（学位第３号様式）

学 位 論 文 要 旨

氏　名	Kittipon Aparatana
題　目	Development of High Accurate Evaluation Systems for Sugarcane Quality using Combined Non-Destructive Analysis (非破壊センサーの複合利用によるサトウキビの高度品質評価システムの開発)

Soluble solids content (Brix) and polarimetric sucrose (Pol) are important indexes for evaluating the quality and maturity of sugarcane, and the development of a measurement method that can be evaluated quickly, accurately, and in a short time is desired. In this study, we developed a sugarcane quality evaluation system that combines using a benchtop visible-near infrared (Vis-NIR) spectrometer, a portable Vis-NIR spectrometer, and an unmanned aerial system (UAS).

As the first step, the sugar content of the squeezed sugarcane juice is measured by the conventional measurement method (Horn's method), and the NIR spectrum is acquired with a benchtop Vis-NIR spectrometer to develop a calibration model. Secondly, we measured the Vis-NIR spectra of sugarcane stalks using a portable Vis-NIR spectrometer. A calibration model for directly estimating the sugar content of stalks from the Vis-NIR spectrum of sugarcane stalks was developed using the calibration model obtained in the first experiment. As the third step, we developed a calibration model for estimating Pol sugar content from UAS images taken from the above sugarcane fields. We developed a model using the Pol obtained by a portable Vis-NIR spectrometer and considered the effect of region of interest (ROI) size on image processing.

In the non-destructive evaluation of a small amount of squeezed liquid using a benchtop Vis-NIR spectrometer, we examined the effect of pre-processing of NIR spectra on the calibration model, SNV processing, and the second derivative processing verified to be the most effective of pre-processing to develop the PLSR calibration model. Furthermore, in developing a Pol calibration model for stalks using a portable Vis-NIR spectrometer, it was suggested that second derivative processing and multiple regression models are more effective for quantitative analysis than direct use of NIR spectra.

In the third stage, the sugar content estimation experiment from UAS, multispectral images were obtained and calculated to the vegetation index (VI), which was used to estimate the sugar content. The results show that NDVI, $CI_{RedEdge}$, and $SRPI_b$ effectively evaluate the sugar content. As a result of examining the ROI size, the number of small pixels was small, so the information other than leaves was reflected relatively large, and the accuracy of the prediction model will be decreased. Pol estimation by vegetation index showed a high correlation between $SRPI_b$ and NDVI. In particular, the Pol estimation model based on $SRPI_b$ images had the highest correlation, with R^2 of 0.87 and RMSEC of 0.6%. This model shows that Pol is related to nitrogen in sugarcane leaves.

Furthermore, we analyzed the Pol estimation from the image of each band using multiple linear regression analysis. We showed that the NIR band influences the sugar content estimation and the information on water, sugar, chlorophyll, etc., is effective. This study showed that the combined use of optical sensors enabled consistent sugar content evaluation from field to post-harvest.