using sensor data and AI algorithms, with performance assessed based on factors including net profit, resource-use efficiency, and the quality of the AI strategy. The result demonstrated that Chinese AI researchers could perform competitively in an international, real-world agricultural production setting. Tencent and WUR subsequently co-organized the second Autonomous Greenhouse Challenge in 2020, which focused on AI- and IoT-enabled tomato production. [28]

The significance of these projects is not that they immediately created a commercial product. Rather, they demonstrate that China has developed research capability in AI-based crop management and has been willing to test it against international benchmarks.

The Pinduoduo Smart Agriculture Competition provides another useful example. The 2020 inaugural competition compared AI- and data-driven strawberry production with experienced growers, with technology teams using sensors, greenhouse automation, and algorithms to remotely manage production [29]. The 2021 competition brought together international research teams to grow cherry tomatoes using interdisciplinary approaches combining agronomy, greenhouse automation, sensors, and algorithms [30]. Wageningen University & Research (WUR) subsequently collaborated with Pinduoduo on the 2021 competition, with WUR researchers contributing to the competition as technical experts and judges [30]. These competitions are best understood as research and benchmarking environments rather than evidence of widespread commercial adoption.

Such competitions are useful test environments, but they should not be confused with commercial farms. Their main contribution is to accelerate experimentation, benchmarking and knowledge exchange.

Computer vision

Computer vision has arguably a clearer path to practical deployment. China's "Shi Nong(识农)" platform, developed by Shenzhen Shinong, applies image recognition to crop diseases, pests, weeds and nutrient deficiencies. The Shenzhen AI Industry Association reported that the system could identify more than 100 citrus diseases and pests and more than 1,000 types of weeds, with users and service coverage across major production regions [31]. These are company-associated figures and should therefore be treated as indicative rather than independently verified.

The application nevertheless illustrates an important characteristic of agricultural AI: narrow, task-specific applications may commercialize earlier than general-purpose agricultural AI.

Livestock monitoring

The same principle applies to livestock. Alibaba Cloud's ET Agricultural Brain combined computer vision, audio recognition and environmental monitoring to track pig activity, health and production indicators. Alibaba reported adoption by major pig-farming enterprises [32]. Such systems require investment in cameras, sensors, connectivity and data-processing infrastructure, making their economic case particularly dependent on farm scale and operating conditions [33].

This is an important maturity distinction. AI-based livestock monitoring has moved beyond pure research, but its economics remain an important constraint on wider adoption. Recent research on AI camera systems in pig farming highlights both potential benefits—including reduced labor and medication costs and earlier disease detection—and the still-limited evidence on acquisition, maintenance and implementation costs

AI and precision field operations

AI is also being incorporated into field robotics and precision machinery. In Xinjiang, for example, an intelligent robot has reportedly been used to guide a seeding machine between wheat rows for maize intercropping, using computer vision and autonomous path planning. In the reported demonstration, the system could complete more than 66,700 m² (100 mu) of work per day, while local authorities estimated that the intercropping system could increase returns by around RMB 800 per mu, which is approximately EUR 158 per 1,000 m² [34].

The case is best interpreted as an early field application, rather than evidence of widespread autonomous field farming. Its importance lies in showing how AI is increasingly being attached to specific operational tasks where navigation and precision can potentially generate measurable economic benefit.

4. Agricultural Robotics in China

Agricultural robotics is where the maturity spectrum becomes most visible.

Agricultural drones: the clearest commercial success

Agricultural drones are the strongest example of a Chinese agricultural technology that has moved from innovation to large-scale adoption.

China's Ministry of Agriculture and Rural Affairs reported more than 300,000 agricultural drones in operation in 2025, with annual operating area above 460 million mu [35]. The technology is now embedded in agricultural service markets for spraying, fertilization, monitoring and, increasingly, other field operations.

Precision spraying is an important part of this development. Agricultural drones allow pesticides and other crop-protection inputs to be applied more precisely than conventional blanket spraying, while digital prescription maps, remote sensing and variable-rate application are increasingly being integrated into field operations. This linkes drone deployment with the broader development of precision agriculture and digital farm management.

The important point is that adoption has been supported not only by hardware development but by a service business model. Many Chinese smallholders do not need to purchase and operate a drone themselves. Instead, specialist service providers operate drones on a per-area basis. This model is particularly compatible with China's fragmented agricultural structure. It allows sophisticated equipment to reach smaller farms without requiring each farm household to make a large capital investment.

DJI and XAG are the two most visible Chinese players in this market. International market-share estimates vary and should be treated carefully, particularly where they originate from company-linked investment documents or commercial market reports. The more robust conclusion is simply that Chinese manufacturers have established a strong position in agricultural drones both domestically and internationally.

BeiDou auto-steering: substantial but more concentrated

Satellite-guided tractor assistance and auto-steering provide another example of significant deployment. China's agricultural machinery programs have explicitly promoted the adoption of BeiDou-based assisted-driving systems to improve precision and operational efficiency [5]. In practice, BeiDou-equipped machinery and autonomous-driving systems are already being used in large-scale farming regions such as Xinjiang and Northeast China, including cotton planting and soybean harvesting [36] [37]. These systems can support more precise field operations, including planting, fertilization and crop-protection activities, and are increasingly connected with digital farm management and precision-agriculture platforms.

However, available official sources do not provide a sufficiently robust national figure separating assisted-steering systems from fully autonomous machinery. This article therefore uses the more cautious formulation of large-scale deployment of BeiDou-assisted machinery, rather than citing a precise count of autonomous tractors.

This distinction matters commercially. Assisted steering, navigation and precision control are significantly more mature than fully autonomous agricultural machinery. At the same time, the maturity of these systems should not be equated with technological leadership across precision agriculture as a whole. Dutch suppliers continue to have strong capabilities in integrated precision farming, croo-specific control and the integration of hardware, software and agronomic knowledge.

Harvesting robots: still difficult

Fruit harvesting remains much harder to automate because crops vary in size, color, maturity and position, while fruit can be easily damaged.

China Agricultural University has developed successive generations of strawberry-harvesting robots, with field trials and demonstration applications reported in several provinces [38] [39]. The evidence available does not support describing them as a commercially established product.

The same is true of apple harvesting. Research teams have reportedly developed robotic systems capable of identifying and picking fruit, but reliable operation under variable field conditions remains challenging; again [40].

A more interesting development is the emergence of locally adapted, task-specific harvesting systems. In Shaanxi, a winter-jujube harvesting robot was tested in July 2025, reportedly achieving an approximately 85% ripe-fruit grasping success rate and less than 8% fruit damage in the initial test [41]. The source is a local agricultural-sector report, so these figures should be treated as trial results rather than independently validated commercial performance.

The case is nevertheless useful because it illustrates the logic of agricultural robotics in China: robots are often being developed around a very specific local crop and labor problem.

The "Greenhouse Little Bee" is a good example of the difference between visibility and maturity. Developed by a team associated with the Beijing Academy of Agriculture and Forestry Sciences, the robot uses computer vision and navigation to work on tomato pollination and has appeared in several demonstration projects; no reference documenting this specific project was included in the supplied material [42].

The available evidence supports its status as a serious applied-research project. It does not support describing it as a widely commercialized pollination solution. Domestic reports have cited pollination success rates of around 98%, but these figures have not been independently validated [43].

A different and scientifically stronger example is GEAIR, developed by researchers at the Chinese Academy of Sciences [44][45]. Published in Cell in 2025, the project combines genome editing with AI-based robotics [44]. Researchers modified tomato flower morphology to make automated recognition and cross-pollination easier, then trained a mobile robot to perform the task [44]. The peer-reviewed study reports automated hybrid breeding with efficiency comparable to manual pollination and demonstrates the concept in tomato and soybean [44].

GEAIR is therefore important not because it has already created a commercial robotic breeding industry, but because it demonstrates a more fundamental idea: the crop itself can be redesigned to make robotic agriculture easier. This "crop–robot co-design" approach is potentially more significant than the headline claim of a "world-first pollination robot" [44][45].

Multifunctional greenhouse robots

Another useful pilot case comes from Fudan University. Its multifunctional tomato robot combines pollination, leaf removal, flower and fruit thinning and harvesting and has undergone field validation at Guangming Chongming Farm [46]. According to the university, one robot could save the equivalent of six workers, while its cost was one-fifth to one-tenth that of comparable foreign equipment [46]. These are project claims rather than independently audited benchmarks.

The technology is nevertheless worth monitoring because multifunctional systems may have a better economic proposition than single-purpose robots if one machine can perform several labor-intensive tasks during the production cycle.

Laser weeding

Laser weeding is another emerging area. Chinese universities and companies are testing AI-based systems that identify weeds and target them with lasers. Shanghai University, for example, has reported a prototype laser-weeding robot being tested and demonstrated at vegetable production bases in Shanghai [47].

A separate Chinese system, the Laser Weeder H8, has moved beyond domestic trials and was exported to Australia in July 2026 [48]. This is an interesting example of a technology moving beyond laboratory research, but available evidence is still insufficient to classify it as large-scale adoption.

Autonomous farms

China's "unmanned farm" projects attract considerable attention, but they should be interpreted carefully. Demonstrations in Xinjiang, Heilongjiang and other regions reportedly show that autonomous machinery can perform a growing share of field operations [49] [50].

The remaining challenge is economic integration. A farm may achieve a high degree of machine autonomy in one operation while still requiring people for supervision, logistics, maintenance and other tasks. The concept of a completely unmanned farm therefore remains much less mature than the media narrative sometimes suggests.

The broader lesson is clear: China has demonstrated many individual autonomous agricultural functions, but the fully integrated autonomous farm remains a pilot concept rather than an established business model.

5. Potential Areas for China–Netherlands Collaboration

Based on the analysis above, there is considerable scope for China-Netherlands cooperation in agricultural innovation. The two countries bring complementary strengths to the development and deployment of agricultural technologies. China combines a large agricultural production base, rapidly developing AI and engineering capabilities, and extensive testing and demonstration environments, while the Netherlands has longstanding strengths in crop science, precision cultivation, controlled-environment agriculture, genetics, resource efficiency and the integration of technologies into commercially viable production systems.

The complementarity suggests that future cooperation does not need to be limited to technology transfer from the Netherlands to China. There is increasing potential for joint development, local adaptation, testing and validation, and for combining Dutch agronomic and production expertise with Chinese capabilities in AI, data, robotics, engineering and large-scale deployment.

The China–Netherlands agricultural relationship has evolved alongside China's agricultural innovation system. Cooperation is no longer limited to transferring agricultural technologies into China. It increasingly involves joint research, local adaptation, knowledge exchange, demonstration projects and competition between suppliers.

Government-level cooperation remains active. The China–Netherlands High-Level Working Group on Agriculture held its 20th meeting in The Hague in 2025 and its 21st meeting in Beijing in 2026, covering areas including protected agriculture, seeds, dairy and horticulture.

Wageningen University & Research (WUR) also remains closely connected to China’s agricultural research and innovation ecosystem through long-standing research partnerships, the Beijing JingWa Agricultural Science and Technology Innovation Center, joint training programs, and agricultural innovation competitions [51–53]. The JingWa Center was jointly established by Beijing and WUR as a platform for agricultural science and technology cooperation, with demonstration and research facilities covering areas including greenhouse horticulture, fruit production, and dairy [51]. WUR also jointly runs the Sino-Dutch Agriculture Green Development PhD program with China Agricultural University [53]. In applied agricultural innovation, WUR has collaborated with Pinduoduo on its Smart Agriculture Competition, with WUR researchers serving as technical advisers and judges in the competition [54]. The competition provided a practical testing environment in which international and Chinese teams combined agronomic knowledge with greenhouse automation, sensors, computer vision, and algorithms [54] [55].

The opportunity for Dutch stakeholders is therefore broader than selling equipment.

Genetics and breeding

Genetics remains an area where Dutch companies have substantial expertise and established market relationships. At the same time, Chinese investment in breeding technologies, genome editing, and intelligent breeding is increasing.

China's revised *Plant Variety Protection Regulation*, which entered into force in June 2025, strengthened the legal framework for plant variety rights and established a phased approach to the protection of essentially derived varieties (EDVs) [56]. In 2025, the Ministry of Agriculture and Rural Affairs also announced measures to accelerate implementation of the EDV system, including the preparation of a first implementation catalogue, crop-specific identification standards, and supporting expert and testing systems [57]. The first implementation catalogue was subsequently formally introduced in 2026, covering ten crops including rice, wheat, cotton, rapeseed, peanut, Chinese cabbage, chili pepper, foxtail millet, broad bean, and peach [58].

The practical effectiveness of these mechanisms will take time to assess, but stronger variety protection could improve the environment for international breeding companies, particularly by strengthening protection against unauthorized reproduction and imitation of protected varieties.

Integrated crop management

Dutch competitiveness is not limited to hardware. Crop knowledge, cultivation strategies, water and nutrient management, biological control, data interpretation, and the integration of different technologies remain important sources of value [59][60].

This becomes increasingly relevant as Chinese producers develop their own equipment and technology platforms. The strategic question is therefore less whether a particular component is Dutch or Chinese, and more whether an integrated production system can deliver reliable yields, resource efficiency, and commercially attractive returns. For Dutch companies, this creates opportunities to contribute knowledge and system-level expertise even where individual hardware components can be sourced locally.

Digital agriculture and AI

Digital agriculture is a particularly promising area for cooperation because the two countries have complementary strengths. China offers large-scale production environments, a rapidly developing technology ecosystem, and increasingly sophisticated digital and AI capabilities. The Netherlands contributes expertise in crop science, greenhouse horticulture, data-driven cultivation, and agricultural research [59][60].

This creates opportunities to move beyond conventional technology transfer toward joint development, local adaptation, and validation. Rather than simply introducing Dutch technologies into China, cooperation can increasingly involve adapting technologies to Chinese production conditions and combining Dutch agronomic knowledge with Chinese digital and engineering capabilities.

Robotics and precision cultivation

The rapid development of Chinese agricultural robotics creates a similar opportunity. Chinese companies and research institutes increasingly provide capabilities in robotics, sensors, AI, and cost-efficient engineering, while Dutch horticultural companies can contribute crop-specific knowledge, cultivation requirements, and experience in integrating technology into commercial production systems [60][61].

For Dutch companies, the most promising strategy may therefore be selective participation in Chinese innovation ecosystems rather than assuming that innovation will always move in one direction.

Partnerships in which Chinese engineering capabilities are combined with Dutch crop and production expertise may offer greater potential than competing on individual pieces of hardware alone.

Increasing competition and local adaptation

At the same time, competition should not be underestimated.

The Beijing competitive benchmarking trial for greenhouse technologies provides a useful example. Over a 294-day production cycle, domestically developed greenhouse control systems were tested against a Priva-controlled system under standardized production conditions [62]. The organizers presented the results as an important breakthrough in domestic greenhouse-control technology. The results are noteworthy, but they represent one controlled trial, one location, and one production cycle. They should therefore be interpreted as evidence of increasing domestic innovation and benchmarking capability—not as proof that Chinese greenhouse-control systems have generally overtaken Dutch systems.

This distinction is increasingly important for Dutch companies. China's innovation ecosystem is becoming more capable of developing lower-cost and locally adapted alternatives. This does not eliminate the market for international expertise, but it changes the basis on which suppliers compete.

The strongest opportunities may increasingly lie where technology is combined with scarce domain knowledge: advanced breeding, crop-management systems, resource efficiency, high-value horticulture, digital twins, precision cultivation, integrated production systems, and research collaboration.

The China–Netherlands relationship is consequently becoming more multidirectional. Chinese companies and research institutes are developing their own technological capabilities, while Dutch companies retain strong expertise in several high-value segments. The opportunity is increasingly not simply to transfer Dutch technology to China, but to combine complementary strengths and develop solutions together.

Conclusion

China's agricultural innovation system is becoming more integrated and increasingly focused on moving technologies from research into practical application. Policy support now extends beyond R&D to demonstration, pilot validation, maturation and commercial deployment [10]. This is helping create a broader pipeline from scientific research to agricultural use.

The maturity of that pipeline remains uneven. Agricultural drones and several forms of precision machinery have clearly reached significant commercial scale [35]. Digital farm-management systems and selected AI applications are also moving into practical use. By contrast, many agricultural robots, autonomous farms and agricultural foundation models remain in research, demonstration or pilot stages, where cost, reliability and business-model questions are still being tested.

For Dutch stakeholders, this creates both opportunities and competition. China's expanding innovation ecosystem offers a large market, extensive testing environments and potential partners, while Dutch strengths in genetics, crop management, controlled-environment agriculture, resource efficiency and integrated production systems remain relevant. Cooperation is also becoming more multidirectional, with greater scope for joint development and adaptation.

The practical response is therefore to remain engaged, monitor technological maturity carefully and focus on areas where complementary capabilities can produce value. Understanding not only what China can

demonstrate, but what it can deploy profitably and at scale, will be increasingly important for sound commercial and policy decisions.

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