Development of a real-time protein sensor mounted on a combine harvester

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1. Introduction

Since the 20th century, precision agriculture was introduced. Nowadays, large-scaled farmers manage their field in groups. Protein content is important consideration in grain sale price, particularly wheat varieties. Therefore, a real-time protein sensor is badly needed. The objectives of this study are (1) to develop a real-time protein sensor which can be mounted on a combine harvester, and (2) to develop calibration models using different statistical method to select significant wavelengths to predict the protein content.

2. Materials and methods

The wheat samples used in the research were harvested in the wheat field belonging to Hokkaido University. A near-infrared spectrometer was adopted to obtain the reference data of protein content. The sensing system was used as the protein sensor to obtain the reflectance spectra data. After data acquisition, PLS regression, stepwise MLR and Normalized Difference Protein Index (NDPI) were applied to develop estimation model for protein content of wheat.

3. Results and discussion

Based on the PLS results, three zones at approximately 435 ~ 445, 495 ~ 680, 830 ~ 1100 nm of importance for the PLS models could be identified. In order to pick out the optimal wavelength, the SMLR was applied for calibration dataset (samples from year 2011 and 2012). SMLR selected 7 wavelengths (435,530,615,640,685,995 and 1060 nm). Using the 7 wavelengths to develop SMLR model, the R^2 was 0.89. The results were verified in validation data set (samples from year 2012). NDPI is defined in this study. As seen from Fig.1, using the reflectance data from the combination of λ_{690} and λ_{780} can yield the highest R^2, which is equaled to 0.71. Fig.2 shows the appearance of the developed protein sensor. It is composed of three parts, which are the optical system design, hardware design, and software design. After developed sensor experiments were conducted on sensor test.

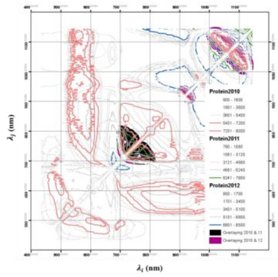

Fig.1 The distribution of R^2

4. Conclusion

(1) The PLSR, the SMLR and the NDPI were applied. Some wavelengths were identified as the optimal wavelengths; (2) the protein sensor was developed, and the result of the test experiment showed that the sensor was not only stable but also had potential to improve sensor performance of accuracy.

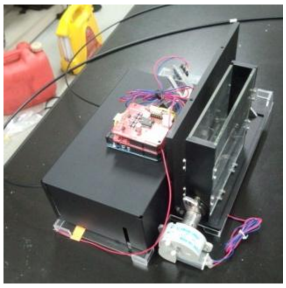

Fig.2 The appearance of the developed sensor