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## Chinese Academy of Sciences Luancheng Agro-ecosystem Experimental Station Postprint

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### Abstract

### Full Text

### Preamble

The Luancheng Agro-Ecosystem Experimental Station of the Chinese Academy of Sciences (hereinafter referred to as “Luancheng Station”) was established in 1981. It joined the Chinese Ecosystem Research Network (CERN) in 1988, became a member of the Global Terrestrial Observing System (GTOS) in 1999, and was incorporated into the Chinese National Ecosystem Research Network (CNERN) in 2005. During the 2006–2010 comprehensive evaluation of CERN, Luancheng Station was awarded “Excellent Field Station.”

### Research Objectives and Positioning

Luancheng Station targets international frontiers in agro-ecology and addresses national needs for food security and water resource security. Focusing on ecological and environmental issues in the groundwater over-exploitation areas of the North China Plain, the station conducts long-term comprehensive observations of regional agricultural ecosystem structure, function, and evolution processes, as well as research on response mechanisms to global change and intensive production. The station explores energy, water, and nutrient transfer processes at ecosystem interfaces and their internal regulatory mechanisms, and investigates optimization and control mechanisms for the structure and function of agro-ecological-economic composite systems. Key research and development efforts focus on integrating modern water-saving agriculture technologies, clean fertilization management techniques, molecular breeding technologies, and precision agriculture applications to achieve efficient resource utilization and management. The station aims to develop a theoretical system and regional optimiza-

tion demonstration models for sustainable agricultural ecosystem management in the North China Plain.

## Research Achievements and Scientific Contributions

Luancheng Station has conducted theoretical research and technology demonstration on water-saving irrigation, balanced fertilization, crop varieties, plain animal husbandry, facility agriculture, agricultural machinery, and rural new energy sources. The station has made several significant scientific contributions. First, it clarified farmland water interface flux and evapotranspiration structure, proposed a “rebound response mechanism” for crops under moderate water stress, enriched non-full irrigation theory and technology, and developed a limited irrigation theory and interface water-saving regulation technology system. Second, the station quantified nitrogen flux in farmland ecosystems in the piedmont plain of the Taihang Mountains, elucidated nutrient processes and non-point source pollution control mechanisms, and reached innovative conclusions regarding the promotion of denitrification in deep soil layers to reduce nitrate leaching and groundwater contamination risks. Third, it clarified farmland water balance mechanisms, revealed water movement and solute transport processes in deep vadose zones, and proposed adjustment pathways for agricultural cropping systems suitable for local hydroclimatic characteristics, providing scientific support for groundwater exploitation reduction policies.

Fourth, Luancheng Station pioneered research on biological water saving, empirically demonstrating the physiological potential of water use efficiency (WUE) differences in wheat and maize, revealing relationships between WUE and key physiological traits, and establishing a comprehensive crop drought resistance evaluation index system to guide water-saving variety breeding. Fifth, using environmental simulation systems such as CO<sub>2</sub> enrichment and warming experiments, the station studied response and feedback mechanisms of farmland productivity, water, and nutrient processes, and established an indicator system for farmland ecosystem health evaluation and methods for assessing farmland ecosystem service functions. Sixth, the station established China’s first county-level precision agriculture demonstration area, preliminarily exploring precision agriculture models suitable for national conditions with farm management units as the main body at both field and county scales. Seventh, the station constructed a food chain nutrient pyramid theory, clarified the relationship between nutrient management and sustainable development of food systems, and expanded nutrient management research from farmland to the entire food chain system, providing a theoretical foundation for nutrient optimization management.

## Research Capacity and Technical Platforms

After more than 30 years of development, Luancheng Station has achieved substantial progress in public monitoring platforms, experimental research plat-

forms, and service platform construction, laying the foundation for gradually becoming an international-level long-term ecological research base. For public monitoring, the station has established standardized observation fields and long-term observation sampling plots in accordance with CERN and CNERN monitoring specifications, equipped with advanced monitoring instruments and a complete, professionally configured monitoring technical team. The station implements a management system assigning monitoring tasks to specific individuals and a three-level data quality control system of “field monitoring personnel → professional quality control group → data manager and station director,” successfully completing various monitoring tasks.

The station’s experimental research platforms include well-equipped meteorological fields, comprehensive observation fields, water balance fields, nutrient balance fields, precision agriculture demonstration fields, and wheat breeding fields, covering 417 mu of land with flat roads, complete facilities, and comprehensive support conditions for communication and other services to meet standardized farmland management and experimental requirements. Advanced observation and research facilities include a remote sensing tower, large lysimeters, deep wells for water and solute migration observation, greenhouse gas observation systems, OTC (Open-Top Chambers), infrared warming systems, rain shelters, eddy covariance systems, Bowen ratio stations, large-aperture scintillometers, GeoProbe deep soil samplers, field isotope mass spectrometers, spectrometers, and photosynthesis systems.

For public laboratory platforms, Luancheng Station has established an analysis and testing center and a data acquisition center, along with specialized laboratories including a farmland SPAC (Soil-Plant-Atmosphere Continuum) water process laboratory, precision agriculture laboratory, and seed analysis and low-temperature storage rooms. The service platform features smooth network connectivity, comfortable and quiet working and living environments, timely entry of all public monitoring data and some research data into databases, and service provision through a data sharing cloud platform. The science communication platform has become increasingly sophisticated, serving as a research, training, and practice base for multiple scientific research institutes, universities, and middle schools, and providing science popularization, technology demonstration, and extension services to the public, middle and high school students, government functional departments, and agricultural professional cooperatives.

## Talent Cultivation and Team Building

Luancheng Station currently comprises eight innovation research units covering water cycle, nutrient cycle, precision agriculture, molecular breeding, agricultural-food chain nutrient flow and circular agriculture, and global change. The station has 33 research and technical personnel, including one academician of the Chinese Academy of Sciences, nine professors, 14 associate professors, six assistant researchers, and three research interns. The team includes 20 PhDs and six master’s degree holders, with an average age of 39 years and

an average work experience of 16 years, constituting a young and experienced research team. The station also has 22 PhD students and 56 master's students in training, with visiting and flowing personnel (including graduate students and guest researchers) accounting for over 50% of on-site researchers, forming the backbone of Luancheng Station and its related innovation research units.

Over the past decade, the station has trained 118 graduate students, including 68 master's students and 50 PhD students. Among them, one received the CAS President's Special Prize, with their doctoral thesis rated as an CAS Excellent Doctoral Dissertation, and another received the CAS President's Excellence Award.

## Openness and Exchange

Luancheng Station is a member unit of the FAO's Global Terrestrial Observing System (GTOS) and serves as a baseline station for the University of Maryland's Global Change Institute and Japan's International Research Center for Agricultural Sciences in simulating the impacts of East Asian monsoon climate variation and disastrous climate on food security production. The station has jointly established a long-term hydrological and water resources dynamic monitoring network for the North China ecological transect with Chiba University, Tsukuba University, and Tokyo University in Japan, becoming an influential long-term ecological observation platform internationally.

The station has established long-term cooperative relationships with universities and research institutions in the United States, Japan, Australia, Germany, the Netherlands, and other countries in research areas including agricultural water saving, precision agriculture, crop breeding, farmland water and nitrogen management, and greenhouse gas emissions. In recent years, more than 30 international scientists and researchers have visited Luancheng Station annually for academic visits and cooperative research. Countries and regions cooperating and exchanging with the station include more than 20 nations such as the United States, Germany, the Netherlands, the United Kingdom, Japan, and Australia. Foreign research institutions with staff working at the station include the U.S. Department of Agriculture, Australia's CSIRO, Germany's ZALF, Wageningen University, Imperial College London, the University of Tokyo, Chiba University, and more than 30 other universities or institutions. The station has become an influential open platform for cooperative research and academic exchange both domestically and internationally.

## Development Goals

The development and construction goals of Luancheng Station are: (1) to build an internationally first-class long-term comprehensive observation and research platform for agricultural ecology; (2) to establish a research and demonstration center for modern agriculture and efficient utilization of water, fertilizer, soil, and seed resources with regional characteristics of the North China Plain; (3) to

create an advanced base for agricultural technology transformation and application, providing demonstration models and supporting technologies for optimized management of agricultural ecosystems and sustainable water resource utilization in northern China; (4) to provide scientific basis for global change and national ecological environment assessment; and (5) to provide macro decision-making support for China's social and economic sustainable development.

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**Correction:** In the 2018 Issue 4, page 432, “August 4–8, 1978” should be corrected to “August 4–8, 1977.”

*Note: Figure translations are in progress. See original paper for figures.*

*Source: ChinaXiv — Machine translation. Verify with original.*