



Research Report on UK-China Cooperation in Agricultural Research and Innovation (Final Report)

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Abbreviations

BBSRC	Biotechnology and Biological Sciences Research Council
CAAS	Chinese Academy of Agricultural Sciences
CAS	Chinese Academy of Sciences
CEPAMS	Centre of Excellence for Plant and Microbial Science
CSC	China Scholarship Council
DEFRA	Department for Environment, Food and Rural Affairs of UK
DFID	Department For International Development of the UK
GCRF	Global Challenges Research Fund
IGDB	Institute of Genetics and Developmental Biology of CAS
JHI	The James Hutton Institute
JIC	John Innes Centre
MARA	Ministry of Agriculture and Rural Affairs of China
MoE	Ministry of Education of China
MOST	Ministry of Science and Technology of China
N8 Agri-food Group	Agri-Food Group of 8 Research Intensive Universities in North of England (Durham, Lancaster, Leeds, Liverpool, Manchester, Newcastle, Sheffield and York)
NAU	Nanjing Agricultural University
NSFC	National Natural Science Foundation of China
NUBS	Nottingham University Business School
S&T	Science and Technology
UKRI	UK Research and Innovation
UNNC	University of Nottingham Ningbo China
UoN	University of Nottingham

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Chinese research team led by Dr. Xuebiao Zhang at the Agricultural Information Institute of CAAS is responsible for the project implementation for the China side. A total of the 25 Chinese institutions were involved in the project, among which eight are research institutes affiliated to the CAAS, and seventeen are agricultural universities and research institutes, including Chinese Academy of Sciences, China Agricultural University, Beijing Academy of Agriculture and Forestry Sciences, Nanjing Agricultural University, South China Agricultural University, Chinese Academy of Fishery Sciences, Chinese Academy of Tropical Agricultural Sciences, Jiangsu Academy of Agricultural Sciences, Shandong Academy of Agricultural Sciences, etc. Special thanks to professor Nie Fengying of the Agricultural Information Research Institute of CAAS for his contributions to the project delivery plan.

The UK research team is led by Dr. Bin Wu, Senior Research Fellow at NUBS, Founder and Coordinator of the Consortium of Future Rural Studies (CFRS) of the UoN. Participants include UoN Food Systems Institute (FSI, in preparation), Agri-food Group of N8 Research Partnership (N8 Group), and the James Hutton Institute (JHI). Special thanks go to Professor Andrew Salter and Dr. Pete Noy from the FSI of the UoN, Professor Tim Daniel of the University of Sheffield, Dr Jonathan Snape of the JHI, Professor Steven Banwart of the University of Leeds, Mr Charles Crofton Atkins of Allied Peak Ltd, and Mr. Zhang Ning, a PhD student at the UoN, for their contributions in the delivery of this project. Dr. Chris Sims, Institute for Policy and Engagement of the UoN; Ms Victoria Hayward from the Faculty of Social Sciences of the UoN; Ms Debbie Promosso, Ms Janet Cook, and Dr. Davide Pero from UNBS; and Mr John Koniarski, Ms. Rebecca Knight; Mr Jason Feehily, Mr Ben Peng, and others from the Research and Innovation of the UoN have contributed to the initiation and smooth running of this project.

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Executive Summary

Both the UK and China play an important role in global agricultural research and innovation to drive the green transformation and sustainable development of agriculture. Facing severe challenges in climate change, biodiversity loss, land resources degradation, overexploitation of water resources, energy crisis, increased plant and animal disease and air pollution, it is impossible for one country or single discipline to propose effective solutions to cope with these challenges. Given the leading role the UK and China play in these areas, it is necessary to strengthen and deepen exchanges and cooperation in various fields of agricultural research and innovation to provide new ideas and solutions to cope with these challenges.

In this context, the British Embassy Beijing and the Department of International Cooperation of Chinese Academy of Agricultural Sciences (CAAS) jointly planned a research on the UK-China cooperation in agricultural research and innovation. The British Embassy Beijing funded and commissioned two research teams from the CAAS and the University of Nottingham (UoN) to conduct this research. By incorporating the perspectives from two research teams, mixed methods (interviews, questionnaires, workshop and case studies) were taken to achieve these aims.

Firstly, the achievements, experience and practices, challenges and areas of improvement, and respective advantages of UK-China cooperation in agricultural research over the past 10 years (including projects under the UK-China Agritech Flagship Challenge Programme) are systematically summarized. Secondly, priority research areas and mechanisms for future cooperation are identified. Thirdly, new ideas to deepen UK-China cooperation in agricultural research and innovation are presented for reference to research funders and policy makers, including collaborative funding mode, multiple stakeholder participation, project evaluation, and joint PhD training programmes.

The main achievements in the UK-China cooperation in agricultural research over the past 10 years are **as follows:**

- 1) Key actors engaged in bilateral cooperation have been extending from research institutions to include industrial enterprises, farmers' organisations, international organisations and third-party countries.
- 2) Diversified cooperation models have been developed, including: signed agreements and memorandum of understanding between government agencies, joint research projects between universities or research institutes; joint research centres (or laboratories), personnel exchanges, joint training of doctoral students, joint publication, etc. For example, the CAS-JIC Centre of Excellence for Plant and Microbial Science (CEPAMS), which has provided a platform for knowledge exchange and close research cooperation between British and Chinese scientists.
- 3) The UK-China Joint Research and Innovation Partnership Fund focuses on basic research and encourages innovation, achieving remarkable results. The bilateral cooperation has

resulted in more than 1,000 projects completed, established mutual trust and cooperation partnerships extending to other disciplines, countries or regions beyond the scope of original funding schemes.

Based upon data collection and analysis of both interviews and questionnaire survey among senior managers and experienced researchers from the two countries, **the research findings** can be highlighted as follows:

- 1) The bilateral projects in the past were mainly funded from governmental sources, among which the joint projects funded by the UK National Research and Innovation Agency (UKRI) with the Ministry of Science and Technology of China (MOST) and the National Natural Science Foundation of China (NSFC) have been playing a key role in developing and deepening bilateral research cooperation. To strengthen existing partnerships and research links, respondents from both sides jointly called for the government agencies, research funders and other relevant sectors from the two countries working together to further develop, broaden and improve bilateral funding mechanisms to support joint research and talent training in global sustainable agriculture development.
- 2) Addressing the real needs of agricultural technology development has always been taken into consideration by the governments of both UK and China respectively when adjusting the priority areas for collaboration. Respondents from both sides believe that there are a wide range of areas for future bilateral collaboration, with smart agriculture, agroecology and environmental protection, carbon neutrality, climate change, and food health, nutrition and quality and safety standards identified as common interests and priorities.
- 3) The importance and positive influence of multilateral cooperation is emerging, which was particularly emphasized by the British respondents.
- 4) Respondents from both sides agree that global and local challenges as well as cutting-edge research should be considered as the most important factors in future bilateral cooperation.
- 5) The project identified some differences in the academic backgrounds and research interests between respondents from both sides. Nevertheless, respondents attached special importance to collaborative research related to agro-ecosystems, and showed strong interests in developing and strengthening interdisciplinary and cross-field collaboration in the future.
- 6) The participation of companies in the UK-China Agriculture Flagship Challenge Programme demonstrates the value and potential of industrial engagement contributing to bilateral research cooperation.
- 7) Joint PhD training and other longer-term exchange programmes have strengthened mutual understanding, laying a solid foundation for closer research cooperation between the UK and China. Respondents from both sides also expressed strong willingness to strengthen the exchange among young researchers.
- 8) Respondents from both sides have a broad consensus and strong willingness to develop and strengthen bilateral cooperation network in many aspects, including: research norms and methods, technical standards, and project management.

This project also identified **some challenges in bilateral cooperation** based on the review of cooperation in the last 10 years and are as follows:

- 1) There are different project management and evaluation systems between the UK and China's institutions, as well as different expectations for outcomes or impacts from bilateral cooperative projects, an important factor influencing project design and implementation, as well as the diffusion of research outcomes.
- 2) There is a lack of an aligned coordination, management and evaluation mechanism for bilateral projects.
- 3) There are uncertainties in the availability of longer term funding for bilateral projects.
- 4) There are challenges in the data sharing and the exchange of germplasm resources. Although relevant agreements have been signed, the implementation of these agreements needs to be improved during project implementation.
- 5) The level of participation of social scientists, entrepreneurs and farmers relatively low for applied research and innovation projects, creating challenges in project evaluation and the commercialisation of research outcome.
- 6) Long-term exchange programmes mainly happened in the UK with support from the Chinese side. However, the demand from British scholars to study and work in China is not strong.

Looking ahead, the UK and China derive their own advantages and disadvantages which are complementary to each other in many aspects, including: agricultural science and technology resources, financial support, total number of R&D personnel, application and commercialisation of agricultural science and technology achievements, and international R&D networks. It is clear that there is great potential and wide remit for future cooperation in agricultural science and technology innovation. Based upon both research findings and the assembly of suggestions from respondents from both countries, this report proposes following recommendations and policy suggestions for the consideration of relevant funding agencies and other interested organisations from both the UK and China.

- 1) The development and improvement of bilateral project management and coordination mechanisms with specific implementation paths and countermeasures to address issues raised by respondents.
- 2) Improving the evaluation mechanisms for bilateral project outcomes, adopting a multi-dimensional approach.
- 3) Focusing on agricultural related global challenges, jointly exploring financing mechanisms for multilateral cooperation.
- 4) Exploring innovative approaches to diversify financing models.
- 5) Strengthening long-term stable funding support for projects in priority fields or for high-quality projects.
- 6) Establishing an integrated cooperation model of "research project + talent training + trial base + matched funding from enterprises".

- 7) Enhancing the engagement of social scientists, entrepreneurs and relevant stakeholders in bilateral cooperation in applied research, technology innovation and commercialisation.
- 8) Collecting ideas and research proposals through multiple channels in regards to global challenges in agriculture and sustainability and to advise on the planning and design of bilateral cooperation and encourage interdisciplinary cooperation.
- 9) Actively organising high-level academic seminars to review achievements obtained through bilateral cooperation, set the direction and identify priority areas and mechanisms for post-pandemic bilateral cooperation.
- 10) Establishing a UK-China Young Researchers & Innovators Alliance, and promoting and improving the exchange programs for young scholars and the joint training programs for PhD students.

1 Introduction

1.1 Background of UK-China Cooperation in Agricultural Research and Innovation

Agriculture is fundamental to human survival and social development. Promoting sustainable agricultural development has become a shared challenge for the UK, China and the world, as it effectively addresses pressing issues such as global population growth, food security, climate change, energy crisis, malnutrition, antimicrobial resistance, zoonotic diseases and air pollution.

The UK has strong expertise in agricultural research and innovation, and is leading the world in basic research, as well as its well-developed international research cooperation network. The UK has stronger capacity in key technology development and commercialisation than China. As the world's largest developing country, China is facing a series of challenges in agricultural development, such as the lack of coordination and planning in agricultural production and operation amongst 200 million smallholders, widespread low uptake of information technology, rising production costs and increasing constraints of resources and the environment. Nonetheless, China also has a variety of advantages for cooperation, such as large market potential, rich agricultural resources endowment, increase in R&D investment intensity year by year, a large number of researchers, continuous increase in the level of research and innovation capacity, and a wide range of needs for cooperation across different fields.

Therefore, the UK and China have strong complementarities and shared interests in agricultural research and innovation. Strengthening the UK-China cooperation in agriculture is of mutual benefits and would explore new ideas and solutions to solve challenges in global agricultural transformation and sustainable development. To this end, a problem-oriented and result-driven research and innovation cooperation model should be established to further deepen the UK-China cooperation.

1.2 Project Background

This project was funded by the British Embassy Beijing and commissioned by two research teams from the University of Nottingham (UoN) and the Chinese Academy of Agricultural Sciences (CAAS). Harnessing the rich experience accumulated by the UoN and the CAAS over the years in the field of UK-China cooperation in agricultural research and innovation, the project aims to obtain first-hand data for different research objects through various research methods. Additionally, it aims to propose some feasible suggestions to advise on and improve future cooperation.

1.3 Theme and Objectives

Theme. Research on UK-China Cooperation in Agricultural Research and Innovation.

Objectives. Based on a systematic review of UK-China cooperation in the past 10 years, the project examined the challenges and priorities for future cooperation, as well as experiences and practices worth learning from in order to promote better cooperation between the UK and China in agricultural research and innovation. The project utilized a combination of questionnaire survey, interview, case study and workshop, incorporating the perspectives from both UK and China. The project proposed advices to relevant stakeholders such as research funders and decision-makers in terms of stakeholder engagement, communication models, project evaluation, project sustainability, joint training of PhD students, priority fields for cooperation, and funding models.

1.4 The UK and China Project Teams

Project Sponsor. British Embassy Beijing.

The UK Research Team. It consists of 8 members each from the UoN, the Nottingham University Ningbo China, the N8 Agri-food Group of eight Universities in Northern England and the James Hutton Institute (JHI) in Scotland. The research team is led by Dr. Zoe Wilson, Pro-Vice-Chancellor of the UoN, and Ms. Min He, Director of the Research and Knowledge Exchange of Nottingham University Ningbo China. Dr. Bin Wu, Senior Research Fellow of NUBS and Coordinator of the Consortium of Future Rural Studies (CFRS) of the UoN, took full responsibility for research design, implementation and coordination on the UK side. Members of the project team include Dr. Peter Noy of the UoN, who was involved in the project design and facilitated the workshop; Professor Tim Daniel of the University of Sheffield (workshop facilitator); Dr. Jonathan Snape of the James Hutton Institute (workshop facilitator); Dr. Chris Sims of the UoN (involved in the project design); and Mr. Ning Zhang of the UoN (involved in the workshop organisation and transcription of interview data); and Yucheng Zhang, Yuning Fang, Xiaoran Zhang and other PhD students from the UoN who have participated in the transcription of interview data.

The Chinese Research Team. There are a total of 9 members from the Department of International Cooperation of CAAS, the Agricultural Information Institute of CAAS, and the Graduate School of CAAS. Dr. Yu Qian, Deputy Director General of the Department of International Cooperation of CAAS, Dr. Tianjin Chen, Director of the Department of International Cooperation of CAAS, and Dr. Xuebiao Zhang, Director of the International Information Division of Agricultural Information Institute of CAAS, organised and coordinated the overall work of the project on the Chinese side. The specific division of labor is as follows: Dr. Hongxia Liu was responsible for the overall design, implementation, and general report writing of the project, and participates in offline/online interviews and field research; Dr. Jingyi Wang was responsible for the specific management matters of the project and the English translation of the full report, and participated in the writing of the main report and offline/online interviews; Dr. Chunhong Qu was responsible for the review of the report; Ms. Xinhe Chen, Ms. Lin Xie and Xinli Han (master's student) were responsible for the distribution of questionnaires and the collection, collation and analysis of data.

2 Project Design and Implementation

2.1 Research Participants, Scope and Questions

Research participants are those British and Chinese researchers, project managers, and senior officials from the funding agencies (e.g. UKRI) who have had substantial experience in participating or managing bilateral projects in the past.

Scope of the study. A total of 26 institutions participated in the research activities of the UK project, including 6 agricultural research institutions, 14 universities and 3 institutions affiliated to UKRI. In addition, 3 UK agricultural innovation companies and institutions participated (Annex A). A total of 26 Chinese institutions participated in the research activities, including 18 nation-level agricultural research institutions, 2 province-level agricultural research institutions, 5 nation-level key agricultural universities and 1 government funding institution (see Annex B). The above institutions made positive contributions to the smooth operation of the project through participation in questionnaires, fieldwork, online/offline interviews, workshops and other ways.

Research questions include:

- The research questions for researchers mainly include an overview of the cooperation between the researchers and their collaborative partners in the past 10 years, best practices that can be shared, challenges faced in the cooperation, and suggestions or expectations for better cooperation between the UK and China in agricultural research and innovation in the future.
- The research questions for project managers mainly include the overview of the UK-China cooperation of the investigated research institutions in the past 10 years, and the main partners, the current challenges in cooperation, the benefits of cooperation, the priority

fields for cooperation in the future, good experiences and practices, and the suggestions for promoting the UK-China cooperation in the future.

- The research questions for senior officials of the funders include the successful experiences and cases in the UK-China cooperation in agricultural research, the challenges encountered, priority fields of cooperation and the suggestions and expectations for better UK-China cooperation in agricultural research and innovation in the future.

2.2 Research Methods and Sample Selection

2.2.1 Research methods

Feedback from stakeholders in the UK and China were collected through survey questionnaires (see Annexes C and D for the design of the questionnaires for both parties), telephone and face-to-face interviews (see Annexes E and F for the content of the interviews for both parties), workshops (Annex G) and case studies (Annex H). The data obtained from online/offline interviews, workshops and case studies were mainly used for the qualitative analysis and the relevant recommendations. The data obtained from the survey were mainly used for the quantitative analysis, providing some necessary complements to the qualitative analysis.

Considering the short timeline (only one month), the amount of work (combining qualitative interviews with questionnaires, matching empirical study with relevant recommendations), and the need to understand the views, ideas and expectations of frontline researchers on the development of bilateral cooperation in depth, the UK project team decided to organise an online workshop to mobilise relevant institutions, project leaders and researchers interested in bilateral cooperation to participate in the workshop, share their successful experiences, puzzles and faced challenges, solutions and relevant recommendations. The half-day workshop successfully attracted 40 registrations (30 actually attended the meeting). Through keynote speeches, group presentations and two rounds of parallel group discussions at the conference, participants were able to fully express their opinions and build consensus, achieving the goal of sending a common voice of UK agricultural researchers to relevant government departments, project funding agencies and their partners (see Annex G for the workshop agenda).

2.2.2 Sample selection

The interviewees from the UK side were recommended by the CAAS and the main institutions involved in the project (UoN, Nottingham University Ningbo China, Agricultural and Food Research Alliance of Northern University of England). In addition to three UKRI-affiliated institutions (Biotechnology and Biological Sciences Research Council, Natural Environment Research Council and Innovate UK), 11 research institutions or researchers were selected for interviews based on their roles and reputation in the UK agricultural research system (such as research institutions, universities and innovation platforms), as well as considering the distribution and representativeness of professional fields (such as basic research, applied

research and industrial innovation diffusion), along with their experience, influence and representativeness in participation in UK-China cooperation in agricultural research. Channels for disseminating workshop information include recommendations from interviewees and individuals, as well as promotion through relevant academic and professional media platforms (such as LinkedIn, Eventbrite, and university websites). The participation of three UK agricultural innovation institutions and companies (Agri EPI Centre, James Hutton Ltd. and Allied Peak Ltd.) in this project has made an important contribution to understanding how agricultural research institutions align with the market and farmers' needs in bilateral cooperation.

The interviewees for the Chinese project are mainly from 25 agricultural research institutions and 1 government funding institution. The rationales for the selection of the 25 research institutions are as follows:

- Eighteen nation-level agricultural research institutions, such as CAAS, were selected as research objects based on their wide coverage of various disciplines (including forestry, fisheries and tropical agriculture), strong innovation capabilities, first-class academic standards in China, high openness to international cooperation, focus on international talent cultivation, and long-established good cooperation links with the UK.
- The selection of two province-level academies of agricultural sciences was based on their geographic locations in provinces with relatively high levels of agricultural development, featured scenarios for applied research, and different ecological zones.
- The five nation-level agricultural universities are key agricultural research universities of the Ministry of Education with high academic standards and rich experience in international research cooperation. The universities are located in different provinces with significant differences in agricultural production levels and ecological characteristics, encompassing diverse experimental conditions for bilateral cooperation.

2.3 Data Collection and Analysis

2.3.1 Data collection

Online interviews, distribution and collection of questionnaires, and the workshop in the UK were completed in November 2022. Due to the influence of COVID-19 pandemic, the online survey for the Chinese side was mainly conducted from November to December 2022; telephone interviews and face-to-face interviews were completed from December 2022 to January 2023. By the end of January 2023, a total of 63 valid survey responses were collected among which 19 were from the UK side and 44 were from the Chinese side. The questionnaire data from the UK side and the Chinese side were mainly presented in tabular form; the interview data were mainly presented in the form of interview summaries, with 15 from the UK side and 20 from the Chinese side. Key points discussed at the workshop were presented through a workshop summary report. Due to the influence of China's COVID control measures and the relatively short project cycle, the data for the case study of Nanjing Agricultural University

(NAU) was extracted from the field survey conducted by the Chinese research team in November 2020, which includes the achievements and challenges in the UK-China cooperation in agricultural research, as well as fields for cooperation. This report also drew on some of the views, opinions and suggestions shared by experts at the online seminar themed on "UK-China Cooperation in Agricultural Science, Research and Innovation" organised by the Department of International Cooperation of the Ministry of Science and Technology of China (MOST) on 22 April 2020, which attracted the participation of 14 institutions.

2.3.2 Data analysis

The methodology adopted for the qualitative analysis in this report mainly includes judgement analysis, inquiry analysis, inductive analysis and comparative analysis. Structural analysis and comparative analysis were mainly used for the quantitative analysis section. The structural analysis is a methodology that observes and analyses the percentage of certain indicator(s) against the total value; the cross-comparison analysis methodology identifies certain indicators for comparative analysis between the UK and China.

2.4 Limitations of Project Implementation

The limitations of the implementation of this project mainly include the following four aspects:

- Due to the impact of China's epidemic prevention policy, the field research in China outside Beijing has not been carried out as planned. Telephone interviews and questionnaire surveys were conducted as alternatives, lacking in-depth conversations, which has affected the comprehensiveness of the interview data.
- Due to the short project cycle (starting from the signing of the contract in October), the timeframe for designing, distributing and collecting the questionnaires was tight, resulting in insufficient data coverage and a relatively limited timeframe for report writing. The UK online survey was conducted in parallel with the workshop (held on 28 November) and the content overlapped, with most people opting to attend the workshop to better share their experiences and ideas, which affected the number of respondents for the questionnaire survey.
- The research design did not include stakeholders such as smallholder farmers, farmers' cooperatives and social groups. Additionally, there was also a lack of survey on R&D enterprises, which resulted in their voices and demands for bilateral cooperation not being fully reflected in this report.
- The variation in the level of experience and understanding of bilateral cooperation among respondents, as well as differences in the areas of expertise and willingness to respond to certain questions, have resulted in invalid survey responses, which to a certain extent has affected the comprehensiveness and accuracy of the feedback and interview responses.

3 Overview of Bilateral Cooperation: Major Achievements and Best Practices

3.1 Overview of Cooperation

The UK-China cooperation in agricultural research and innovation began in 1978. The two sides have carried out in-depth cooperation in agricultural research in a wide range of areas between the governments, research institutions and enterprises, laying a good foundation for future cooperation.

Projects and Fields of Cooperation. According to incomplete statistics, during the period from early 2006 to the end of 2019, the UK and China have carried out 116 joint research projects, of which a total of 82 were jointly funded in the research topics have been clustered around six areas, including smart agriculture, animal and plant sciences, agricultural engineering, nutrition, precision agriculture and food safety.

Funding Agencies. UK funders include UKRI, Royal Society, British Council, the Department for Environment, Food & Rural Affairs (DEFRA) and the Department for International Development (DFID), etc. Chinese funders include the MOST, the National Natural Science Foundation of China (NSFC), the Ministry of Agriculture and Rural Affairs (MARA), the Ministry of Education (MoE), the China Scholarship Council, universities and research institutions, etc. Most projects are jointly funded by UKRI and MOST and NSFC.

Modes of Cooperation. At the governmental level, the UK and China have signed a number of agreements and memoranda of understandings (MoUs). For example, following the signing of an MoU on science, technology and innovation cooperation between the science and technology departments of the two sides, a meeting was held in 2019 to discuss the implementation of the MoU regarding cooperation in science, technology and innovation in agriculture. At the institutional level, cooperation between the universities and research institutes of the UK and China are mainly through joint research projects, the establishment of joint research centres (or laboratories), the commercialisation of research achievements, joint training of doctoral students, and personnel exchanges. For example, eight Chinese institutions, including CAAS and CAS, and 11 UK universities, including the University of Leeds, have conducted collaborative research in plant and animal genetics, environmental science, food science and human nutrition, functional food, clean technology and waste recycling.

3.2 Key Achievements

Over the past 40 years, the UK-China cooperation in agricultural research and innovation has deepened and expanded. The two sides have conducted joint research to address major global

challenges, achieve scientific breakthroughs, and promote technological innovation opening up broad prospects for future cooperation. The UK and China have established a collaborative culture and effective mechanisms, with significant achievements in joint research, joint research centres (or laboratories), joint student training, international academic conferences and joint publications.

As the largest public research funding agency in the UK, the UKRI has been working with the MOST and the NSFC to jointly fund UK-China research and innovation projects. According to incomplete statistics, UKRI has funded a total of 98 UKRI-China projects cover the topics of Agricultural Technology and Food Security and 18 joint research centres, producing 954 Scopus publications covering the Scopus subject category Agricultural and Biological Sciences, with 67% of the articles in the top 10% cited globally. The citation impact of the UKRI China research in the Agricultural and Biological Sciences is 2.7 times higher than the world average. A total of 305 policy documents have cited UKRI China research in Agricultural and Biological Sciences.

The UK-China Joint Science and Innovation Fund (the UK side funding was from the Newton Fund with match funding from the Chinese government and research funding institutions for each collaborative project) was a long-term mechanism for promoting the cooperation in research and innovation between the two countries. Focusing on basic research and promoting technology innovation and commercialisation, significant achievements have been made under the Fund. Activities supported by the Fund were mainly scientific research projects, research outcome commercialisation and personnel mobility projects, with most of the Fund invested in scientific research projects. The mobility projects included the cooperation between doctoral students and researchers. The funding model of the Newton Fund started in 2014 and ended in 2022, with approximately £180 million invested to support UK-China cooperation. During this period, a total of 260 UK institutions and 120 Chinese institutions were involved. Researchers from the two sides have jointly completed more than 1,000 projects and established many mutually trusted relationships, extended the research topics and partnerships to fields and other countries or regions that were beyond the scope of the Fund. In addition to basic research, the UK side also attaches great importance to the commercialisation of research outcomes, with an emphasis on "practicality". With joint funding from Innovate UK and the MOST, many projects have developed products for real-world application. For example, a project ("R&D and Application of the Intelligent Monitoring IoT System for Poultry Farms") jointly delivered by the Guangxi Veterinary Research Institute and the Queen Mary University in London has transformed animal husbandry knowledge into physical products that can be used by farmers. In this project, researchers from the UK and China co-developed a wearable device for farmers to wear on their bodies to monitor the health status of poultry and the changes in the barn environment, helping to increase production and economic income.

In addition, **two key achievements** are listed below:

- **The CAS-John Innes Centre Joint Research Centre for Plant and Microbial Sciences (CAS-JIC Joint Research Centre, CEPAMS for short), jointly established by the UK and China.** Secure and nutritious food supply against the pressures of climate change is an issue of vital importance to people in the UK, China and elsewhere as arable land

becomes scarcer and populations grow. To address this grand challenge, the CEPAMS was established as a result of joint funding from the UKRI-BBSRC and the CAS. The initiative has brought together three leading research institutions in the UK and China (John Innes Centre, the Institute of Genetics and Developmental Biology of CAS, IGDB and the Centre for Excellence in Molecular Plant Sciences of the CAS, CEMPS) to conduct research on the improvement of food crops and the production of high-value products based on plants and microbes for the benefit of health of all human beings. At present, the CEPAMS has been developed into one joint centre with "three science parks", which are located in the JIC in the UK (Norwich), Beijing IGDB and the former Shanghai Institute of Plant Physiology and Ecology (SIPPE) of CAS. The CEPAMS is jointly funded by UKRI-BBSRC and the CAS. The main achievements of CEPAMS includes: (i) a good communication platform for British and Chinese academics. The annual bilateral academic seminar has created a venue to facilitate visits and exchanges between British and Chinese researchers at all levels, enhancing mutual understanding and promoting substantive cooperation; (ii) a series of bilateral cooperation projects. As of early 2020, the CEPAMS launched 29 bilateral cooperation projects, conducted collaborative research in plants and microbes which are of common interests to the UK and China with milestones achieved including the joint publication of 19 papers in international journals such as Science, PNAS, Science Advances and Molecular Plant; and (iii) strengthened the relationship between the UK and China. As a successful example of UK-China research cooperation, CEPAMS has received great attention from the world. Recommended by the MOST, the cooperation model and achievements of CEPAMS were showcased at the UK-China Science, Technology and Innovation Cooperation Achievements Exhibition jointly organised by the Department for Business, Energy and Industrial Strategy of the UK and the MOST in London in December 2017; in November 2018, the CEPAMS was selected as one of the nine key achievements exhibited at the UK-China Research and Innovation Project Achievement Exhibition organised by the UKRI China Office in Beijing.

- **The UK-China Joint Institute for Environmental Research & Education (LEC-SCAU-GIG), jointly established by the Lancaster Environment Centre (LEC) of Lancaster University, the South China Agricultural University and the Guangzhou Institute of Geochemistry of CAS.** The LEC-SCAU-GIG is a joint institute dedicated to promoting research, teaching and innovation activities in the field of environment. This institution is committed to promoting the international influence of elite teams, including researchers, students, developers, and other workers in the study of the environment. In addition, the Joint Institute brought together scientists from China, Southeast Asia and the rest of the world in various fields such as soil environment, water environment and green energy created world-leading research achievements in the field of agricultural environmental science. In 2019, the LEC-SCAU-GIG has developed six new materials, established four new processes and developed five new technologies. There are 27 ongoing research projects, with a total funding of RMB 26.6875 million, including 19 new projects launched in 2019 (accounting for RMB 12.285 million research funding). These projects provided technical support for the safe use of contaminated farmland in Guangdong Province, adjusting the planting structure of oil crops and the soil test formulas. This has contributed to the safe use of more than 90% of the contaminated farmland in Zhongshan

city, the adjustment of planting structure by 15000 *mu* farmland in Qujiang District (1 *mu* = 0.067 ha.) in Shaoguan city, and the application of soil test formulas and organic fertiliser substitution in 16 cities and counties.

3.3 Practices and Experiences

3.3.1 Bilateral projects are mainly funded by government sources. The collaborative projects between UKRI and the MOST and the NSFC are crucial to promote and deepen the bilateral research cooperation.

According to respondents from both sides, government funding is still the main funding source for bilateral cooperation projects in agriculture, especially for those addressing global agricultural challenges. The respondents from both sides jointly appeal to the governments, research funding agencies and relevant departments on both sides to further develop, expand and deepen the bilateral funding mechanism to strengthen the established partnerships focusing on sustainable agricultural development, talent training for agritech innovation and building synergy mechanism of research and innovation.

3.3.2 The governments of both sides frequently adjust the priority areas of cooperation to align with the practical needs of agricultural science and technology development in their respective countries. Interdisciplinary research is expected to emerge as a key trend in the future bilateral cooperation.

Agriculture is an industry with a long investment cycle, high risks and slow returns. The investment from the government plays a very important role in promoting the high-quality development of agriculture in both UK and China. Therefore, necessary adjustments are often made to the priority fields of cooperation by the governments of UK and China based on the practical needs of the agricultural science and technology development. At present, instead of relying on the knowledge and methods from a single discipline, both UK and China have been attaching great importance to the perspectives of multiple disciplines to explore solutions to address agricultural challenges. Cross-disciplinary research approach has become a real need to solve the increasingly complex challenges of sustainable agricultural development, and a trend for bilateral cooperation in the future.

3.3.3 The significance of multi-party cooperation has been fully demonstrated by the outcome of multilateral cooperation. Respondents from both sides have expressed a strong willingness to engage in multi-party cooperation.

A sustainable rice research project brought together partners from the UK, China and Southeast Asian countries (including Philippines, Thailand, Vietnam, etc.), and expanded the fields of bilateral cooperation between the UK and China. This plan not only effectively expands the areas of bilateral cooperation between the UK and China, but also incorporates Southeast Asian countries into a tripartite partnership, due to China's developed rice planting technology, which is very suitable for the Southeast Asian region. Through UK-China cooperation, exploring rice planting technologies suitable for the Southeast Asian region will have a positive impact on helping Southeast Asian countries develop their rice industry, and also expanding the global influence of UK-China cooperation.

3.3.4 The UK-China Agritech Flagship Challenge Programme involves enterprises, highlighting the value of active engagement of companies in research projects.

Research institutions have more advantages in cutting-edge research and publication, while enterprises pay more attention to practical applications, input-output ratios, approaches to bring real benefits to farmers, and the adoption and affordability of new technologies for farmers. Therefore, multi-stakeholder engagement in agricultural technology innovation is necessary to ensure direct benefits to smallholder farmers. At present, the eight projects under the UK-China Agritech Flagship Challenge Programme are progressing, focusing on exploring practical solutions to smart horticulture, smart dairy farm and agricultural remote sensing.

3.3.5 Both sides have demonstrated a strong willingness to cooperation on smart agriculture and green and sustainable agricultural development.

Compared with traditional agriculture, smart agriculture has absolute advantages in ensuring precision management for modern agriculture, efficiency, environmental protection, and poverty alleviation; overcoming resource deficiencies; and achieving agricultural leapfrog development. Smart agriculture is one of the best choices for the green and sustainable

agricultural development in both UK and China. The UK-China intergovernmental research project - "Key Technologies for Accurate Decision Making on Smart Farms Based on High Resolution Remote Sensing Information Fusion from Earth, Space and Satellite" - fully reflects the willingness of the two countries to cooperate in the area of smart agriculture. The UK-China intergovernmental research projects - "Environmentally Friendly Compound Bioinsecticides" and "Changing Agricultural Pest Control in the UK and China"- reflect the willingness of both sides to collaborate in the field of green and sustainable agricultural development.

3.3.6 The joint student training and long-term exchange projects have strengthened mutual understanding, fostered cooperation, and established an expanded network for UK-China research cooperation.

The joint student training and long-term exchange programs not only contribute to the improved understanding of cultural differences and working styles of the two countries, but also benefit young Chinese scientists in terms of career development with a global perspective through knowledge exchange, driving changes and development to the relevant scientific fields. These programs also equip young scientists from the UK with China knowledge and experience to better respond to global challenges. In addition, international students returning from the UK to work in China, especially PhD students, have played a catalytic role in promoting changes in relevant scientific fields in China. Returning students from the UK have also become a bridge for science, technology and innovation cooperation between the UK and China. According to respondents from both sides, research links for most of the bilateral cooperation projects are established through PhD students jointly trained by the UK and China. These students also have made significant contributions to the exchange of ideas and innovation for these projects.

4 Major Issues and Barriers against Bilateral Cooperation

Although the UK and China share common interests in the agricultural research cooperation and have achieved remarkable results, there are still some challenges and mechanism differences to address.

4.1 Major Issues

4.1.1 There are challenges in data sharing, exchange of germplasm resources and intellectual property protection.

Although the agreement between the two parties has been signed and entered into force, implementation need to be strengthened. Specific implementation measures to ensure data sharing, the smooth exchange of germplasm resources and the protection of intellectual property (IP) rights is often not included in the agreement, which might be caused by a combination of different factors. For example, the consideration of intellectual property protection by both sides, as well as the inconsistent policies and legal frameworks in data sharing and import and export control between the UK and China; the need for official approval for the import and export of samples (soil and plants), and the complexity linked to the sample acquisition procedures, which could influence the progress of project implementation.

4.1.2 The engagement of enterprises and farmers in applied research and innovation projects is insufficient, which poses challenges in the application of the project outcomes.

The main participants in applied research and innovation cooperation projects funded by the Chinese government are universities and research institutes, with low level of participation by enterprises and farmers. Some well-known enterprises do not receive funding from the Chinese government for bilateral cooperation projects. Match funding is required from companies for involvement in such projects. According to the interviewees from the UK, the sources of funding for bilateral cooperation in the UK side are relatively diversified, outnumbering China in terms of the funding from enterprises. At present, universities and research institutes are mainly involved in the front end of the S&T innovation chain, while the back end of the S&T innovation chain requires the active engagement of enterprises and farmers. However, the engagement of farmers and enterprises, especially from the Chinese side, remains low for the majority of the bilateral cooperation projects, creating challenges in the acceptance of some bilateral cooperation outcomes by farmers. Therefore, enterprises lack the incentive to commercialise the research outcome, demotivating enterprises to participate in innovation projects, which has created more challenges in the application of cooperation outcomes.

4.1.3 The involvement of social scientists in the design and implementation of certain bilateral cooperation projects can be increased.

According to current cooperative projects, the design of some projects has a strong focus on increasing the output and economic benefits of animals and plants through "technological breakthroughs", while social benefits, ecological and environmental benefits, and sustainable agricultural development have not been widely reflected. In addition, the involvement of social scientists is often not mentioned in call for proposal for such projects. As a result, the angle to align the rural social environment with the technological needs of smallholders is not factored in the project design, creating challenges in the commercialisation of bilateral cooperation outcomes, the economic, social and resource utilisation efficiencies, and the flexibility and sustainability of agricultural systems.

4.1.4 Uncertainties in the long-term funding for bilateral cooperation projects

The R&D of agricultural technologies is a long cycle with high investment, high risk and low output. Achieving significant achievements requires a certain time period, which is often longer than the current funding cycle of two to three years. Interviewees from both sides reached consensus that the cooperation platforms lack subsequent stable and sustainable financial support due to the reliance on the three-year project cycle. Due to funding uncertainties, after achieving initial results, further research and technology application and commercialisation have been disrupted for many cooperative projects.

4.1.5 Differences between the UK and China in terms of the expected outcomes of cooperative projects

In China, more emphasis is placed on the production of high-quality publications, while less emphasis seems to be placed on the commercialisation, application and the social impact of research outcomes. This may be related to the comprehensive performance evaluation of scientists by Chinese institutions. The Chinese government has recognised this as a problem and has actively introduced some policy measures to reduce the weight on paper output against the commercialisation and application of R&D outcomes, including the introduction of incentive mechanisms. The UK side gives a balanced weight on high-quality paper output from bilateral cooperation, and the practical application of research outcomes, farmers' technological needs, and the impact on solving global challenges.

4.1.6 Long-term personnel exchange projects mainly take place in the UK, and the willingness of young British scientists to study and work in China needs to be improved.

According to respondents from both sides, the UK is the main host for long-term exchange projects between young scientists and senior scholars, which is generally supported by China. However, due to various factors, the willingness to study and work in China is not strong for young scientists and senior scholars in the UK, narrowed the communication channels and resulted in imbalanced personnel exchange between the two sides, which also to certain extent limited the breadth and depth of bilateral cooperation.

4.2 Mechanism Differences to address

4.2.1 The absence of a standardized project cooperation and management mechanism for bilateral cooperation

Respondents from the UK and China both noted the needs to improve the understanding of laws and regulations, the challenges caused by inconsistencies in project management frameworks, financial management policies, and areas for improvements in the commercialisation of research outcomes. For example, there are differences in the intellectual property protection policies and regulations between the UK and China; China has more restrictions in cross-border fund transfer, creating operational challenges for China to directly fund project activities in the UK, which limits the flexibility of project design.

4.2.2 The lack of a synchronized project evaluation mechanism for UK-China cooperation

Project evaluation is required after the completion of the project by both the UK and China according to the research funders' requirements. The differences in the evaluation indicators between the UK and China caused by the inconsistencies in the evaluation mechanism has led to differences in the evaluation outcomes, which will have a certain impact on the subsequent funding for the project. Positive project evaluation outcome in China does not always directly translate into a positive outcome in the UK and vice versa. Many respondents has little understanding on the project evaluation process in the partner country, and therefore cannot predict whether there is a need to continue funding the project in the future. This is a common concern identified by respondents from both sides and a challenge which requires actions to be taken by research funders.

5 Research Findings from Questionnaire Survey

5.1 Distribution of British and Chinese Respondents

A total of 63 valid questionnaires are collected in this study, including 19 from the British side and 44 from the Chinese side. As shown in Table 5.1, all of the Chinese respondents are from universities and research institutes; 12 of the British respondents are from universities and research institutes, accounting for 63.2% of the total sample, and respondents from the UK side also includes 2 representatives from private organisations and 5 from agricultural consulting companies. The shortcoming of the questionnaire survey is the lack of stakeholders such as farmers or farmers' organisations, R&D enterprises, etc.

In terms of the experience in bilateral cooperation, a total of 21 respondents from China have been working with the UK for 1-5 years, and 16 respondents for more than 10 years, some even for more than 20 years; however, the majority of the respondents have less than five UK partners in their institute with less than three UK-China agricultural research cooperation projects since 2012. Among the UK respondents, 3 have been working with China for more than 20 years, 4 have been working with China for less than 5 years. 11 respondents have less than five Chinese partners in their institute, while 3 respondents have more than 10 partners with China in their institutes. Since 2012, 61.1% of the respondents' institutes have completed less than three research cooperation projects with the UK. It is worth pointing out that although the sample participated in this questionnaire survey does not necessarily represent the full picture of the institutions that have been involved in UK-China bilateral cooperation, it has demonstrated a solid foundation of cooperation between the two sides, which is conducive to deepen the UK-China research cooperation in a wider range of areas.

Table 5.1 Types of the Respondents' Affiliations

Type	China		UK	
	No.	%	No.	%
University	3	6.8	12	63.2
Research institute	41	93.2		
Civil society	0	0	2	10.5
Agricultural consulting company	0	0	5	26.3
Sum	44	100	19	100

5.2 Research Areas

The research fields related to agriculture are divided into 12 subjects (see Table 5.2). According to statistical analysis, the research fields of 22 Chinese respondents are plants (crops,

horticulture, forestry) (accounting for 50.0% of the total sample), followed by prevention and treatment of animal and plant pests (10, 22.8%), soil, water and ecosystem services (10, 22.8%), and aquaculture, information technology, agricultural information system and animal husbandry (accounting for about 11.4%). For the UK respondents, the main research fields are soil, water and ecosystem services (10, 52.6%), prevention and treatment of animal and plant pests (8, 42.1%) and food systems, culture and policy (7, 36.8%). The research fields of plants (crops, horticulture, forestry), agricultural economy and policy and animal husbandry are 6 (31.6%), 5 (26.3%) and 5 (26.3%), respectively.

It can be seen that there are more respondents specialised in botany from the Chinese side, while for the UK side, there are more respondents involved in the fields of soil, water and ecosystems. The Chinese side lacks respondents in the fields of harvesting, storage and logistics, while the UK side lacks respondents in the fields of agricultural machinery and engineering. In terms of the coverage of the research fields of the respondents, the cross-discipline degree of China is 1.68 (74/44), while that of the UK is 2.32 (44/19). A wider research scope have been captured by the UK respondents who are more interested in agricultural ecosystems, interdisciplinary studies, especially policy related fields.

Table 5.2 Distribution of Research Fields of Respondents (Multiple Choice Questions)

Types	China		UK	
	No.	%	No.	%
Plants (crops, horticulture, forestry)	22	50.0	6	31.6
Aquaculture	7	15.9	1	5.3
Harvesting, storage, and logistics	0	0.0	1	5.3
Information Technology and Agricultural Information System	7	15.9	3	15.8
Agricultural Machinery and Engineering	2	4.5	0	0.0
Agricultural Economy and Policy	1	2.8	5	26.3
Animal Husbandry	7	15.9	5	26.3
Prevention and Control of Animal and Plant Diseases and Insect Pests	10	22.8	8	42.1
Food processing and technology	5	11.4	1	5.3
Soil, Water, and Ecosystem Services	10	22.8	10	52.6
Food System, Culture, and Policy	2	4.5	7	36.8
Others	1	1.4	0	0.0
Sum	74	100	47	100

5.3 Motivation for Respondents' Participation in Bilateral Cooperation

A combination of various factors have contributed to the engagement of the UK and China in

agricultural research cooperation (Table 5), with 'further strengthening and developing bilateral cooperation networks' being the primary driver for both the British and Chinese respondents (accounting for 84.1% and 63.2% of the total sample, respectively). Mutual learning, knowledge and experience sharing of good research norms, research methods, technical standards and project management practices are also important driving factors. There is a broad consensus and strong willingness on the new technologies defined by the cooperative projects to address agricultural challenges and to attract/train young researchers to engage in bilateral cooperation. In addition, respondents from the UK expressed stronger willingness to actively engage in bilateral cooperation to achieve the United Nations 2030 Sustainable Development Goals.

Table 5.3 Driving Factors of Respondents' Engagement in Agricultural Research Cooperation (Multiple Choice Questions)

Drivers	China		UK	
	No.	%	No.	%
Further strengthen and develop bilateral cooperation networks	37	84.1	12	63.2
New technologies to address agricultural challenges as defined by the cooperative projects	22	50.0	11	57.9
Mutual Learning, reference and sharing of good research norms, research methods, technical standards and project management practices	23	52.3	8	42.1
Attract/train young researchers to engage in bilateral cooperation	11	25.0	7	36.8
A new management system for efficient/sustainable resource use	4	9.1	6	31.6

5.4 Recognition of Respondents to Achievements of Bilateral Cooperation

There are mainly five different models for cooperation, namely memoranda of understandings (MoUs), joint research centres (or laboratories), bilateral research alliances, joint projects and others (see Table 4). Feedback received from the Chinese respondents suggested that MoUs were deemed to be the most significant outcome (accounting for 70% of the total sample), followed by the delivery of joint research projects (47.7%) and the establishment of joint research centres (or laboratories, 27.3%). Feedback from the UK respondents also showed that the significance of MoUs were acknowledged by the majority of the respondents (50.5%), followed by joint research projects (38.9%) and the establishment of bilateral research alliances (38.9%). These statistics suggests that, from both the British and Chinese perspectives, the

signing of MoUs and the delivery of joint research projects have become the most important models for the cooperation between the two countries. However, Chinese respondents attached greater importance to the establishment of joint research centres (or laboratories), while bilateral research alliances were of greater significance to the UK side.

Table 5.4 Cooperation Results of Both Parties

Cooperation results	China		UK	China	
	No.	%	No.	%	
Memorandum of cooperation	31	70.0	9	50.0	
Joint research centre (or laboratory)	12	27.3	3	16.7	
Bilateral research alliance	10	22.7	7	38.9	
Joint research projects	18	47.7	7	38.9	
Others	13	29.5	5	27.8	

5.5 Perceptions of Respondents Regarding Challenges Facing Bilateral Cooperation

Respondents were asked to rate the statement provided based on the significance. Then an average score was calculated based on the total sample size. Respondents from both UK and China rated planning long-term bilateral cooperation (with an average score of 4.0 for the Chinese side and 3.9 for the British side) as the biggest challenge, as there have been few cooperative projects with a project cycle of more than 5 years. In addition, differences in project management approaches and systems (3.8 points for the Chinese side and 3.7 points for the UK side) and different motivations, perspectives and evaluation systems for collaboration (3.2 points for the Chinese side and 3.4 points for the UK side) were also rated as concerns for respondents from both sides. It is worth highlighting that, compared to Chinese respondents, British respondents attached more importance to challenges in assessing the social impact of projects (3.3 points) and direct communication with rural communities, farmers and grassroots officials (3.1 points). Chinese respondents also identified germplasm resources exchange, interdisciplinary cooperation and intellectual property protection as challenges to deepening the cooperation between UK and China.

Table 5.5 Challenges Faced in UK-China Agricultural Research Cooperation

Challenges	China	UK
Different project management methods and systems	3.8	3.7
Different motivation, perspective, and achievement evaluation systems	3.2	3.4
Challenges in planning long-term bilateral cooperation	4.0	3.9

Challenges in measuring the social impact of the project	2.8	3.3
It is not easy to enter the field and communicate directly with the local people	2.6	3.1

Notes: Each question is divided into 1-5 points based on its importance. The interviewees rate the options, and finally aggregate to get an average to obtain the data in the table.

5.6 Impact of Bilateral Funding on Future Cooperation in Agriculture

Respondents from both UK and China has come to an agreement that bilateral funding plays a very important role in agricultural research and innovation collaboration (see Table 7). Without bilateral funding, most bilateral cooperation projects in the future may not be sustainable, affecting the development and sustainability of existing cooperation, which will be a loss for both sides. Chinese interviewees also stressed the importance of bilateral funding in deepening and or expanding existing partnerships and providing valuable opportunities for the career development of young researchers in international cooperation.

Table 5.6 Impacts of Bilateral Funding on UK-China Agricultural Research Cooperation

Impacts	China		UK	
	No.	%	No.	%
Bilateral cooperation cannot proceed without bilateral cooperation funds	27	61.4	13	68.4
Bilateral cooperation funds deepen or expand our existing partnership	44	100	3	15.8
Bilateral cooperation funds provide opportunities for young researchers and staff in international cooperation	40	90.9	3	15.8

5.7 Main Factors Considered by Respondents for Future Cooperation

In terms of factors considered for future cooperation in agricultural research, cutting-edge research and innovation was the primary factor for Chinese respondents (with an average score of 4.4 points), followed by addressing global or regional challenges (3.7 points), innovation diffusion and social impact of projects (3.5 points). The British respondents placed more importance on addressing global or regional challenges (4.6 points), followed by cutting-edge research and innovation (4.2 points), diffusion of innovation and social impact of projects (4.1

points), engagement of social scientists (4.1 points) and potential impact on the Global South (3.6 points). Addressing global or regional challenges and cutting-edge research and innovation were the key factors considered by respondents from both UK and China when involving in bilateral cooperation. Compared with China, the UK side has attached greater importance to the engagement of social scientists and the potential impact on the global South in bilateral cooperation.

Table 5.7 Factors for Prioritising Future Research Cooperation

Priority Factors	China	UK
Addressing global or local challenges	3.7	4.6
Cutting-edge research and innovation	4.4	4.2
Innovation diffusion and social impact of projects	3.5	4.1
Engagement of social scientists	1.3	4.1
Impact on Global South development	1.4	3.6

Notes: Each question is divided into 1-5 points based on its importance. The interviewees rate the options, and finally aggregate to get an average to obtain the data in the table.

5.8 Priority Areas of Future Cooperation Recognized by Respondents

In terms of the areas for future bilateral cooperation in agricultural research and innovation, the Chinese respondents prioritised agricultural ecology and environmental protection (75.0% of the total sample), smart agriculture (65.9%), pathways and technologies for net zero (45.5%), food health, nutrition and quality safety standards (43.2%), animal and plant breeding and genetics (40.9%). The UK side identified smart agriculture (57.9%), agricultural resilience to climate change (47.4%), agri-environment and environmental protection (42.1%), food health, nutrition, quality and safety standards (31.6%), pathways and technologies for net zero (31.6%) and diffusion and adoption of innovations by farmers (31.6%) as priority areas. It is worth noting that animal and plant breeding and genetics was ranked fourth by Chinese respondents (40.9%) and seventh by the UK side (15.8%). In terms of innovation diffusion and farmer adoption, the UK attached greater importance than the Chinese side, ranking sixth (26.3%) and 11th (6.8%) respectively. In general, five of the top six priority areas for future cooperation are of mutual interest to the UK and China, including smart agriculture, agricultural ecology and environmental protection, carbon neutrality approaches and technologies, food health, nutrition and quality safety standards, and agricultural resilience to climate change.

Table 5.8 Priority Areas for Future UK-China Cooperation in Agricultural Research

Areas	China		UK	
	No.	%	No.	%
Smart agriculture	29	65.9	11	57.9
Agricultural ecology and environmental protection	33	75.0	8	42.1
Food health, nutrition, quality and safety standards	19	43.2	6	31.6
Innovation diffusion and farmers' adoption	3	6.8	5	26.3
Carbon neutralisation approaches and technologies	20	45.5	5	26.3
Agricultural Machinery and Engineering	6	13.6	0	0.0
Animal and Plant Breeding and Genetics	18	40.9	3	15.8
Transformation of the food system	11	25.0	3	15.8
Agricultural resilience to climate change	13	29.5	9	47.4
Developing research cooperation with the Global South	5	11.4	2	10.5
Conservation of biodiversity	4	9.1	3	15.8

5.9 Respondents' Views on Seeding or Matched Funds for Bilateral Cooperation

Regarding the question about the availability of enabling or matching funding for future UK-China cooperation in agricultural research and innovation in the respondents' institutions, 39 respondents from China did not have a clear understanding of the funding situation, while 5 respondents confirmed the availability of such funding. Six respondents from the UK clearly responded that such funding is not available, while 12 respondents did not have a clear sight on funding within their institutions. Respondents from the China side also confirmed that the matching funds from their institutions are mainly used for talent training and the operation of joint research centres (or laboratories). The fact that a large proportion of respondents on both sides are unsure about the availability of enabling or matching funds within their institutions for bilateral cooperation projects in the future to certain extent reflected the common concern among scholars on both sides about the sustainability of future bilateral projects.

Table 5.9 Internal Start-Up or Matching Funds for Future Cooperation

Answers	China		UK	
	No.	%	No.	百分比 (%)
Yes	5	11.4	0	0.0
No	0	0	6	33.3
Not sure	39	88.6	12	66.7
Sum	44	100	18	100

5.10 Impact of COVID-19 Pandemic on Bilateral Cooperation

According to respondents from both sides, the impact of the COVID-19 pandemic on bilateral cooperation is mainly reflected in the following aspects:

- COVID-19 had a significant impact on the mobility of personnel and the smooth delivery of research activities, especially for personnel exchange projects, joint training programs of doctoral students and technology demonstration projects. In addition, during the pandemic, some laboratories were closed for one or two months, which significantly affected the progress of experiments. In the absence of other alternatives, some collaborative activities are mainly conducted through "online meetings".
- COVID-19 has reduced opportunities for face-to-face communication between researchers, creating challenges in expanding researcher links and setting up new projects. The turnover and retirement of researchers during this period further interrupted cooperation channels making substantial cooperation even more challenging.
- Some cooperation projects were suspended due to the lack of timely financial support.
- Some technology companies from both UK and China were facing challenges due to the lack of face-to-face communication with end users and government staff and the follow-up from local teams. As a result, these companies were unable to understand the local market scale and the structure of governments at all levels, disrupting the continuity of product testing locally and delaying the market entry process of products.

5.11 Brief Summary of Research Findings from the Survey

Based on the analysis of the questionnaire survey results, it was found that:

- The UK and China have a good foundation for the cooperation in agricultural research and innovation, with MoUs, joint research projects, joint research centres (or laboratories), and joint research alliances recognised as the most significant outcomes.
- The main source of funding for cooperative projects between the two countries is government funding.
- Respondents from both sides agreed that bilateral cooperation needs to be further developed and strengthened rather than weakened, and that the joint funding mechanism for bilateral cooperation is crucial for maintaining and developing bilateral research and innovation cooperation in agriculture (and rural areas) in the future.
- In terms of the most important factors to be considered when planning for future bilateral cooperation in agricultural research and innovation, addressing global and regional challenges and the cutting-edge agricultural research areas are the most important factors suggested by respondents from both sides.
- The priority areas of future bilateral cooperation that are of shared interest for respondents from both sides include: smart agriculture, agricultural ecology and environmental

protection, pathways and technologies to net zero, food health, nutrition and quality safety standards, and agricultural resilience to climate change.

- The results of the questionnaire survey provided evidence to support the findings of the qualitative analysis in regards to the effects of mutual challenges and mechanisms on projects. Research findings from the 2 different methodologies also reflected that there were certain cognitive differences between the respondents from both sides on the expectations of the outcomes of bilateral cooperation, especially on the social impact of the cooperation outcomes, how social scientists and related enterprises and farmers' groups benefited from the cooperation.

6 Prospects for Future Cooperation: Basis, Priorities and Suggestions

6.1 Basis of Bilateral Cooperation

Both the UK and China have their own advantages and disadvantages in terms of agricultural research resources endowment, transformation capability of agricultural research achievements, intensity of R&D investment, and capacity to establish international research network. It is particularly worth noting that as the advocates and leaders of the United Nations Sustainable Development Goals, the UK and China have broad consensus and great potential for cooperation in addressing global challenges, including climate change, biodiversity conservation and food security. Looking to the future, the development potential and scope for bilateral cooperation in agricultural research and innovation are particularly evident in the following aspects:

- There are the complementary advantages of agricultural research resources between the two countries. The UK has significant advantages in basic research and technology commercialisation, with world-class agricultural technology innovation achievements and a thorough intellectual property protection system. However, the UK faces challenges such as small land area, limited ecological types of agricultural resources, and insufficient diffusion of advanced and mature research achievements. China has a vast territory, abundant animal and plant germplasm resources, and diverse ecological zones, making it a very suitable trial and demonstration base for conducting joint research across disciplines and for the commercialisation of research achievements. Moreover, the agricultural development in China is at a critical stage of rapid growth and transformation, with strong demands for various new technologies and great market potential, creating opportunities for promoting the application and large-scale commercialisation of research achievements through UK-China cooperation.
- Both the UK and China are committed to increase the intensity of R&D investment. The UK has set a target of raising investment on R&D to 2.4% of GDP by 2027. China plans to maintain an R&D investment intensity of over 2.4% during the 14th Five-Year Plan

Period. In this context, both the UK and China can harness the respective strengths in the innovation capabilities of researchers, experimental facilities and research platform construction capabilities to explore opportunities for win-win cooperation. For example, China can moderately channel the R&D funding into projects that address global challenges such as climate change, food security and clean energy. China and UK can jointly build world-leading research infrastructure and research platforms to tackle global challenges.

- Building international research networks complements each other's advantages. The UK and China share common interests and responsibilities in tackling global climate change, achieving net zero, biodiversity conservation, poverty alleviation and ensuring food security. The UK has an established international research cooperation network worldwide, while China still needs to accumulate more experiences expanding international links. Leveraging UK-China bilateral cooperation to actively promote the multilateral research cooperation under the network established by the UK could enhance the global impact of research outcome, contributing to the achievement of the UN Sustainable Development Goals by 2030.

6.2 Priority Areas for Future Cooperation

At present, it is crucial for both the UK and China to promote the transformation of the agricultural system towards green, low-carbon and sustainable development. This is not only vital to the security and development of contemporary agriculture in the UK and China, but also to the long-term development of agriculture in both countries and the world. In this regard, both the UK and China have a wide range of potential areas for future cooperation, with shared interests in many priority fields.

The fields of cooperation that China pays more attention to include: the basic and applied research related to smart agriculture, agricultural ecology and environmental protection, net zero, climate change, food health, nutrition and quality safety standards, animal and plant breeding and others, interdisciplinary research, exchange of young scientists, joint training of doctoral students, establishment of joint research centres (or laboratories), high-level international conferences, joint publications, etc.

The UK is more interested in the following fields of cooperation: the basic and the applied research related to smart agriculture, agro-ecology and environmental protection, climate change, food health, nutrition and quality safety standards, net zero and others, interdisciplinary research, young researcher exchanges, joint doctoral training, intellectual property protection, and tripartite cooperation.

Fields of mutual interest for future cooperation: the basic and the applied research related to smart agriculture, agricultural ecology and environmental protection, net zero, climate change, food health, nutrition, quality safety standards and others, interdisciplinary research, exchanges of young scientists, joint training of doctoral students, etc.

6.3 Suggestions for Cooperation Mechanisms

Based on the review of the achievements, practices and challenges of UK-China cooperation in agricultural research and innovation over the past 10 years, as well as a summary and analysis of the opinions and suggestions of the interviewees from both sides, the following suggestions are proposed for the reference of decision-makers and research funding agencies in UK-China S&T cooperation:

6.3.1 Developing and improving bilateral project management and coordination mechanisms with specific implementation approaches and countermeasures to address the issues raised by respondents

This report suggests that the government departments of both the UK and China strengthen discussions and coordinate amongst respective relevant institutions to develop and improve bilateral economic and trade relations, optimize the ecosystems of bilateral cooperation, and develop a unified mechanism for project coordination and management for bilateral cooperation, introducing relevant guiding principles and implementation details (for example, for data sharing, specifying what data can be shared, where data can be obtained, and who can use the data). The government departments of both countries are suggested to bring together experts and decision-makers from both countries through dialogues or seminars to encourage discussion, providing references for the formulation of implementation rules. In addition, it is recommended that the relevant sectors of both countries consolidate relevant resources and international cooperation plans based on the issues and suggestions raised in this report, discuss approaches and strategies to develop and improve bilateral cooperation mechanisms, and maximize the benefits of limited bilateral R&D investments.

6.3.2 Improving the evaluation mechanisms for bilateral project outcomes, and evaluating the outcomes from multiple dimensions

This report suggests that research funders from both UK and China establish a third-party evaluation mechanism to provide evidence to justify the subsequent funding for current or future cooperative projects. The third-party evaluation mechanism should include detailed evaluation criteria based on the characteristics and evaluation objectives of different types of cooperative projects, such as basic research, applied research, technological development and industrialisation. The evaluation criteria should also cover various dimensions, including

contributions to scientific development; technological progress; ecological development; economic benefits; social benefits; and cultural value.

6.3.3 Focusing on global agricultural challenges, jointly exploring financing mechanisms for multilateral cooperation

This report suggests that, in the future, the UK and China should explore bilateral research cooperation models that differ from the traditional international development assistance funding frameworks. Through the development of "tripartite" cooperation (such as UK-China-Southeast Asia, UK-China-Sub-Saharan Africa) or multi-party cooperation (such as UK-China, EU or other international organisations with developing countries) to establish multilateral cooperation mechanisms, funding channels, special funds, etc. The establishment of a multilateral cooperation funding mechanism will not only help consolidate and develop the achievements of the established UK-China cooperation in agricultural research and innovation, but also benefit other parties involved into the cooperation. The advantages of China lies in the vast territory, rich biodiversity and resources in agricultural ecosystems, a 5,000-year history of organic farming and the experience and lessons learnt in the research and practice of agricultural modernisation after the founding of the People's Republic of China. China also has enormous intellectual resources and coordination capacity to provide strong human resources and in-kind support for multilateral cooperation. The UK has strong historical links within the Commonwealth network, including South/Southeast Asian and African countries and mature project management approaches. Harnessing the advantages of the UK and China, the two countries can build a "tripartite" (or multi-party) cooperation network and mechanism and create a cooperation model that benefits all parties, which will contribute to the achievement of UN Sustainable Development Goals and joint tackling of the global challenges in climate change, poverty, food security and biodiversity loss.

6.3.4 Exploring innovative approaches to diversify the financing models

This report suggests that in the future, research funders from both the UK and China should involve more stakeholders in cooperative projects through various tax incentives and research achievement sharing policies encouraging enterprises and social groups to invest and engage in joint research and innovation. This will not only ensure the diversification of collaboration institutions, but also promote the commercialisation of joint research results and the sustainability of cooperative projects.

6.3.5 Strengthening long-term, stable funding support for projects in priority fields or high-quality projects

This report suggests that funders from the UK and China should focus on the strategic planning, key areas, implementation pathways and targets for each stage and field of long-term funding (such as 5 or 10 years), and publish funding opportunities in advance to provide references for partner institutions and researchers from the UK and China to formulate long-term cooperation plans. In addition, it is recommended to provide subsequent funding support to joint projects that are evaluated as high performing by both sides, so as to promote the transformation of more cooperative research outcomes into practical productivity and create more economic and social benefits for both the UK and China.

6.3.6 Establishing an integrated cooperation model of “research project + talent training + trial base + funding match from enterprises”

This report suggests that in the future, projects solely focused on research cooperation should be transformed into an integrated cooperation model of "research project + talent training + trial base + matched funding", with the matched funds mainly coming from the enterprises of both sides. This integrated model not only promotes bilateral technology exchange, talent training and talent exchange, but also brings together a group of outstanding scientists and research achievements. Under the platform of the trial bases, the research results can be transformed into practical solutions, benefiting both the UK and China and contributing to the sustainable development of global agriculture through the expertise of both UK and China.

6.3.7 Enhancing the engagement of social scientists, entrepreneurs and relevant stakeholders in bilateral projects on applied research, technology development and industrialisation

Apart from the involvement of government departments and research institutions, this report suggests that stakeholders such as social scientists, enterprises and farmers should be more engaged in the cooperative projects on applied research, technology development and industrialisation. Social scientists need to be fully involved in the design, implementation, and evaluation of the socio-economic impacts of bilateral cooperation projects, so as to drive the integration of natural and social sciences between the UK and China, promote the

commercialisation of research achievements, advance the agricultural and economic development in both countries, and generate benefits for all mankind. It is necessary to strengthen the engagement of enterprises from both countries in the future, as enterprises form an important part of the agricultural research and innovation ecosystem. Enterprises also maintains channels and advantages for direct communication with farmers or farmers' organisations, which helps to link research results with farmers' needs and related markets, addressing challenges in the low transformation rate of bilateral cooperative research results and insufficient social impact.

6.3.8 Collecting ideas and research proposals through multiple channels for bilateral or multilateral collaboration to address global challenges in sustainable agriculture and rural development, and meanwhile encouraging cooperation in multidisciplinary innovation

From the perspectives of challenges in the global agricultural sustainable development, the research funding institutions of both UK and China should collect and integrate the collaboration needs from various stakeholders, such as government departments, scientific researchers, enterprises, farmers and farmers' organisations, and plan and design priority areas for future cooperation, ensuring the achievement substantial joint research and innovation outcomes that meet the interests of both countries and transform the outcomes into productivity; It is recommended to encourage interdisciplinary cooperation in technology innovation between experts from different countries with expertise in different disciplines at the front, middle and back ends of the agricultural technology innovation chain to address more complex and comprehensive challenges in the global agricultural development.

6.3.9 Actively organising high-level academic seminars to review the achievements of bilateral cooperation and explore the direction, key areas and mechanisms of bilateral cooperation in the post-epidemic period

This report suggests that research funders from both the UK and China should work with government departments to provide financial support to the respective universities and research institutes. Research funders should actively organise high-level academic seminars in various fields, convene scientists from different countries and fields to share their experiences and practices in promoting sustainable agricultural development, and seek suggestions on topics for

future research to promote sustainable agricultural development. In addition, research funders should timely understand the development trajectory of the cutting-edge technologies and practical needs to tailor the key areas of bilateral or multilateral cooperation to allocate finite research resources in areas that meet the practical needs of both countries such as smart agriculture, climate change, ecological environmental protection, green energy, etc.

6.3.10 Establishing a UK-China Young Researchers & Innovators Alliance, and promoting and improving the exchange programs for young scholars and the joint training programs for doctoral students

This report proposes that research funders from both the UK and China work together with the respective universities to initiate and establish a "UK-China Young Researchers & Innovators Alliance". The aim of this platform is to mobilise young researchers from both sides to pay attention to the industrialisation of agricultural research achievements; establish and develop communication channels and cooperation relationships with agricultural enterprises and farmers' organisations to encourage discussions on challenges that are of concern to stakeholders; and timely share good experiences and practices from different countries and regions. It is also recommended that both the UK and China further develop and improve the exchange of young scholars and the joint training programme for postgraduate students, making it an important hook or lever for UK-China agricultural research cooperation in the new era. The relevant government departments, universities and research institutes from the UK and China are recommended to work closely to jointly open courses themed on "global sustainable agricultural and rural development", attracting young British scholars and postgraduate students to study and work in China, and conduct field research in the rural areas of China.

Annex A. List of 26 Institutions Participatory in the UK

The three UKRI Councils:

BBSRC, NERC and Innovate UK, Interview

The 23 UK institutions are as follows:

- Rothamsted Research, Interview
- John Innes Centre, JIC, Interview+Workshop
- CAB International, Interview+Workshop
- The James Hutton Insititute, JHI, Interview+Workshop
- Agri-EPI Centre, Interview
- The University of Nottingham, Interview+Workshop

- University of Leeds, Interview+Workshop
- University of Sheffield, Interview+Workshop
- Loughborough University, Interview+Workshop
- University of Stirling, Interview
- University of Lincoln, Interview
- National Institute of Agricultural Botany, Workshop
- Royal Agricultural University, Workshop
- ARBI, Workshop
- University of Edinburgh, Workshop
- Newcastle University, Workshop
- Royal Holloway University, Workshop
- Queen Mary University, Workshop
- University of Exeter, Workshop
- Durham University, Workshop
- Lancaster University, Workshop
- James Hutton Ltd, Workshop
- Allied Peak Ltd, Workshop

Annex B. List of 26 Institutions Participatory in China

The one funding institution:

- Ministry of Science and Technology of China, Interview

The 25 research institutions are as follows:

- Department of International Cooperation of Chinese Academy of Agricultural Sciences, CAAS, Field Research
- Agricultural Information Institute of CAAS, Questionnaire + Field Research
- Institute of Crop Sciences of CAAS, Questionnaire+Interview
- Institute of Plant Protection of CAAS, Questionnaire+Interview
- Institute of animal Sciences of CAAS, Questionnaire+Interview
- Institute of Vegetables and Flowers of CAAS, Questionnaire+Interview
- Institute of Agricultural Resources and Regional Planning of CAAS, Questionnaire+Interview
- Institute of Food Science and Technology of CAAS, Questionnaire+Interview
- Harbin Institute of Veterinary Research of CAAS, Questionnaire+Interview
- Lanzhou Institute of Husbandry and Pharmaceutical Sciences of CAAS, Questionnaire+Interview
- Chinese Academy of Sciences - John Innes Centre, Interview
- Institute of Botany, Chinese Academy of Sciences, Questionnaire
- Institute of Genetics and Developmental Biology, Chinese Academy of Sciences), Questionnaire+Interview

- China Agricultural University, Questionnaire+Interview
- Nanjing Agricultural University, Questionnaire+Interview
- South China Agricultural University, Questionnaire+Interview
- Huazhong Agricultural University, Questionnaire+Interview
- Northwest Agriculture and Forestry University, Questionnaire
- Chinese Academy of forestry, Questionnaire+Interview
- Chinese Academy of fishery sciences, Questionnaire+Interview
- Chinese Academy of Tropical Agriculture, Questionnaire+Interview
- Research Centre of Information Technology of Beijing Academy of Agriculture and Forestry Sciences, Questionnaire+Interview
- Jiangsu Academy of Agricultural Sciences, Questionnaire+Interview
- Shandong Academy of Agricultural Sciences, Questionnaire+Interview
- Zhejiang University, Questionnaire

Annex C. Questionnaire Designed for UK's Participants

This is a tendered project invited by the British Embassy Beijing recently to conduct a research with theme of UK perspectives on priorities, mechanisms and best practices for UK-China Cooperation in agricultural research (broadly defined including basic or applied research) and innovation (multiple stakeholders involved). Accordingly, this questionnaire is designed to collect relevant information, opinions and suggestions from senior managers of research groups (or consortium, School/Department) to individual researchers/project managers within UK's institutions or universities who have had experience involved bilateral cooperation. Your views, voices and suggestions are important for us to prepare a joint research report with Chinese Academy of Agricultural Sciences presented to UKRI and Chinese agencies (e.g. MOST and NSFC). The survey is anonymous and confidential. Information collected through this survey will be used in the project funded by the British Embassy, and for further related academic analysis led by the University of Nottingham only. We are very grateful for your support by filling online questionnaire before **30 November 2022**.

Dr Bin Wu, Senior Research Fellow of NUBS and PI of this project

1 Type of organisation (Single):

- | | |
|---|---|
| <input type="checkbox"/> Academic Institution (e.g. University) | <input type="checkbox"/> Civil Society |
| <input type="checkbox"/> Independent Research institute | <input type="checkbox"/> Agri-Relevant Consulting Company |
| <input type="checkbox"/> Other (Please specify) _____ | |

2 Your current position:

- Dean or Head of School/Department of Institution

- Leader of a Consortium or Research Group
- Established researchers (e.g. Professor, AS Professor or Researcher >10 ys PhD)
- Young researchers understand 10 years since gained PhD
- Project manager or Project supporter (e.g. technician)
- Other (Please specify) _____

3 Your age band (year old):

- <30 30 -39 40-49 50 or above

4 Disciplinary:

- Nature/Engineering Social Sciences Mix

5 Area of your expertise (Multiple):

- | | |
|--|--|
| <input type="checkbox"/> Plant (seeds, horticulture, forestry) | <input type="checkbox"/> Animal husbandry |
| <input type="checkbox"/> Aquaculture | <input type="checkbox"/> Pests & disease management |
| <input type="checkbox"/> Harvest, store & logistics | <input type="checkbox"/> Food processing technology |
| <input type="checkbox"/> IT and agri-information system | <input type="checkbox"/> Soil, water, ecosystem services |
| <input type="checkbox"/> Agricultural economy and politics | <input type="checkbox"/> Food system, culture and policy |
| <input type="checkbox"/> Others (Please specify): _____ | |

6 How long has you or your group engaged with Chinese partners? _____(years)

7 How many Chinese institutional partners have you or group involved? _____

8 How many bilateral projects have you or group completed since 2012? _____

9 What are outcomes of bilateral cooperation led by your organisation (multiple)?

- Consortium Joint centre Signed MoU Joint programme

10 Successful funding applications of your group with Chinese partners? (Multiple)

- Newton Fund or other bilateral programmes
- Other funding programmes in the UK (e.g. GCRF, UKRI, Royal Society, etc)
- Other funding programmes in China (e.g. NSFC Int'l Cooperation etc)
- Government funding in UK or China (DFID, DEFRA, MARA, MoE, MOST)
- Industrial funding (Specify) _____

11 Who are key stakeholders of your group for bilateral cooperation?

- Research institutions
- Industrial/trade companies
- Government agencies
- Non-government organisations
- Farmer association/cooperative
- Private farmers
- Other _____

12 What are motivation/factors behind you or group involving the cooperation? (Multiple)

- New technology to cope with challenges
- Share of standards, methods and good practices
- New system for efficient/sustainable use of resources
- Academic networking for bilateral cooperation
- Opportunities for young researchers
- Other _____

13 What benefits have you gained from bilateral cooperation so far? (Please √ where appropriate, from 1 lowest to 5 highest)

	1	2	3	4	5	N.A.
Understanding local challenges & good practices	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
High quality publications in high ranked journals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
New technology to tackle challenges	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Innovation diffusion & social impact widely	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pathways to empower small farmers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Network building, ECR career, teamwork	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (please specify): _____						

14 What barriers or lessons have you learnt from bilateral cooperation in the past?

Item	1	2	3	4	5	N.A.
Different approach, evaluation system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Different management system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Difficult in access to local people site	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Difficult in measuring social impact	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Difficult for a long term plan	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (please specify): _____						

15 From your personal perspective what are the most important from bilateral cooperation regardless of Covid interruption? (Please √ where appropriate, from 1 lowest to 5 highest)

Criteria	1	2	3	4	5	N.A.
Mutual trust building	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
High quality publications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Government support or recognition	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Teamwork and capacity building	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Interdisciplinary collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

16 Applying above criteria, do you have a specific example? If so, please provide the title of project with a brief explanation below:

17 To what extent has the Covid pandemic interrupted the bilateral cooperation?

Impact	1	2	3	4	5	N.A.
Confident for long term cooperation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional partnership	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Difficult to complete funded projects	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Difficult to maintain academic collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (please specify): _____						

18 To what extent is the bilateral funding vital for the collaboration with China? (Single)

- Without the funding, our collaboration won't take place
- Accelerating or scaling up our existing partnership
- Accelerating innovation diffusion/social impact in China or beyond
- Contributed to capacity building for bilateral cooperation
- Other (Specify) _____

19 For future bilateral cooperation, what factors should be taken into account

Factors	1	2	3	4	5	N.A.
Global and local challenges	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cutting-edge research	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Innovation diffusion & social impact	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Participation of local communities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Potential impact in the global south	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (please specify): _____						

20 Could you select up to three items below as priority areas recommended to UKRI and its Chinese counterparts for consideration?

- Smart agriculture (husbandry, farm) Seeding & genetics (plant, animal)
- Sustainable use of soil & water resources Biodiversity protection
- Food health, nutrition, safety standard Food system transition

Innovation diffusion and farmer adoption Agriculture resilience against climate change

Pathway & tech of carbon neutrality Research collaboration in the global south

21 For bilateral cooperation in the future, do your institution have internal seed funding or match-funding to enable bilateral projects?

Yes No Maybe

22 Do you have any idea, comment or suggestion? If so, we really appreciate if you could write down into the box below

MANY THANKS FOR YOUR PARTICIPATION AND SUPPORT

Annex D. Questionnaire Designed for Chinese Participants

This questionnaire is based on the principles of data openness and citation, and aims to systematically understand UK-China collaboration in agricultural research over the past 10 years (since 2012), and identify areas of improvement in collaboration and future fields of collaboration. Based on team's rich experiences in UK-China agricultural research collaboration over the years, hoping to take time out of your busy schedule and provide feedback before 31 November 2022. Project team of CAAS will greatly appreciate it.

The research report based on the contents of this questionnaire will be submitted to the higher authority for international cooperation, and will serve as a reference for further promoting UK-China collaboration in agricultural research and innovation.

Project Team of CAAS

1 Type of your unit

Higher education institutions

Civil society

Research institutions

Agricultural consulting company

Others (please specify)

2 Basic information of your team

Name of team contact:

Phone number of team contact:

Email of team contact:

3 Research areas of your team (multiple)

<input type="checkbox"/> Botany (crops, horticulture, forestry)	<input type="checkbox"/> Husbandry
<input type="checkbox"/> Aquaculture	<input type="checkbox"/> Prevention and Control of Animal and Plant Diseases and Pests
<input type="checkbox"/> Harvesting, storage, and logistics	<input type="checkbox"/> Food processing and technology
<input type="checkbox"/> Information Technology and Agricultural Information System	<input type="checkbox"/> Soil, Water, and Ecosystem Services
<input type="checkbox"/> Agricultural Machinery and Engineering	<input type="checkbox"/> Food System, Culture, and Policy
<input type="checkbox"/> Agricultural Economy and Policy	<input type="checkbox"/> Others (please specify) _____

4 Background of UK-China agricultural research collaboration in your team

How many years has your team worked with UK partners?

How many UK partners has your team worked with? _____

How many UK-China agricultural research cooperation projects has your team completed since 2012? _____

5 What are the channels through which your team and UK partners have successfully applied for funding for collaborative projects (multiple)?

Newton Fund	<input type="checkbox"/>
Other UKRI-funded projects, the Royal Society of the UK, etc	<input type="checkbox"/>
NSFC projects	<input type="checkbox"/>
Projects funded by the Chinese or British institutions (Department for International Development, Department of Environment, Food and Rural Affairs, Ministry of Agriculture and Rural Affairs, Ministry of Science and Technology, Ministry of Education)	<input type="checkbox"/>
Enterprise funded projects (please specify) _____	<input type="checkbox"/>

6 Who are the key stakeholders in your team for UK-China collaboration in agricultural research?

Type	China	UK
Higher education institutions	<input type="checkbox"/>	<input type="checkbox"/>
Public or private enterprise institutions	<input type="checkbox"/>	<input type="checkbox"/>
Government agencies	<input type="checkbox"/>	<input type="checkbox"/>
Scientific research institutions	<input type="checkbox"/>	<input type="checkbox"/>
Non-governmental organisations	<input type="checkbox"/>	<input type="checkbox"/>
Farmers' associations or farmers' cooperatives	<input type="checkbox"/>	<input type="checkbox"/>
Others (please specify) _____		

7 What are the driving factors for your team's participation in UK-China collaboration in agricultural research? (Multiple)

◆ New understanding of agricultural challenges in the UK or globally	<input type="checkbox"/>
◆ New technologies defined through funding projects to address	<input type="checkbox"/>

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agricultural challenges

- ◆ Knowledge exchange to share standards, methods and best practice

- ◆ Accelerating the application of new technology systems in production

- ◆ New management systems for effective/sustainable use of resources

- ◆ Opportunities to participate in bilateral collaboration to build academic networks

- ◆ Provide opportunities for stakeholders to participate in bilateral collaboration

- ◆ Attracting/providing opportunities for young researchers to participate in bilateral collaboration

- ◆ Others (please specify) _____

8 What benefits has your team gained from UK-China collaboration in agricultural research so far? (Please tick where appropriate, with scores ranging from 1 to 5)

Items						Not
	1	2	3	4	5	relevant
Visiting the local area to identify local challenges or good practice	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Publishing high quality papers in high impact journals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Setting up collaborative platforms (such as joint laboratories)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
New technologies or solutions to address challenges	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Innovation disseminated widely in the UK or other regions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Social impact and sustainability in the UK or other regions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Addressing the needs of small farmers in the UK or other regions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Network building research, early career development, long-term team collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Supporting China's research and development, economic growth and international trade	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
International cooperation and the Sustainable Development Goals of the Global South	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

9 What challenges to overcome has your team encountered or learned from previous bilateral collaboration? (Please tick where appropriate, with scores ranging from 1 to 5)

Items	1	2	3	4	5	Not relevant
Unequal interests	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Challenges in sharing germplasm resources	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Challenges in sharing data	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Different motives, methods and evaluation systems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Differences in management methods and systems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Challenges in interdisciplinary collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Challenges in designing and measuring social impact	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lack of talent in bilateral S&T cooperation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Language challenges	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Long-term cooperation with insufficient funding	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Challenges in protecting intellectual property	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

10 From your team's perspective, despite the impact of COVID-19, pandemic what should be the main focus of bilateral collaboration? (Please tick where appropriate, with scores ranging from 1 to 5)

Items	1	2	3	4	5	Not relevant
Long-term cooperation based on mutual trust	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
High quality publications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Provide users with mature technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Good recognition from authority/society	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Teamwork and capacity building	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Building research networks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Training of young researchers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

11 To what extent has COVID-19 pandemic affected your team's UK-China collaboration in agricultural research? (Please tick where appropriate, with scores ranging from 1 to 5)

Items	1	2	3	4	5	Not relevant
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Research Report on UK-China Cooperation in Agricultural Research and Innovation

Confidence in long-term collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Institutional/partner interaction	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Completing collaborative projects	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Planning new projects	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sustaining academic collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Maintaining research networks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Academic exchanges and visiting scientists	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Funding opportunities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

12 To what extent has bilateral funding affected your team's agricultural research collaboration with the UK? (multiple)

◆ Without bilateral funds, bilateral collaboration cannot take place	<input type="checkbox"/>
◆ Bilateral collaboration funds deepen or broaden our existing partnership.	<input type="checkbox"/>
◆ Bilateral funds set the direction for research cooperation	<input type="checkbox"/>
◆ Bilateral funds have contributed to young researchers and staff in international collaboration	<input type="checkbox"/>
◆ Bilateral funds have contributed to the capacity development of other countries in the Global South.	<input type="checkbox"/>

13 Which of the following factors should your team consider for future UK-China agricultural research collaboration (please tick where appropriate, scoring from 1 to 5)?

Factors	1	2	3	4	5	Not relevant
Food security	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Global and local challenges	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cutting-edge research and innovation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Stakeholder involvement in solution development	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Involvement of social scientists	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Agroecology/ecosystem	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Social innovation for smallholder farmers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Innovation diffusion and social impact	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Potential impact on the Global South	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

14 Can you select up to 5 priority areas for the next round of bilateral funding?

<input type="checkbox"/> Smart agriculture	<input type="checkbox"/> Animal and Plant Breeding and Genetics
<input type="checkbox"/> Sustainable use of water and soil resources	<input type="checkbox"/> Conservation of biodiversity
<input type="checkbox"/> Food health, nutrition, quality and safety standards	<input type="checkbox"/> Transformation of the food system
<input type="checkbox"/> Diffusion and adoption of innovations by farmers	<input type="checkbox"/> Agricultural resilience to climate change
<input type="checkbox"/> Carbon-neutral approaches and technologies	<input type="checkbox"/> Research Cooperation in the Global South
<input type="checkbox"/> Agricultural machinery and equipment	<input type="checkbox"/> Agroecology and environmental protection

15 For future bilateral cooperation, does your institution have start-up or matched funds for bilateral projects?

Yes <input type="checkbox"/>	No <input type="checkbox"/>	Not sure <input type="checkbox"/>
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Annex E. List of Key Questions for Interviews for UK Participants

This document is prepared to conduct interviews with senior managers or key informants of selected institutions to develop in-depth understanding about progresses, achievements, good practices and key issues for bilateral cooperation in the past and future. Alongside background information of CfP and institutional questionnaire, the list of questions is to provide a guidance for effective communication although the process of the interview may not necessarily follow or limited to listed questions. Around one hour interview will be delivered and recorded via MS Team meeting. The interview is confidential for academic analysis only. The release of relevant information will follow GDPR regulation and university code. I pass the privacy notice and consent form for your information. We would be grateful if you could confirm to accept the interview by filling and returning the consent form, associated with timeslot availability from Monday 7th until Wednesday 23rd this Month so we can organise a suitable meeting invitation.

Dr Bin Wu, Senior Research Fellow of NUBS and PI of this project

The key questions are as follows:

- Briefly introduce yourself, your institution, previous research cooperation with Chinese institutions in agricultural research and innovation. How many Chinese institutional partners has your organisation collaborated with in this domain?
- What is the scope of the institution's bilateral collaborations in terms of discipline, research & knowledge exchange? How many staff have been involved and how important is this

domain to your institution? What additional strengths do you have for bilateral cooperation among UK institutions?

- Regardless of Covid impact, what has been the distribution of external funding sources for bilateral cooperation: e.g. UK programmes such as bilateral programs (Newton Fund), or other UK programmes (UKRI, GCRF, Leverhulme, British Academy, British Council, Royal Society, etc) and China (NSFC, MOST), governmental funding (e.g. DFID, DEFRA in the UK, MARA, Ministry of Education, CSC, local governments in China), industrial funding sources?
- What achievements have you gained from the bilateral cooperation? Can you recommend and discuss **three good practices** in the past? What criteria do you adopt for evaluation, and how does this differ between domestic or international projects? What are key factors behind success, and to what extents are above projects sustainable, duplicated, or disseminated widely?
- According to your observation, what are common issues or barriers against bilateral cooperation? Could you give one or two cases to illustrate these issues? In your opinion, what are major factors, or causes behind these problems and can you suggest strategies to allow barriers to be removed or mitigated?
- To what extents has the Covid pandemic interrupted bilateral cooperation? Could you give one or two examples to help explain how serious impact?
- In relation to bilateral cooperation in the post-Covid era, what are priorities areas or challenging issues to be addressed in your institution? Where are resources and opportunities to do so? Do you have any good models/or mechanisms to recommend for institutional/individual collaboration? What qualities of Chinese partners attract your institution to help initiate collaboration?
- In relation to potential future bilateral funding policies, could you offer some suggestions about funding models, coordination mechanisms and/or evaluation systems or other key aspects that could improve successful interaction? What are principles or experiences behind your recommendation? And what particular challenges, fields (e.g. technology, system and management) or platform should be prioritised, and why? Does your institution provide internal seed funding or match-funding for bilateral collaboration?
- In the context of global challenges and sustainable development goals, can you comment on links between bilateral (UK-China) and triangular (UK-China-Global South) cooperation? Do you have any ideas, good practices, recommendations or suggestions for research institutions, funding agencies or others who may be particularly important to include?

List of key questions for interviews with UK's funders

This document is prepared to conduct interviews with representatives of research councils to develop in-depth understanding about progress, achievements, good practice and key issues associated with bilateral cooperation both in the past and future. Alongside background information of CfP and information gathered from a research institution questionnaire, this list of questions aims to help effective communication although the process of the interview may not necessarily follow or be limited to the listed questions. An interview of around one hour will be delivered and recorded via a MS Team meeting. The interview is confidential and for academic analysis and joint report with CAAS. Following GDPR regulation and university code, I have attached the privacy notice and consent form. We would be grateful if you could confirm your acceptance for the interview by filling and returning the consent form, including availability of your timeslots from Monday 7th until Wednesday 23rd this Month so we can organise meetings.

Dr Bin Wu, Senior Research Fellow of NUBS and PI of this project

The key questions are as follows:

- Briefly introduce yourself and the mission and functions of your council in relation to funding supporting UK-China research cooperation in general and agricultural research and innovation in particular.
- How many programmes have you issued and completed relating to bilateral cooperation in agricultural research and innovation in the past 10 years? What was the scope, aims and rationale for these programmes? How important are those programmes for bilateral cooperation between the UK and China and other countries? How was this funding different to opportunities from other research councils or funding sources? Have you been involved in funding calls jointly with other UK funders?
- Can you outline the achievements that have been gained from bilateral cooperation in terms of research, application, platform/consortium, capacity building, social impact? Can you provide **a few examples of successful cases or good practices with details for us**? In your opinion, what are key factors behind successful projects, and to what extent are those projects sustainable, duplicated, or disseminated widely?
- What are common issues or barriers against bilateral cooperation? What are major factors or causes behind, and by what strategies above barriers may be removed or mitigated?
- In relation to bilateral cooperation in the post-Covid era, what are your priority areas or challenge issues to be addressed or developed? What criteria or rationale relate to your consideration of these areas?
- In terms of partnerships with Chinese funding counterparts including Ministry of Science and Technology (MOST) and Natural Science Foundation of China (NSFC), can you provide an overview of joint programmes in the past 10 years and what changes have happened? Which programmes have been successful, how and why? Similarly what lessons can be learnt for the improvement in the future? Compared with other country's counterparts, what are your perceptions of the features and differences of Chinese partners in terms of approach, priority, programme management?
- To what extent have global challenges and sustainable development goals influenced past

bilateral funding programmes? What are your views or comments on the relationship between bilateral (UK-China) and triangular (UK-China-Global South) cooperation?

Annex F. List of Key Questions for Interviews for Chinese Participants

This interview follows the principle of data openness and citation, and aims to systematically understand the cooperation between the UK and China and in the field of agricultural research in the past 10 years (from 2012), and to sort out the challenges faced in the cooperation. At the same time, in order to further promote better cooperation between the UK and China in the field of agricultural research and innovation in the future, hope to provide some opinions and suggestions based on the years of cooperation achievements and experiences.

The research report prepared on the basis of the content of this interview will be submitted to the higher authority for international cooperation and will serve as a reference for the further promotion of UK-China agricultural technology cooperation.

Project team of CAAS

List of key questions for Interviews with project managers

The key questions include:

- Brief information about your organisation
 - Name:
 - City:
 - Name of contact:
 - Phone of contact:
 - Email of contact:
- Overview of UK-China cooperation
 - In which year did your organisation start cooperation with the UK?
 - Has your organisation cooperated with the UK in agricultural research in the past 10 years?
 - With how many institutions in the UK has your organisation cooperated in agricultural research in the past 10 years?
 - How many projects of UK-China cooperation in agricultural research has your institution carried out in the past 10 years?
 - What are the types of UK-China cooperation projects in agricultural research in the past 10 years (such as basic research, technical cooperation, establishment of joint laboratories, seminars and training, short-term visits, exchange projects, joint training, joint publications, etc.)?

- What are the sources of funding for UK-China cooperation projects in agricultural research in the past 10 years?
- Is there currently a break in cooperation between your organisation and the UK's partners? If so, what is the reason for the interruption?
- Does your organisation have a joint laboratory with the UK's partners?
- If so, is the laboratory now operating normally?
- If the joint laboratory is not operating normally, what is the problem?
- Over the past 10 years, what proportion of UK-China cooperation projects in agricultural research have been basic research projects? What is the proportion of technical cooperation projects?
- Has your organisation ever participated in multilateral cooperation projects involving both the UK and China? If so, what is the name of the project? Who is funding the project?
- Experience and Lessons
 - What have been the achievements of your organisation in the process of cooperation between the UK and China in the last 10 years? Please list 1-2 successful cases and practices?
 - What challenge has your organisation encountered in the process of cooperation between the UK and China in the past 10 years? Please list them.
 - What profound lessons has your organisation learnt in the process of cooperation between the UK and China in the past 10 years that are worth learning from?
- Future collaboration opportunities
 - What are the advantages of agricultural research in your organisation?
 - In what aspects has the UK attracted your organisation to cooperate with it?
 - In which institutions and areas of agricultural research does your organisation plan to cooperate with the UK in the future?
 - What are the possible areas of cooperation between the UK and China in the future? (such as basic research, technical cooperation, establishment of joint laboratories, seminars and training, short-term visits, exchange projects, joint training, joint publications, etc.)
- Recommendations

In order to promote better cooperation between the UK and China in the field of agricultural research in the future and make a positive impact, hope to put forward some suggestions from the following aspects:

- Proposals for joint application projects.
- Suggestions for joint funding models.
- Suggestions for models of communication and exchange.
- Suggestions for the evaluation of cooperative projects.
- Suggestions for the sustainability of cooperative projects.

List of Questions for Interviews with Chinese Funders

The key questions are as follows:

- As a Chinese sponsor, what outstanding achievements have been recognized by the MOST in the China-UK bilateral cooperation in agricultural science, technology and innovation over the past 10 years?
- What are the challenges faced by the Ministry of Science and Technology and the National Natural Science Foundation of China in working with the various research councils of UKRI?
- After the completion of the UK-China cooperation project, how do the Ministry of Science and Technology and the National Natural Science Foundation of China evaluate the outcomes of the cooperation project in the future?
- What are the priority areas for future cooperation between the Ministry of Science and Technology and the National Natural Science Foundation of China and the UK in agricultural science and technology cooperation? What are the suggestions or expectations for future bilateral cooperation?

Annex G. Programme of UK-China Cooperation in Agricultural Research and Innovation Workshop: Review and Prospect

(9:30 -12:30, 28 November 2022, MS Teams)

Session I Introduction and keynote speech (9:30 to 10:15)

Chair: Prof. Tim Daniell, University of Sheffield

9:30 – 9:40 Welcome and introduction with Ms Jingjing Jiang from the British Embassy Beijing

9:40 – 9:50 Why is bilateral cooperation important for both sides? Prof Steve Banwart, Director of Global Food and Environment Institute, Leeds University

9:50 – 10:00 How to make successful bilateral cooperations: lessons learnt from practical experience, Dr. Jonathan Snape, Head of James Hutton Limited

10:00 – 10:10 Systematic innovation approach for agricultural sustainability and bilateral cooperation, Dr. Bin Wu, University of Nottingham, PI of this project

10:10-10:15 Q & A

Session II (discussion 1): Share experiences and lessons (10:15-11:15)

Chair: Dr Peter Noy, Associate Director of Research, Future Food Beacon, UoN

Parallel Rooms to introduce or discuss following questions [**45 minutes**]:

- Self introduction of attendees including bilateral project/programme involved
- What are good practices or mechanisms to be shared?
- What challenges arose in those projects or what lessons can be learnt?

Plenary Room for five group reports and further discussion

Session III (discussion 2): Priorities and mechanisms (11:15-12:15)

Chair: Dr Jonathan Snape, Head of James Hutton Limited

Parallel Rooms (Group I to V) to discuss following questions [**45 minutes**]:

- What priority areas do you recommend and why?
- What mechanisms do you recommend to enhance bilateral cooperation?
- What can we do to enhance institutional partnership for cooperation?

Plenary Room for five group reports and further discussion

Session V Wrap-up and conclusion (12:15-12:30)

Chair: Ms Min Rose, Director of Knowledge Exchange, UoN Ningbo China (UNNC)

Panellists: Tim Daniell; Lesley Torrance; Andrew Salter; Jonathan Snape; Peter, Noy; Bin Wu

Questions:

- What most important achievements do you want to highlight?
- What are key messages which can pass to UKRI, FCDO & other funders?
- What are your suggestions to enhance our cooperation?

Annex H. Summary of Two Case Studies

Conducted by CAAS

1. Basis for Case Selection

The case study of this project mainly selects two institutions, namely the CAAS and Nanjing Agricultural University (NAU). The basis of selection is as follows:

- The CAAS was chosen as the first case study mainly because it has the following advantages:
 - As a nation-level comprehensive agricultural research institution and an important national strategic research force in agriculture, it undertakes the tasks of national agricultural basic research, applied research and high-tech research.

- It has made significant achievements in international cooperation. At present, it has established extensive research cooperation relations with 83 countries, 38 international organisations, 7 multinational companies and the Gates Foundation. A total of 13 international organisations have set up offices in China at the CAAS, and 62 joint laboratories/joint research centres have been established.
- It has excellent research achievements. A large number of new materials, technologies and equipment, represented by avian flu vaccines, biogas, hybrid rice and small farm machinery, have gone abroad one after another.
- The selection of the NAU as the second case study is mainly based on the following two points:
 - As a national key agricultural university, it has a complete range of disciplines. With over 110 years of educational history, it is a national key university directly under the MoE, with advantages and characteristics in agriculture and life sciences, and the coordinated development of multiple disciplines such as agriculture, science, economics, management, engineering, humanities and law.
 - The level of internationalisation is high, and international cooperation has achieved significant achievements. It has conducted the projects of joint student training, academic exchanges and research cooperation with more than 160 top universities and research institutions from over 30 countries and regions. In 2012, the NAU initiated the establishment of the "World Agricultural Award", which has been held for 10 consecutive sessions.

2 A Case on UK-China Cooperation of the CAAS

2.1 Cooperation Achievements

The main cooperation achievements include:

- Further expanding the partnerships. By 2022, the CAAS has already signed cooperation agreements and established good partnerships with 12 agricultural research institutions and universities in the UK.
- Continuously improving agricultural research cooperation mechanism. In 2015, the CAAS and the Lausanne Research established the "UK-China Joint Centre for Sustainable and Intensive Agricultural Development". In 2016, the Graduate School of the CAAS and the University of Aberdeen jointly established the "UK-China Agricultural Nitrogen Management Centre". In 2017, the Shanghai Veterinary Research Institute jointly established the "UK-China Joint Laboratory for Poultry Disease Research" with the Pirbright Research Institute in the UK.
- Continuously expanding and refining fields of cooperation. For example, genetic research on changes in the flowering period of the *Cruciferae* family has been carried out with the JIC, soil productivity and nutrient cycling with the Centre for Ecology & Hydrology and joint research on technology for the prevention and control of avian tumour disease and

the pathogenesis of avian tumour disease with the Pirbright Institute.

- Academic exchanges between researchers becoming more frequent. In 2017, the CAAS dispatched a total of 49 delegations and 103 researchers to visit cooperative institutions in the UK, enhancing mutual trust between the two sides.

2.2 Challenges Faced in the Cooperation

The main challenges include:

- Due to differences in the management mechanisms of research projects between the two parties, communication and exchanges on the project are not smooth.
- Due to uncertain supporting funds from the Chinese side, the sustainability of the project is poor.
- There are some challenges to overcome in the exchange of germplasm resources, resulting in insufficient in-depth cooperation between research institutions and seed companies on both sides.
- The complex customs procedures have led to delays in the delivery of research materials, which has affected the progress of the cooperative project.
- The lack of understanding between the two parties on their respective international cooperation policies has increased the uncertainty of successfully applying for the cooperative project.
- There are challenges in sharing data, which prevents the two parties from deep cooperation.

2.3 Future Fields of Cooperation

The CAAS has 34 research institutes directly under it and 9 jointly established research institutes, and has made a large number of important research achievements with the international advanced level in the fields of crop science, horticulture, animal husbandry, veterinary medicine, resources and environment, engineering and machinery, quality assurance and processing, information and economics. In the future, it is expected to fully understand the R&D progress of the UK's leading research institutions, leading experts and key fields, further strengthen cooperative R&D in the fields such as smart agriculture, agricultural biotechnology, bio-information, plant science, plant nutrition, integrated pest control, foreign biological invasion, agricultural remote sensing, soil, resources and environment, food safety, agricultural economy, and meanwhile to further promote the joint training programme of doctoral students and collaboration in joint laboratory construction, intellectual property protection and other aspects.

3 A Case on UK-China Cooperation of the NAU

3.1 Cooperation Achievements

The main cooperation achievements are as follows:

- **Continued expansion of partnerships.** Currently, the NAU has signed inter-university cooperation agreements with 11 universities and research institutions in the UK.
- **Diversified cooperation models.** Current cooperation models mainly include:
 - Carrying out joint research projects and jointly undertaking international cooperation projects.
 - Talent training, including joint training of teachers and students, exchange and study abroad, etc.
 - Joint construction of a joint research centre.
 - Joint holding of international conferences.
- Continuously strengthening cooperation at a deeper level with partners. Collaboration with the Rothamsted Research initially consisted of joint publication of papers and mutual visits of personnel; then Chinese personnel went to the Lausanne Research as visiting scholars and post-doctoral fellows, and both sides collaborated in publishing papers in high-level journals. Later, the two sides jointly undertook international cooperation projects.
- Continuous development of student projects under inter-university agreements. In 2011, a cooperation with the University of Reading was established, and by 2020, a total of 15 students have studied at the University of Reading.
- Good results in transforming research achievements. the NAU filed an international patent application with British Plant Biotechnology Limited (PBL) for the genetically modified plant OsNRT2.3b, which was researched in cooperation with Dr Miller and the College of Resources and Environmental Sciences of the NAU.

3.2 Challenges Faced in the Cooperation

The NAU faces the following challenges in its cooperation with its British partners:

- There are certain differences between the rules governing research project management and those governing financial management, resulting in a certain lack of understanding between the two parties.
- There is a lack of specific plans and guidelines for data sharing and security.
- There is a lack of stable and sustainable cooperative teams. Due to changes in cooperation personnel and institutions, there have been changes in partners and cooperation models, and some cooperative projects cannot be continued well.
- There is a lack of interdisciplinary talent with international perspectives and cooperation skills, resulting in fields of cooperation that are not truly aligned with the common interests of both parties.
- There is a lack of sustainable cooperation mechanisms, such as a lack of long-term

financial support, which means that cooperation cannot be proceeded to a deeper level.

3.3 Future Fields of Cooperation

The NAU is located in economically developed Jiangsu Province, which has good agricultural resources and an excellent ecological environment for research and innovation. It is very suitable for trialing, demonstrating and transferring research achievements in agricultural projects. In addition, the NAU has a comprehensive range of disciplines, a total of 104 national and provincial research platforms, and over 9000 *mu* of teaching and research bases (1 *mu* = 0.067 ha.), which can provide software and hardware support for research cooperation between the two sides. In the future, it is expected to further strengthen cooperative R&D in smart agriculture, ecological agriculture, plant phenotype, plant nutrition, entomology and other fields, and actively promote practical cooperation in intellectual property protection, the establishment of joint laboratories, the joint training of students and the joint holding of international conferences.

