Growth status assessment from a hand-held crop measuring sensor in Italian ryegrass field

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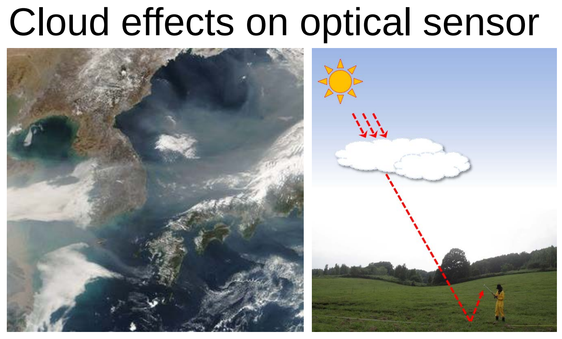
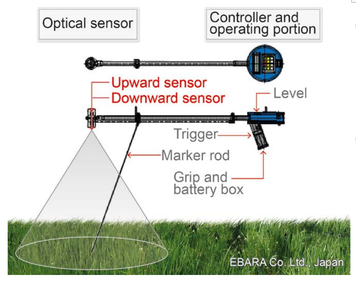
Introduction

- Cloud effects on optical sensor



- Development of cloud free multispectral radiometer for paddy field by Bio-oriented Technology Research Advancement Institution, Japan

Hand-held crop measuring device



- Bi-direction sensor
  - Upward
  - Downward
- 3 bands
  - Green (550nm)
  - Red (650nm)
  - Near infrared (NIR) (880nm)

equation

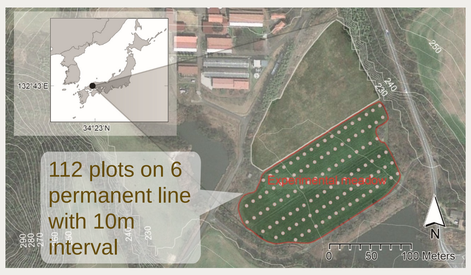
$$r_x = \frac{I_{dx} - D_{dx}}{I_{ux} - D_{ux}} \times W_x$$

Objectives

- Applicable on grassland?
  - Is it cloud free?
  - What is suitable analysis methods for assessment ?

Martials and Methods

Study site



- Setouchi Field Science Center, Saijo Station (34° 23'N, 132° 43'E), Hiroshima University, Japan
- Italian ryegrass (*Lolium multiflorum* Lam.) meadow (1.8 ha)
- Seeded in October and harvest twice in mid-May and early-June

Field data measurements (2 growing seasons)

- 2 types of data measurements by puposes
  1) Calibration : 12 randomly selected quadrats (0.05 m^2) with vegetation sampling
  2) Mapping : 6 permanent line plot with 10 m interval (112 quadrats) without vegetation sampling

Regression analysis

- Simple linear regression analysis to estimate herbage biomass (BM) and leaf area index (LAI) with normal and logarithmic form using 8 vegetation indices using Matlab (ver. 7.10)

Abbreviation	Name	Formula	Reference
RVI	Ratio vegetation index	NIR/RED	Jordan (1969)
Green / Red	Green/red ratio	$GREEN/RED$	Kanemasu (1974)
NDVI	Normalized difference VI	$(NIR - RED)/(NIR + RED)$	Rouse et al. (1973)
GNDVI	Green NDVI	$(NIR - GREEN)/(NIR + GREEN)$	Gitelson (1996)
SAVI	Soil adjusted VI	$\{(NIR - RED)/(NIR + RED + L)\} * (1 + L)$	Huete (1988)
MSAVI	Modified SAVI	$\left(2NIR + 1 - \sqrt{(2NIR + 1)^2 - 8(NIR - RED)}\right)/2$	Qi et al. (1994)
RDVI	renormalized DVI	$(NIR - RED)/\sqrt{NIR + RED}$	Roujean & Breon (1995)
MSR	Modified simple ratio	$(NIR/RED - 1)/\sqrt{NIR/RED + 1}$	Chen (1996)

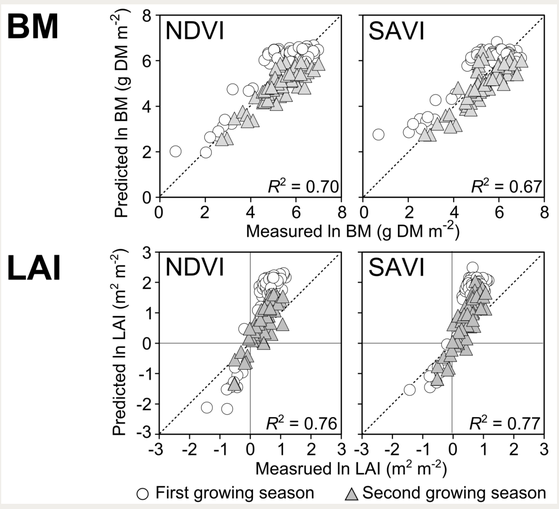
- Cross-year validation
  - BM and LAI were estimated using the other year's model.

Geostatistical Analysis

- To find out the spatial and temporal variability of BM and LAI using canopy reflectance data measured in permanent line plot.
  - Calculating semivariance and selcet vest fitted model
  - Ordinary point kriging
  - Software : "R" statistical software version 2.13.0 (package: gstat, automap)

Results and Discussions

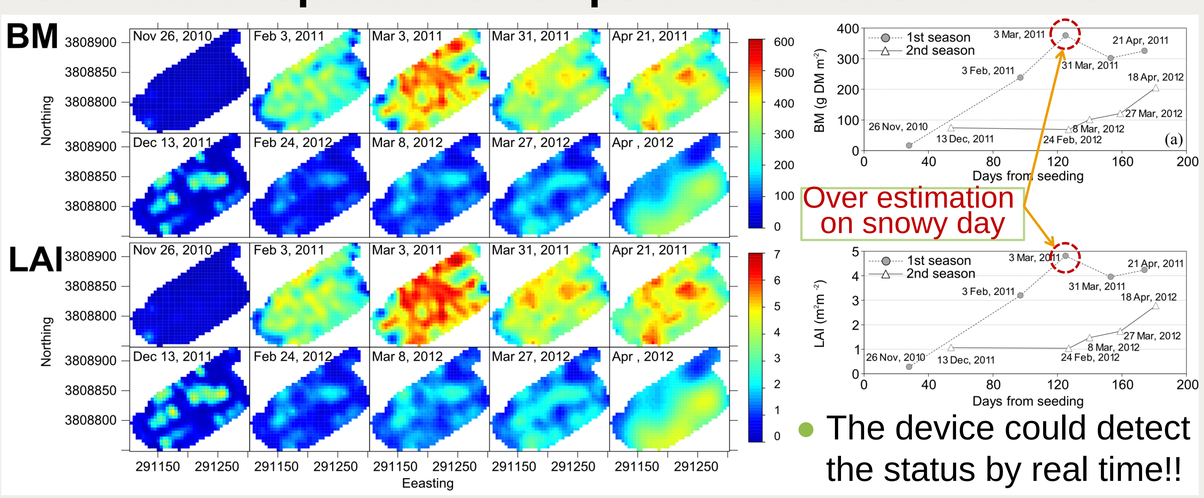
Estimation of BM and LAI



Vegetation index	Parameters: ln BM R^2	ln BM RMSE	ln BM Cross-year validation	ln LAI R^2	ln LAI RMSE	ln LAI Cross-year validation
RVI	0.60	0.75	0.41	0.68	0.61	0.52
Green/Red	0.02*	1.17	0.06	0.03*	1.06	0.09
NDVI	0.77	0.57	0.70	0.81	0.47	0.76
GNDVI	0.66	0.69	0.53	0.71	0.58	0.61
SAVI	0.73	0.62	0.67	0.80	0.48	0.77
MSAVI	0.75	0.59	0.66	0.81	0.47	0.75
RDVI	0.71	0.64	0.62	0.79	0.50	0.73
MSR	0.68	0.68	0.51	0.74	0.55	0.61

- Logarithmic form showed better performance than normal form
- The calibration model of NDVI and SAVI showed good robustness for prediction

Estimated of Spatial and Temporal Distribution of BM & LAI

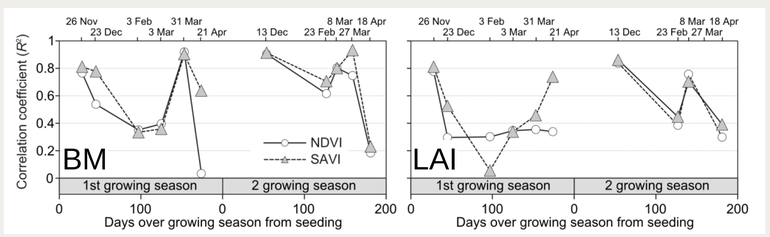


- The device could detect the status by real time!!

Suitable VIs to estimate BM and LAI using the device

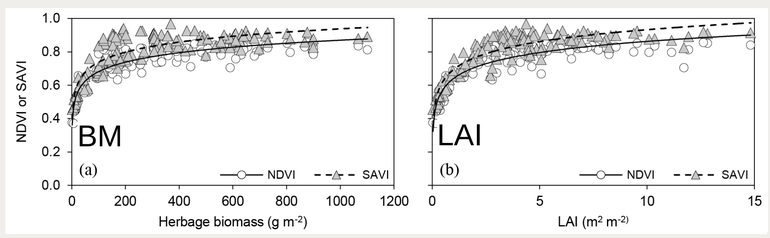
R^2 values between NDVI and SAVI and BM and LAI over growing season

- NDVI was most appropriate VI in the pooled dataset, however SAVI shows better performance in each measurement.



Relationship with BM and LAI and NDVI and SAVI

- Due to the saturation in high biomass, it need to consider for practical application in late growing season.



Conclusion

Applicability under cloudy weather

- The device could works well most of weather condition except for snowy day.

The limitation of the device

- Saturation effects of Vegetation Indices on high biomass stage, however most of important practices for management such as fertilizer and pesticide application are decided in early to mid growing season. The device is still powerful.

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