

# Development of a Real-time Quality Sensor for Wheat on a Combine Harvester

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## 1. Introduction

Moisture content and temperature of the grain are the essential parameters that determine the storage life of grain and protein content determines the process and usage of wheat grain harvested. In this research, to develop a real-time quality sensor for moisture and protein prediction of wheat, based on reflectance spectroscopy, calibration based on static experiments and prediction on a grain conveyor of a combine harvester were performed. Additionally, experimental trials for assessing the feasibility of yield monitoring by single wavelength reflectance was conducted.

## 2. Methods

1) **Materials** Wheat samples used in the present study include two places of production, Sapporo from 2011 to 2014 and Tokachi region in 2013 and 2014. A mini-spectrometer had been used to get reflectance spectra of wheat samples in the range of 435 nm to 1144 nm. A grain conveyor separated from a specified combine harvester was used to conduct experiments of real-time prediction and yield monitoring.

2) **Calibration and prediction** Reference moisture and protein contents data and pretreated reflectance spectra were used for calibration and prediction. Partial least squares regression were used for calibration. Calibration and prediction were performed based on only data of static experiments for evaluating the feasibility of the data processing methods. Then, models of moisture and protein were calibrated based on the data from 2011 to 2014 of Sapporo and the data of 2013 and 2014 of Tokachi region and used for the prediction in real time on the grain conveyor. In addition, preliminary experiments of yield monitoring were also conducted.

## 3. Results and Discussion

1) **Real-time prediction** Numbers of component of PLS models were 12 in both of moisture and protein contents calibrations. There were four samples for real-time experiments on the grain conveyor and two times of each sample were performed to verify the reproducibility. The results of errors of two times

Table 1 Results of real-time prediction

Prediction		No. 1	No. 2	No. 3	No. 4
Moisture (%)	Reference	21.57	22.57	19.00	19.37
	1 <sup>st</sup> Errors	-0.90	-0.72	0.12	-0.64
	2 <sup>nd</sup> Errors	-0.15	-0.38	0.13	-0.11
Protein (%)	Reference	12.13	12.63	10.93	11.17
	1 <sup>st</sup> Errors	-0.33	-0.22	0.16	-0.19
	2 <sup>nd</sup> Errors	-0.24	-0.50	0.01	0.06

prediction were shown in Table 1. The overall prediction errors were not more than 0.9% and mostly less than 0.5%. Prediction of moisture and protein contents performed well and shown fine reproducibility.

2) **Yield monitoring** The relationship between integral of reflectance of a single wavelength and weight reference of wheat grains transported was used for yield monitoring by simple least squares regression. The feasibility of this method was confirmed.

## 4. Conclusions

Reflectance spectroscopy was used to develop a real-time wheat quality sensor on a combine harvester mainly for moisture and protein contents. The models performed good prediction accuracy and reproducibility. Additionally, experiments of yield monitoring by integral of reflectance of specified single wavelength was conducted tentatively and confirmed the feasibility of the present methodology.