Drone-based remote sensing of sward structure and biomass for precision grazing: state of the art and future challenges

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Grasslands are key ecosystems
How can UAS enable novel decision support tools for grazing management?
What is grazing?
For the plants, a sudden reduction in above ground foliage.
Rising plate meter
Importance of regrowth
For the herbivore, constant choice between a multitude of potential bites
For the herbivore, constant choice between a multitude of potential bites
Time, a critical currency for the grazing herbivore

Bite mass and short-term intake rate (STIR) as a function of pasture height in *Avena strigosa*

Carvalho, 2013
Why spatializing sward structure and biomass?
Grazed grasslands are necessarily heterogeneous
Heterogeneity can benefit the herbivore

Pontes-Prates et al., 2020
https://doi.org/10.3390/su12208676
Remote sensing of grazing conditions
Where do UAS fit in the range of remote sensing solutions?
UAS applications are mainly driven by the sensor

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<th>Visible</th>
<th>Thermal</th>
<th>Multispectral</th>
<th>Hyperspectral</th>
<th>LiDAR</th>
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- **Visible**:<1000
- **Thermal**:4000
- **Multispectral**:6000
- **Hyperspectral**:>50000
- **LiDAR**:>50000 $
3D modelling, a key to sward height

Bendig et al., 2013

https://doi.org/10.1127/1432-8364/2013/0200
Prediction performances of pasture sward height


Michez et al., 2020. https://doi.org/10.3390/rs12101650
Prediction of other pasture structural characteristics using spectral information

(a) 29 April 2015
$R^2 = 0.81$
$P < 0.01$
$RMSE = 0.05$

(b) 11 June 2015
$R^2 = 0.70$
$P < 0.01$
$RMSE = 0.63$

(c) 9 July 2015
$R^2 = 0.65$
$P < 0.01$
$RMSE = 0.57$

(d) 18 September 2015
$R^2 = 0.33$
$P < 0.01$
$RMSE = 1.00$

(a) 29 April 2015
$R^2 = 0.77$
$P < 0.01$
$RMSE = 1.6$

(b) 11 June 2015
$R^2 = 0.48$
$P < 0.01$
$RMSE = 2.18$

(c) 9 July 2015
$R^2 = 0.76$
$P < 0.01$
$RMSE = 18.0$

(d) 18 September 2015
$R^2 = 0.31$
$P < 0.01$
$RMSE = 18.6$
Next steps? Exploring the vertical distribution of the forage resource...

Brem et al., 2012
http://dx.doi.org/10.1016/j.applanim.2012.08.008
...enabling precision grazing
The concept of Rotatiuous Grazing exploiting IT solutions (Italian ryegrass or Tifton 85) enabling optimal grazing...
Hype curve of precision agriculture
Thank you very much for your kind attention!