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## 主論文の要旨

論文題目 Improvement of evaluation system for rice grain characteristics in Cambodia  
(カンボジアにおける米粒形質評価システムの改善)

氏名 SRUN Khema

## 論文内容の要旨

The export of Cambodian milled rice to the international market has been increasing in volume remarkably. Consumer demands for rice in terms of cooking and eating quality are different from country to county. To contribute to the promotion of Cambodian rice exports, evidence-based information about rice quality is very important. The first study (chapter 2) aimed to investigate the availability of application of image processing devices developed originally for temperate japonica rice for evaluating grain quality of indica rice, Cambodia. And the second study (chapter 3) aimed to compare the quality of rice grain employing some sensing device and image processing device on cooked rice. Next, the third study (chapter 4) aimed to compare the grain yield, GRAFC and several parameters relating to the quality of white rice cultivated in farmers' rainfed paddy field with different nutrient managements during the wet season in 14 provinces where nine different soil types are distributed in northern to southern Cambodia to investigate the economic efficiency in fertilizer management focused on qualitative traits, as well as qualitative traits, with the intention of sustainable crop production. Moreover, the fourth study (chapter 5) aimed to study the growth performance and grain characteristics relating to white rice of a Cambodian indica variety Sen Kra Ob in the different fertilizer rate application amounts under the controlled environment in comparison with Japanese variety Koshihikari.

Based on the four studies, the results can be summarized as below. (1) The possibility to utilize sensing equipment analyzers such as a grain scanner (image-processing device), a rice taste analyzer for white rice, and a taste analyzer unit for cooked rice that measures freshness, hardness, and stickiness using a near-

infrared transmission sensor were investigated. As the results, although the analyzers were developed originally for temperate japonica, the data detected by sensing tools were highly correlated with the data by the conventional destructive analysis in some important parameters relating to the quality of white rice in Cambodian varieties. The taste mark detected by the analyzer for white rice showed a negative relationship with the protein and amylose content in white rice. The taste value detected by the analyzer unit for cooked rice showed a highly negative relationship with the nitrogen concentration in white rice and a highly positive relationship with the carbon/nitrogen concentration ratio—the C/N ratio—in white rice and the stickiness/hardness ratio in cooked rice. As shown in the study 1 and study 2, the quality of long grains of Cambodian indica rice varieties can be evaluated by utilizing the sensing and image-processing devices developed for short grains of temperate japonica varieties. Then, some key parameters for evaluating the grain quality of indica varieties were clarified.

(2) From the compare of the yield and several parameters relating to the quality of white rice from different soil-specific nutrient management in 14 provinces where different soil types are distributed, the relationship between the fertilization rate and the yield was not linear in areas where clay soil dominates. In cases of popular varieties cultivated from the northern to southern province in Cambodia, the amount of fertilizer applied was up to 163 kg ha<sup>-1</sup> (sum of N-P2O5-K2O), and the gross return above fertilizer cost (GRAFC: (paddy sales)–(fertilizer cost)) and the fertilization rate showed a nonlinear relationship, with a peak of around 120 kg ha<sup>-1</sup> fertilization. The nitrogen concentration recognized as a negative factor for the quality of rice tended to increase with an increasing fertilization rate, and the carbohydrate concentration and carbohydrate/protein ratio that are a positive factor for the quality were related negatively with the fertilizer rate. The amylopectin concentration in white rice was positively related with the carbohydrate concentration, which decreased with an increasing fertilization rate. The levels of fertilizer application required to achieve a higher yield, GRAFC, and the maintenance and improvement of parameters relating to grain quality were different.

(3) From further individual analysis in detail, the panicle/straw ratio increased with fertilization in the Japanese variety, but it tended to decrease in the Cambodian variety. The increase in panicle weight per amount of fertilizer application was stable regardless of the fertilization rate in the Japanese variety, whereas it decreased significantly with increased fertilization in the Cambodian variety. From these results, it is understood that increasing fertilization for Cambodian variety means reducing the ratio of economically important part to the

promotion of biomass production, and that increasing fertilization is unlikely to lead to an increase in production efficiency. In addition, in Cambodian variety, increased fertilization amounts the number of colored kernels and defective grains, and lowered the C/N ratio and the amylopectin/amylose ratio in brown rice which will determine the balance of stickiness/hardness of cooked rice.

In order to improve the evaluation system for rice grain characteristics in Cambodia, we should develop scientific test procedures on taste and related traits using sensing technology such as image analysis and near-infrared transmission analysis, along with production area information, also, it was considered extremely important to show the production history. Furthermore, providing such information will lead to the evaluation of production technology from the viewpoint of the cultivation of good-tasting rice, with the aim of increasing yields and improving profitability not only for farmers but also for suppliers and consumers. It is considered that these results can be applied to other regions, and are expected to greatly contribute to improving the quality and profitability of tropical rice cultivation in Indochina and other tropical areas as well.