Exploration and Practice of Laboratory Public Platform Management in the Context of High-Quality Development

Xu WANG, Hao JIANG, Junyan ZHU, Chuanyi PENG, Guangjin LIU*

State Key Laboratory of Tea Plant Germplasm Innovation and Resource Utilization, Anhui Agricultural University, Hefei 230036, China

Abstract In the context of "high-quality development" construction, the establishment and operational status of the national-level scientific research platforms at provincial universities—specifically, the large-scale instrument sharing platforms—are critically linked to the production of scientific research outcomes and the development of interdisciplinary talents. This study focuses on the public platform of the State Key Laboratory of Tea Plant Germplasm Innovation and Resource Utilization, aiming to innovate the management system, establish a technical platform, effectively integrate resources, and actively engage graduate students in the platform management. While ensuring the efficient operation of the large-scale instrument platform at state key laboratories, it offers a novel approach to cultivating graduate students into versatile talents.

Key words Open sharing, Large-scale instrument, Management system, Talent cultivation

0 Introduction

The public platform of university laboratories serves as a crucial venue for higher education institutions to fulfill their fundamental functions, including scientific research, talent cultivation, and social services. Additionally, it is a significant indicator for assessing the teaching and research capabilities of universities[1-3]. China has consecutively promulgated a series of policies, including the *Opinions on Opening Up National Major Scientific Research Infrastructure and Large-scale Scientific Research Instruments to the Public* (GF[2014] 70), the *Guiding Opinions of the Office of the Ministry of Education on Strengthening the Open Sharing of Scientific Research Infrastructure and Scientific Research Instruments in Higher Education Institutions* (JJT[2015] 4), the *Management Measures for the Open Sharing of National Major Scientific Research Infrastructure and Large-scale Scientific Research Instruments* (GKFJ[2017] 289), the *Management Measures for the National Science and Technology Resources Sharing Service Platform* (GKFJ[2018] 48), the *Notice on the Management Measures for the Open Sharing of Duty-Free Imported Scientific Research Instruments and Equipment Included in the National Network Management Platform (Trial)* (GKFJ[2018] 245), and the *Detailed Rules for the Evaluation and Assessment of Open Sharing of National Major Scientific Research Infrastructure and Large-scale Scientific Research Instruments* (GKBJ[2022] 93). These policies comprehensively promote the opening and sharing of high-quality scientific and technological resources among universities, research institutes, enterprises, and other entities, with the objective of enhancing the utilization efficiency of large-scale instruments and equipment in universities and enabling these resources to actively contribute to high-quality development through scientific and technological innovation.

Adhering to the concepts of "integration, sharing, service, and innovation", leading domestic universities are actively developing large-scale instrument sharing platforms. These initiatives have yielded significant progress and are playing an increasingly important role in the advancement of university infrastructure[4-6]. The enhancement and optimization of the operational and management mechanisms of laboratory public platforms are crucial for increasing the utilization efficiency of large-scale instruments in universities, improving their effectiveness, and fully realizing their potential in teaching, research, social services, and the sustainable development of national key laboratories[7-9].

1 Basic situation of the public platform of the State Key Laboratory of Tea Plant Germplasm Innovation and Resource Utilization

The State Key Laboratory of Tea Plant Germplasm Innovation and Resource Utilization was approved for establishment on December 31, 2024. The laboratory conducts scientific research and develops new technologies and products in the areas of tea plant germplasm evaluation and creation, secondary metabolism and regulation, breeding technology and variety cultivation, and tea processing and high-value utilization. It has established ten major technical platforms, including metabolomics, isolation and structural identification, flavor chemistry and quality control, molecular biology, bioinformatics analysis, cytological analysis, and experimental animals.

Currently, the laboratory has acquired 98 sets of large-scale instruments and equipment, each valued at 300 000 yuan or more, with a total original value amounting to 65.333 6 million yuan. However, the public platform is staffed by only three full-time laboratory technicians, who are also responsible for the routine ad-

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Xu WANG, doctoral degree, senior experimentalist, research fields: analysis, testing and management of large-scale laboratory instruments and equipment.

* Corresponding author. Guangjin LIU, doctoral degree, associate researcher, research fields: management of laboratory large-scale instrument platforms.

ministrative management of the laboratory. The primary challenges encountered in the management of large-scale instrument platforms include the following: (i) the diversity and high specialization of scientific research instruments; (ii) the large and highly mobile population of graduate students; and (iii) the insufficient number of full-time teaching staff responsible for managing instruments and equipment, resulting in each staff member overseeing assets valued significantly above the standard benchmark of 6 million yuan per person[10], *etc.*

2 Measures to enhance laboratory construction and management

Since the approval of the laboratory's construction, extensive exploratory efforts have been undertaken in the operation and management of the public platform of the state key laboratory to address three practical challenges in its management.

2.1 Improving the institutional construction of laboratories Institutional construction is a critical foundation for the efficient functioning of the laboratory public platform and serves as a robust support mechanism to maximize the platform's effectiveness. The management of the laboratory public platform has implemented several regulatory frameworks, including guidelines for the use and maintenance of instruments and equipment, laboratory safety protocols, laboratory hygiene management procedures, access control and reward and penalty mechanisms for public platform users, reservation and fee structures for large-scale instruments, regular training programs for operating such instruments, appointment procedures for duty assistants, safety inspection protocols for public platforms, and performance evaluation systems for laboratory technicians.

The equipment integrated into the public platform sharing system is divided into two primary categories. The first category comprises instruments with a unit price exceeding 300 000 yuan. In accordance with the *Measures for the Open Sharing Management of Large Scientific Instruments and Facilities in Anhui Province (Trial)*, all instruments within this category are required to be included in the sharing scope of the Anhui Large Scientific Instruments and Equipment Sharing Service Platform. Information regarding these instruments can be accessed and reservations can be made through the platform's website. The second category comprises small equipment that is highly shared within the laboratory and subject to regular maintenance, such as pure water machines and ice makers. Access to large-scale instruments and equipment on the laboratory's public platform requires graduate students to first complete the school's examination and the laboratory-organized safety training, pass the laboratory safety knowledge test, and obtain their supervisors' signatures on a safety responsibility agreement. Any violations, such as improper operation of the instruments or repeated failure to attend scheduled appointments, will result in the termination of usage privileges. Additionally, both the individual and other members of their research group will be restricted from using the public platform instruments and will be subject to formal reprimand within the laboratory.

2.2 Increasing capital investment and strengthening hardware construction After years of investment, the laboratory's public platform has progressively established three major systems: the instrument reservation system, the access control system, and the monitoring system. Large-scale instruments can be reserved online, ensuring equitable access and transparency of information. The platform enables real-time monitoring of its operational status, facilitates supervision of users' standardized instrument operations, and effectively supports efficient platform management, as illustrated in Fig. 1.

2.3 Building professional technical platforms The State Key Laboratory of Tea Plant Germplasm Innovation and Resource Utilization has developed ten technical platforms, each aligned with distinct research directions, as illustrated in Fig. 2. Each platform is equipped with multiple large-scale instruments and equipment. Furthermore, a professional technical and management team has been established, comprising faculty members from various disciplines, specialized technical staff, and several graduate student assistants.

3 Construction achievements

3.1 The utilization rate of large-scale instruments and equipment is optimized in a more scientific and rational manner, resulting in favorable operating conditions for the instruments The development of a large-scale equipment reservation system has facilitated online booking for instrument usage, substantially improving the efficiency of platform management. Instrument information is made open and transparent, including the location of each instrument, the administrator responsible, available reservation time slots, and the contact details of previous and subsequent users, all of which are clearly accessible. Users are able to schedule on-machine testing in advance, thereby effectively preventing conflicts in usage time and enhancing the scientific and rational utilization of instruments. The development of a large-scale equipment reservation system has facilitated the public disclosure of information regarding available instruments, effectively mitigating issues such as redundant purchases and underutilization of large-scale equipment resulting from inadequate information flow. This card-swiping system incorporates an online reservation function that allows for the establishment of distinct reservation rules for each instrument, thereby facilitating personalized management. Billing can be conducted based on either the duration of use or the number of samples processed.

3.2 Platform sharing and rational resource allocation have enabled diversified management For scarce instruments, such as the high-resolution Q-TOF mass spectrometer on the metabolomics platform, students are required to submit a Sample Submission Form prior to scheduling an appointment to use the equipment. The instrument may only be utilized for testing after professional technicians have evaluated and approved the necessity of the submitted samples. This procedure can prevent students from con-

ducting tests blindly and repeatedly due to an inaccurate understanding of the subject matter, thereby effectively avoiding the waste of public resources. Furthermore, the implementation of a charging system allows for the rational allocation of public resources.

Fig. 1 Instrument sharing service platform system of Anhui Agricultural University

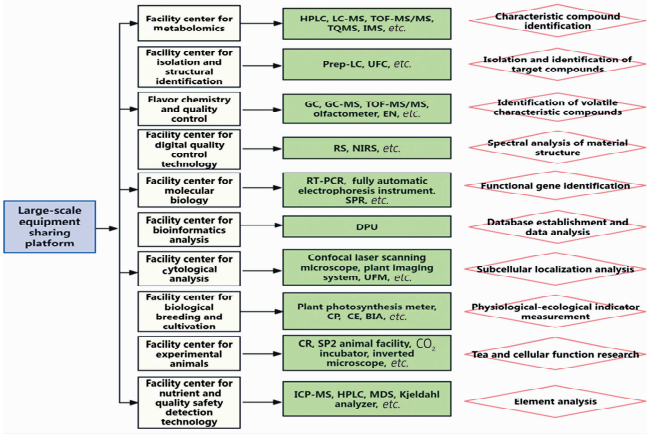
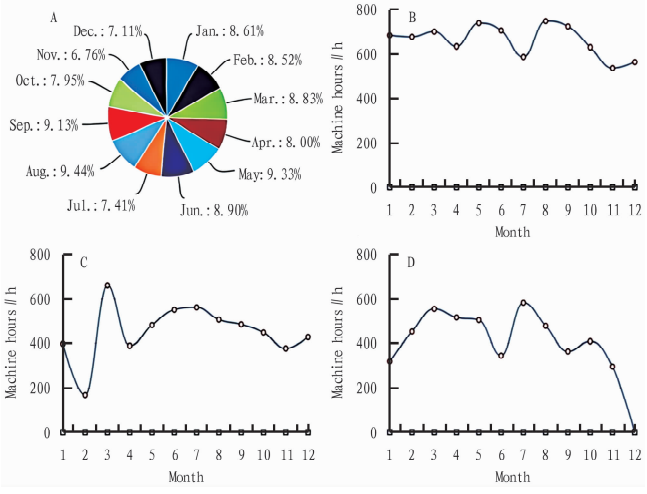


Fig. 2 Operation and management of large-scale instruments and equipment in the laboratory public platform

The personnel categories within the large-scale instrument shared monitoring and management system are classified as system administrators, instrument administrators, teacher users, and student users. Additionally, management can be organized based on affiliations such as "within the unit", "outside the unit", and "research group". Instrument malfunctions resulting from improper operation can be attributed to the person responsible for the research group, thereby significantly increasing the sense of responsibility among student users. The utilization of instruments on the public platform, including machine hours, number of samples tested, and operational status, can be monitored in real time, with records maintained for reference. This diversified management approach facilitates more rational resource allocation.

Effectively preventing the redundant acquisition of instruments is a challenge frequently encountered by research institutes. The machine hours recorded through the card-swiping system offer an objective and accurate measure of equipment utilization, thereby informing procurement decisions and helping to avoid duplicate purchases at the source. Additionally, this data provides an objective indication of the demand for instrument usage. As illustrated in Fig. 3A, the monthly machine hours of the high-resolution mass spectrometer in 2023 remained relatively consistent, indicating that the instrument operated efficiently throughout the year. Fig. 3B-D further demonstrate that the utilization rate of this instrument has been consistently high over the past three years. These data offer valuable reference information for the procurement of new equipment. Based on the aforementioned usage data, to address the analytical and testing requirements of scientific researchers and to alleviate the testing burden on the existing high-resolution mass spectrometer, the laboratory acquired an additional Q-ToF 6530 mass spectrometer in 2023.



NOTE A. Machine hours per month in 2023; B. Machine hours in 2021 (532 – 744 h/month); C. Machine hours in 2022 (176 – 657 h/month); D. Machine hours in 2023 (315 – 580 h/month).

Fig. 3 Operating hours of high-resolution mass spectrometer

3.3 Construction of public platforms and new explorations in talent cultivation The implementation of regular training programs for large-scale instruments, coupled with the designation of on-duty assistants, has effectively mitigated the insufficient transfer of instrument operation skills observed in certain laboratories, which was primarily attributed to the high turnover rate among graduate students. Engineers will introduce the latest methods for instrument data analysis, thereby ensuring timely technological advancements. Firstly, involving graduate students in the routine management of instruments can enhance their practical skills and contribute to improving the quality of data analysis during subsequent testing phases. When issues arise, students will be able to independently identify the underlying causes and make informed improvements to the experimental design. Secondly, it facilitates the enhancement of responsibility awareness education during the process of student development. Engaging in communication with instrument administrators and students conducting sample tests provides an opportunity to develop personal communication skills. Thirdly, graduate students whose research projects are progressing smoothly typically have more time available for scientific research activities. They can offer technical guidance on instrument operation to research groups that lack proficiency in using the equipment and occasionally need to test a small number of samples. This support enhances the efficient operation of the instruments and simultaneously alleviates the workload associated with instrument management for the administrators. Teams that volunteer to

serve as "weekly assistants" for large-scale instruments will be granted preferential consideration in instrument reservations, but usage fees will still apply. Additionally, we periodically organize technical exchange meetings for graduate students to improve their communication skills. These initiatives are exploratory efforts in the development of the laboratory's public platform, particularly in the context of graduate training.

3.4 The establishment of public platforms facilitates the enhancement of technological innovation skills among college students In accordance with national directives aimed at advancing the development of world-class universities and first-class academic disciplines[11], the Tea Science specialty at Anhui Agricultural University was successfully designated as a national first-class undergraduate specialty in Anhui Province in 2019 (WJMG [2020] 11). The development of the public platform at the State Key Laboratory of Tea Plant Germplasm Innovation and Resource Utilization has furnished outstanding hardware support for establishing the national first-class discipline in Tea Science.

In recent years, supported by the college students' innovation and entrepreneurship program, a growing number of undergraduates have actively participated in scientific research, while some graduates have contributed to the daily management of large-scale instrument platforms. According to preliminary statistics, in 2021, Anhui Agricultural University secured 7 national-level, 14 provincial-level, and 32 university-level innovation and entrepreneurship training program projects focused on tea research among college students' scientific research initiatives. Furthermore, graduate students engaged in instrument management possess greater advantages in their post-graduation employment opportunities. There is a notable shortage of positions in areas such as large-scale instrument platforms within colleges and universities, quality control roles in food enterprises, engineering positions in instrument manufacturing companies, and technical support services. Based on feedback from graduates over the past three years following their employment, it has been observed that students who have served as assistants for large-scale instruments and equipment possess certain practical advantages during the interview process for related positions.

3.5 The assessment system for laboratory technicians is well established Under normal circumstances, the research accomplishments of university faculty members do not encompass the responsibilities of public platform management staff. Additionally, laboratory technicians often exhibit low motivation, and their disadvantages in professional title evaluations are notably pronounced[10,12]. Following the implementation of intelligent management on the laboratory public platform, the workload of professional and technical personnel can be objectively assessed based on the platform system's usage records, providing accurate and reliable evidence. When managers report the number of machine hours utilized by the instruments, it mitigates issues related to inaccuracies and low efficiency inherent in traditional manual recording methods, thereby substantially improving operational efficiency. Furthermore, the enhancement of the assessment system has clarified the job responsibilities of laboratory technicians, significantly boosting their work motivation.

4 Conclusions

The large-scale instrument shared monitoring and management system is an inevitable development within the sharing economy and serves as a valuable complement to the traditional laboratory management model. Currently, the management of large-scale equipment platforms in state key laboratories exhibits several deficiencies that require ongoing improvement through the implementation of an enhanced management system. This includes strengthening the development of the laboratory management team, improving the professional competencies of laboratory management personnel, encouraging greater participation of graduate students in management activities, promoting the sharing of instruments and the advancement of usage methods, and better addressing the objective of cultivating graduate students into versatile talents.

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