Soil P_2O_5 Calibration and Mapping using Real-time Soil Sensor (RTSS)

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Objective

- To measure the soil P_2O_5 by RTSS
- To create soil P_2O_5 maps for site-specific management

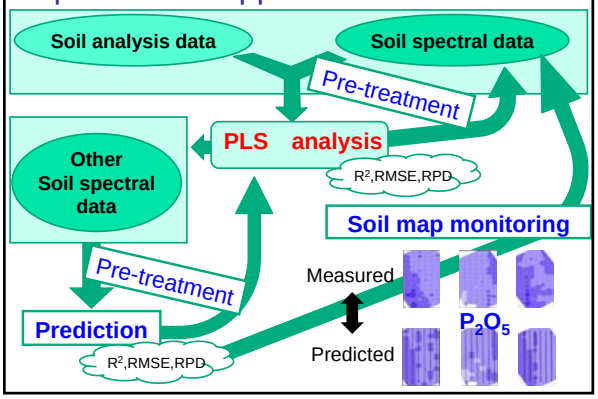
Destination

- R^2, RMSE, and RPD values of the PLS model for soil P_2O_5 were 0.66, 10.12(mg/100g), 1.71
- Similar P_2O_5 containing areas were found between measured and predicted maps, and locations are almost acceptable to make decision

Back ground

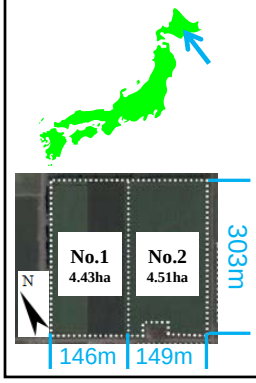
- Japan has faced the increased price by 1.6 times.
- Phosphorus P_2O_5 became a limited nutrition.
- Save and use it efficiently as requested.
- Describe the variability across the field.

Experimental Approach



Material and Methods

Experimental site



- Commercial farm
- Memuro, Hokkaido, Japan
- After crop harvesting in August and October 2008 November 2009
- Alluvial soil

Material and Methods

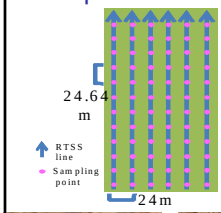
Real-Time Soil Sensor(RTSS)

DGPS : 10 cm accuracy
Distance of probes to bottom : 75 mm
Data collected :
Soil reflectance : 350 to 1700nm
364 wavelengths
Soil color image : Φ 50
Electric conductivity (EC) : capacitance

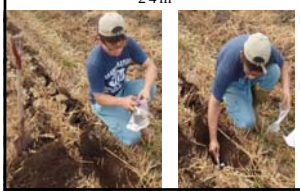
Data size : 780 data/4ha

Material and Methods

Soil spectral data and samples



- Collect soil spectra every 2.24m at a depth of 0.2m
- RTSS move 2 km/h
- Data size : 780 data/4ha
- Collect samples every 24.64m at a depth of 0.2m



Material and Methods

Chemical analysis

- Soil samples were dried in an oven crushed and sieved
- Soil P_2O_5 = plant available P measured by the Truog method with the autoanalyzer QuAAtro

Material and Methods

Spectral data analysis

- Vis-NIR soil reflectance spectra subjected to Savitzky-Golay second derivative treatment
- A partial least squares (PLS) model for the soil P_2O_5 was calculated with full cross validation by Umscrambler 9.8
- R-square(R^2), root mean square error(RMSE) and residual prediction deviations (RPD) are calculated. RPD is the ratio of standard deviation of the measured to the RMSE.

Material and Methods

Soil mapping

- Measured and Predicted map was created as inverse distance weighted (IDW) maps using ArcMap 9.2
- Measured map was derived from data of measured soil P_2O_5
- Predicted map was derived from data of predicted soil P_2O_5 calculated with the PLS model from soil reflectance spectra data

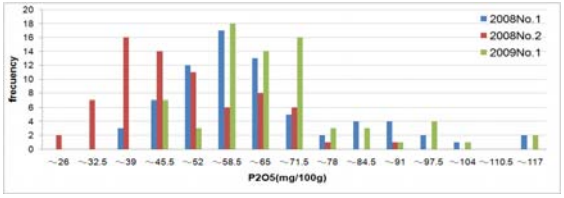
Results and Discussion

Soil sample parameters

	Number	P_2O_5(mg/100g) Max	Min	Average	SD※
2008 No.1	72	114.70	33.40	61.66	17.38
No.2	72	86.30	25.20	46.80	13.73
Total	144	114.70	25.20	54.23	17.29
2009 No.1	72	114.75	40.69	64.36	15.79

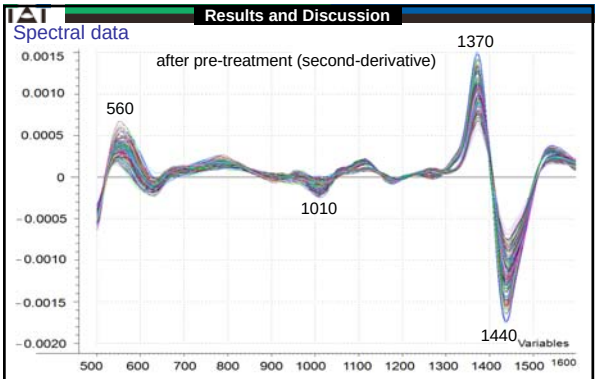
※SD = standard deviation

- Soil P2O5 was higher in field No.1 than No.2
- Soil P2O5 increased slightly from 2008 to 2009
- Stochastic distributions appeared



Results and Discussion

Spectral data

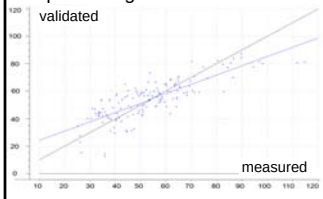


- Large peaks are found at 560nm, 1010nm, 1370nm, and 1440nm

Results and Discussion

PLS model

Measured VS Validated P2O5 value of 2008 No.1 and No.2 samples using PLS model



	calibration	validation
R^2	0.70	0.66
RMSE (mg/100g)	9.48	10.12
RPD		1.71

- R^2 of 0.7-0.8, and RPD of 1.75-2.25 are stated moderately useful.(Mouazen 2006)

  This PLS model is useful to distinguish between low, medium and high values.

Results and Discussion

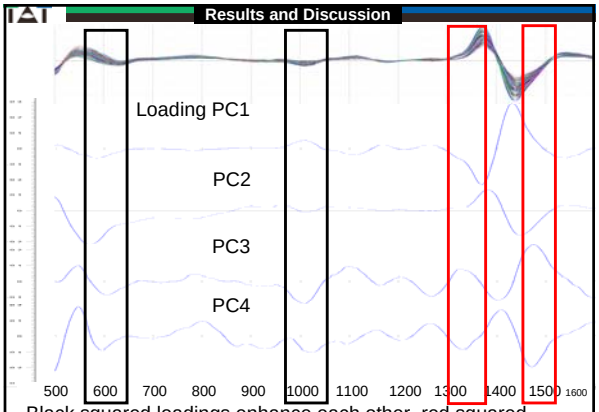
Comparison of values

Authors	*Year*	*Soil analysis*	*Units*	*Spectral range (nm)*	*Multivariate method*
This paper		Truog	mg/100g	350-1700	PLSR (4)
Matunaga	1992	Truog	mg/100g	1100-2500	MR
Chang CW	2001	Mehlich Ⅲ	mg/kg	400-2498	PCR
Mouazen	2006	Olsen	mg/100g	305-1710	PLSR

Authors	*Sample size*	*P*		*RMSE*		*R^2*		*RPD*
		Max	*Min*	*Cal*	*Val*	*Cal*	*Val*	
This paper	144	114	25	9.47	10.1	0.70	0.66	1.71
Matunaga	120	——	——	——	——	——	0.69	——
Chang CW	779	507.6	0.7	32.28		0.40		——
Mouazen	204	11.63	2.95	0.943	1.202	0.83	0.73	1.92

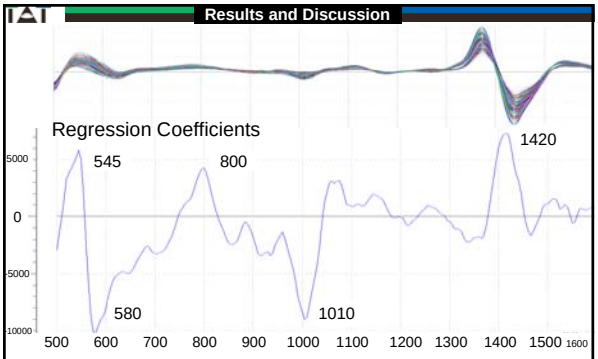
- The R^2 of validation showed that the PLS model for soil P_2O_5 in this study was at least as accurate as that in other studies

Results and Discussion



- Black squared loadings enhance each other red squared loadings compensate each other.

Results and Discussion

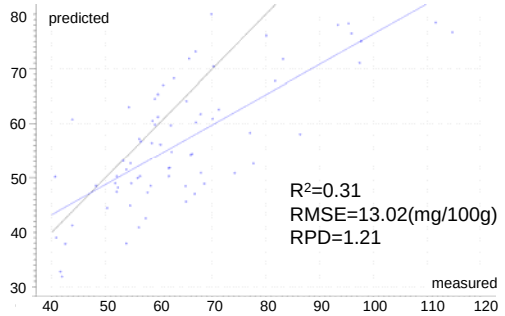


- Large regression coefficients peaks are found at 545nm, 580nm, 800nm, 1010nm, 1420nm.

Results and Discussion

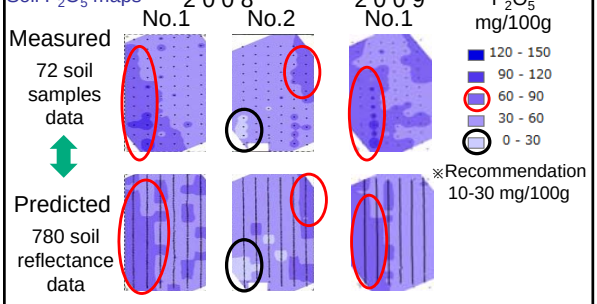
Prediction

Measured VS predicted P_2O_5 value of 2009 No.1 samples using PLS model



Monitoring

Soil P_2O_5 maps



- Red circles show 60 to 90 mg/100g a twice amount of the recommendation, and locations are almost acceptable to make decision. Black circles show 0 to 30 mg/100g and also locations are all right.

Conclusion

- R^2, RMSE, and RPD values of the PLS model for soil P_2O_5 were 0.66, 10.12(mg/100g), 1.71
- The R^2 value of validation showed that the PLS model for soil P_2O_5 in this study was at least as accurate as that in other studies
- Similar P_2O_5 containing areas were found between measured and predicted maps, and locations are almost acceptable to make decision.

Thank you for your attention!!