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Rice Seminar on Utilization of Low-temperature Plasma Report

Rice Seminar on the Utilization of Low-Temperature Plasma Technology under the JICA Knowledge Co-Creation Program

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Development of Core Agricultural Researchers for Rice Promotion

The training program "Development of Core Agricultural Researchers for Rice Promotion in Sub-Saharan Africa", conducted under JICA's Knowledge Co-Creation Program (KCCP), has been implemented for 14 years by the International Center for Research and Education in Agriculture (ICREA), Nagoya University (NU), which serves as the secretariat of the Japan Intellectual Support Network in Agricultural Sciences (JISNAS), in collaboration with its member institutions. This training program consists of two components: "Core Training" and "Individual Training." In the Core Training phase, trainees participate in a two-week program at JICA Chubu, which includes lectures, practical exercises, and field visits. Special lectures are delivered by faculty members of Nagoya University, JISNAS member institutions, and researchers from the National Agriculture and Food Research Organization (NARO)[1]. Following the Core Training, instructors for the Individual Training are selected based on each trainee's area of expertise. The trainees are then accepted by a JISNAS member university or a research organization, such as the Japan International Research Center for Agricultural Sciences (JIRCAS), where they undertake two to three weeks of Individual Training aimed at deepening their specialized knowledge and research methodologies.

NU Rice Seminar on the Utilization of Low-Temperature Plasma Technology

In 2024, marking the inaugural year of the Rice Seminar on the Utilization of Low-Temperature Plasma Technology delivered by Nagoya University, two seminar sessions were held on July 8 and July 10 as part of the 13th training course, "Development of Core Agricultural Researchers for Rice Promotion in Sub-Saharan Africa", program JICA KCCP. Professors Kenji Ishikawa and Hiromasa Tanaka, along with a designated lecturer, Hiroshi Hashizume, from the Center for Low-Temperature Plasma Sciences (cLPS), Nagoya University, introduced applications of low-temperature plasma science to agriculture as an example of industrial–agricultural collaboration and presented research case studies related to rice cultivation. Nagoya University has a history of more than 60 years of plasma research, leading the field both domestically and internationally, and has been among the pioneers in applying plasma science to medicine and agriculture. Participants in the JICA training program showed strong interest in plasma farming as an emerging technology with the potential to reduce dependence on chemical fertilizers, as well as in ongoing field-based research at Nagoya University and the prospects for international collaboration, including initiatives already underway in Southeast Asia.

The NU seminar on the Utilization of Low-Temperature Plasma Technology under the 14th training course, JICA KCCP was held for the second consecutive year in 2025, on July 7. Prior to the seminar, trainees of the JICA program visited the PLASMA Farming NU-FMV Laboratory and the experimental fields at Togo Field (NU University Farm), Field Science Research Center, Nagoya University, where plasma agriculture research is actively being conducted. They received on-site explanations from Hashizume regarding the progress of research and field trials during the year.

Tanaka delivered a lecture entitled "Brief Introduction of the Center for Low-Temperature Plasma Sciences, Nagoya University," in collaboration with Hashizume, Ishikawa, Ehara, and Masaru Hori, Designated Professor at cLPS. He explained that cLPS was established in 2015 and is located on the fourth floor of the National Innovation Complex at Nagoya University. The center houses approximately 160 pieces of state-of-the-art plasma-related equipment on a single floor (about 2,000 m²) and was recognized as a Joint Usage/Research Center in 2019. He also introduced the wide range of applications of low-temperature plasma, including plasma medicine, plasma agriculture, microfabrication, and environmental science, as well as cLPS's global collaborations with institutions in Ireland, Switzerland, France, Germany, Korea, Taiwan, and Malaysia. In addition, he outlined educational activities in engineering, applications of plasma in life sciences and nano processing, field energy control and field devices, ongoing projects such as plasma-driven seed memory, and recent research achievements at cLPS.

Hashizume presented a lecture entitled "Grain Quality Improvement of Brewer's Rice Cultivar by Plasma Irradiation of Caryopsis Based on Environmental Data Collection," in collaboration with Tanaka, Ishikawa, Ehara, and Hori. He introduced part of their collaborative research with Fujitsu Client Computing Ltd. and Enshu Co., Ltd., focusing on a recently published paper[2]. In this study, efforts were made to enhance grain quality in the brewer's rice cultivar Yamadanishiki through plasma treatment of the caryopsis (grains) during the ripening stage. In the case of brewer's rice cultivar, formation of white core, which is insufficient crystallization structure in the central part of endosperm, is important for its quality due to the smooth progress of fermentation with *Aspergillus* sp. In this study, Hashizume et al. have focused on the grain maturation stage after heading, and treated each caryopses with direct plasma irradiation by pen-type He plasma jet (Fig. 1). Seedlings transplanted from a paddy field into pots were grown in a greenhouse, and each caryopsis was treated with plasma on 1, 5, 10 and 15 days after flowering (DAF). The ratio of white-core grains to total number of grains was decreased in the grains treated on DAF1, same level on DAF5, and increased on DAF10 and 15, respectively, compared with control grains (Fig. 2). Moreover, same treatment test was conducted with seedlings transplanted from a paddy field into pots and grown in growth chambers equipped with a sensing system, termed "Smart Agriculture System", to monitor environmental and growth conditions referred to the climatic conditions of paddy fields (Fig. 3). It was demonstrated that plasma treatment of caryopsis was effective for the formation of white core on the grain maturation stage, and that environmental conditions in the growth chamber were simulated to a paddy field.

Following these presentations, Ehara and Nakata explained the progress of ongoing projects at Nagoya University conducted in collaboration with domestic and international partner institutions. They noted that optimal irradiation conditions—such as gas type and device configuration—vary depending on crop species. They also emphasized that plasma irradiation effects tend to be more pronounced under abiotic stress conditions. The trainees actively engaged in discussion, raising questions about the potential applications of low-temperature

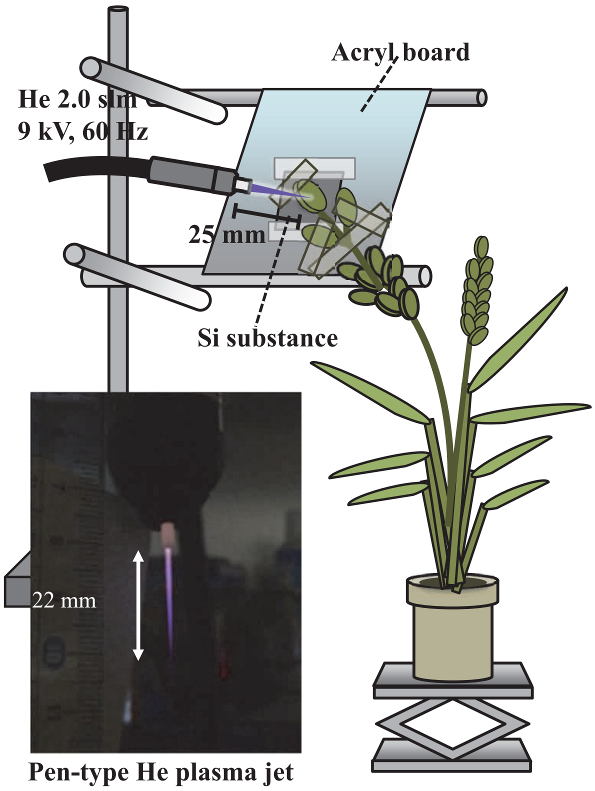

Fig. 1. Direct plasma irradiation of rice spikelet after flowering. (Drawn from Hashizume et al. 2024)

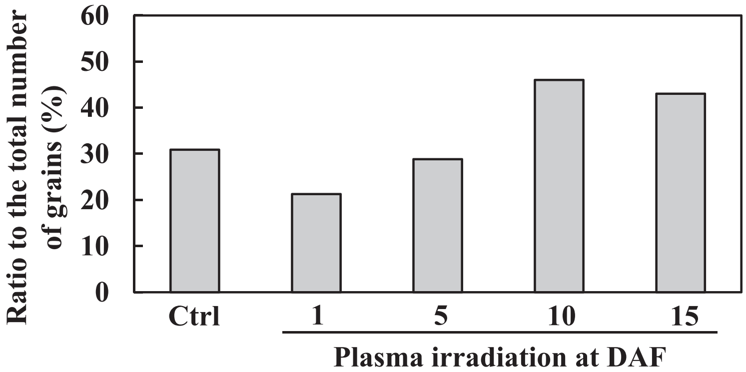

Fig. 2. Ratio of white-core grains to total number of grains. (Drawn from Hashizume et al. 2024)

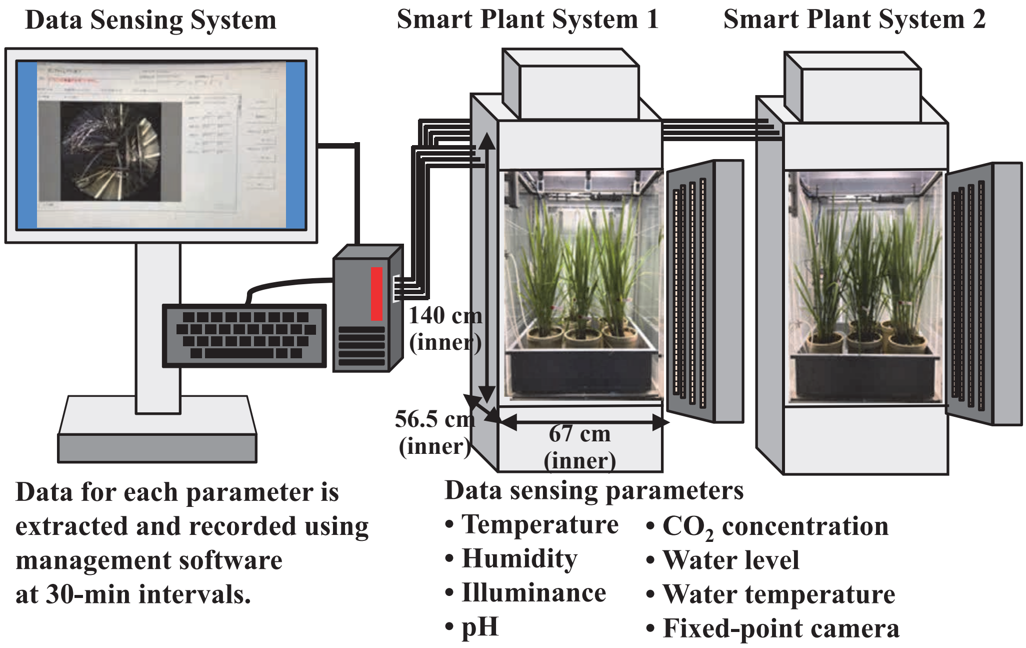

Fig. 3. Schematic image of "Smart Agriculture System". (Drawn from Hashizume et al. 2024)

plasma technology to address challenges in rice cultivation in their home countries. This led to a lively exchange of ideas with the lecturers and JICA staff regarding future applications and collaborative possibilities.

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