ANCILLARY DATA in GRASSLANDS
Read this first

This PPT summarizes the **prefinal** version of the protocol on Ancillary Vegetation Measurements in grasslands (version 20150905). It was presented in a slightly different structure at the ICOS-ETC workshop for Ancillary Measurements held in Gembloux, Belgium, from 7 to 9 September 2015.

- For more details we refer to the full protocol text. It can be found on the Alfresco platform.

- The content of the finalized protocol version, which will likely be ready in November, might differ from what is presented here. We suggest not to start organizing ancillary measurements on the basis of this PPT, but wait until the finalized protocol is available.
Content

1. Measured variables
2. Selected methods
3. Spatial and temporal design
4. Calibration of sensors
5. Data submission: what and how?
1 Measured variables

1.1 Green Area Index (GAI)

*definition:* the photosynthetically active surface area of standing vegetation, expressed per unit of ground area

*units:* $m^2 \cdot m^{-2}$

- includes leaves, stems, flowers, fruits, ...
- expressed on a hemi-surface area basis
- only photosynthetically active parts (“green”)

- not exactly the same as LAI (only leaves) or PAI (also “non-green”)
1 Measured variables

1.1 Green Area Index (GAI)

Why measuring?

• explain variability of observed ecosystem fluxes

\[ NEE = -1.71 \text{LAI} + 0.36 \]
\[ r^2 = 0.77 \]

\( NEE \) (g C m\(^{-2}\) day\(^{-1}\))

\( LAI \)

\( r = 0.94 \)

\( \text{Leaf area index, m}^2 \text{ m}^{-2} \)

\( 0.0 \) to \( 3.0 \)

\( 0.0 \) to \( 3.0 \)

\( -4 \) to \( 2 \)

\( -15 \) to \( 5 \)

Aires et al., 2008

Flanagan et al., 2002
1 Measured variables

1.1 Green Area Index (GAI)

Why measuring?

• provide key data to end users (modellers, remote sensors,...)
1.2 Aboveground biomass (AGB)

**definition:** the dry matter of the aboveground fraction of standing vegetation, expressed per unit of ground area

**units:** g DW m\(^{-2}\)

- includes leaves, stems, flowers, fruits, ...
- includes both green and non-green material

- not detached plant parts (= litter)
1.2 Aboveground biomass (AGB)

Why measuring?

- estimate yearly aboveground primary production (ANPP)

\[
\text{yearly ANPP} \approx A + B + C
\]

(decomposition ignored)

+ estimate harvest biomass and grazed biomass

• provide key data to end users (modellers, remote sensors,...)
1 Measured variables

1.3 Litter biomass

*definition*: the dry mass of litter, expressed per unit of ground area

*units*: g DW m\(^{-2}\)

- green and non-green, detached yet not decayed material
- also harvest residue = cut biomass left on the field after harvest collection
1 Measured variables

1.3 Litter biomass

Why measuring?

• estimate yearly aboveground primary production (ANPP)

\[ \text{yearly ANPP} \approx A + B + C \]

(decomposition ignored)

• estimate fraction of AGB that can enter the soil cycle

• \textit{harvest residue}: correct harvest biomass estimated from AGB
2 Selected methods

OVERVIEW

- GAI & AGB:  (1) destructive sampling
  (2) plate meter: bulk height of vegetation
  ➔ combined in double sampling scheme
  or as an alternative method for GAI:
  (3) the linear ceptometer

- litter biomass: (4) litter collection
2 Selected methods

2.1. Destructive sampling

= “clipping and weighing”
2 Selected methods

2.1. Destructive sampling

**ICOS-specifications**

- for proper regrowth, clip only to stubble height
  - do separate stubble measurements
- separate green (grasses, legumes, non-leg forbs) and non-green
2 Selected methods

2.2 The plate meter: bulk height of vegetation

= height of a weighted plate resting on compressed vegetation beneath
2 Selected methods

2.2 The plate meter: bulk height of vegetation

- correlates well with AGB

\[
y = ax + b
\]
\[
a = 16.4 \pm 4.7
\]
\[
b = 5.5 \pm 29.7
\]
\[
R^2 = 0.89
\]

sown *L. perenne* grassland (Wilrijk, BE)
2 Selected methods

2.2 The plate meter: bulk height of vegetation

- correlates well with AGB
2 Selected methods

2.2 The plate meter: bulk height of vegetation

- ... and with GAI

\[ y = ax + b \]
\[ a = 0.32 \pm 0.19 \]
\[ b = 0.23 \pm 1.25 \]
\[ R^2 = 0.62 \]

sown *L. perenne* grassland (Wilrijk, BE)
2 Selected methods

2.3 The linear ceptometer

- GAI is calculated from measured PAR transmittance
2 Selected methods

2.3 The linear ceptometer

- GAI is calculated from measured PAR transmittance

\[ GAI = f(PAR_{\text{below}} / PAR_{\text{above}}, \ldots) \]
2 Selected methods

2.3 The linear ceptometer

*ICOS specifications:*

- ceptometer does not distinguish between green and non-green: use only in grasslands where vegetation contains few non-green material and is not too short

- compare with direct GAI once per season (recommended)
2 Selected methods

2.4 Litter collection

- handpicking of litter
- (hand)raking of harvest residue

ICOS specifications:

- should only be measured where and when possible...
3 Spatial and temporal sampling design

3.1 General outline: what do we want?

• seasonal patterns of footprint-representative GAI, AGB (and litter)
  → measurements are done:
    • at the start and the end of the growing season
    • at each peak and low of GAI / AGB in the growing season
    • at least 4 to 6 times per growing season
    • at a number of randomly selected sampling points in the footprint

• but also estimation of yearly ANPP...
  → additional measurements needed to estimate grazed biomass

measurements of GAI, AGB and litter biomass are integrated into one sampling design
3 Spatial and temporal sampling design

3.2 Example: an unmanaged grassland

- indicative timing of measurements: one vegetation peak
3.2 Example: an unmanaged grassland

- indicative timing of measurements: two vegetation peaks

<table>
<thead>
<tr>
<th>GAI</th>
<th>AGB</th>
<th>litter biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>measurement</td>
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</table>

*e.g. drought*
3 Spatial and temporal sampling design

3.2 Example: an unmanaged grassland

- measurements at each sampling date

- + ● : Class I (II): 60 (30)
  - plate meter
  - linear ceptometer

- ● : Class I (II): 6-12 (4-6)
  - destructive sampling
  - litter collection

- ○ : Class I (II): 5-10 (3-5)
  - stubble
  (not at each date, though)
3 Spatial and temporal sampling design

3.3 Example: a managed grassland - cutting

- timing of measurements

![Diagram showing GAI, AGB, AGB in grazing cages, and litter biomass over time with specific points labeled for measurements and events like cutting and relocation of cages.]
3.3 Example: a managed grassland - cutting

(1) a measurement of GAI, AGB and litter just before the cutting
3 Spatial and temporal sampling design

3.3 Example: a managed grassland - cutting

(2) a new measurement of GAI, AGB and litter just after the cutting
3 Spatial and temporal sampling design

3.3 Example: a managed grassland - cutting

(3) a measurement of harvest residue after harvest collection
3 Spatial and temporal sampling design

3.3 Example: a managed grassland – continuous grazing

- timing of measurements

![Graph showing GAI, AGB, AGB in grazing cages, and litter biomass over time with various measurement points and labels.](image-url)
3 Spatial and temporal sampling design

3.3 Example: a managed grassland – continuous grazing

(1) a measurement of GAI, AGB and litter
+ installation of cages
3 Spatial and temporal sampling design

3.3 Example: a managed grassland – continuous grazing

(2) a new measurement of GAI, AGB and litter
   + measurement of AGB in cages + relocation of cages
3 Spatial and temporal sampling design

3.3 Example: a managed grassland – rotational grazing

- timing of measurements
3 Spatial and temporal sampling design

3.3 Example: a managed grassland – rotational grazing

- measurements for estimating grazed biomass

a) short grazing time in paddocks: AGB measurement before and after grazing of paddock
b) longer grazing time in paddocks: AGB measurement in- and outside grazing cages* after grazing of the paddock

* installed at start of grazing
3 Spatial and temporal sampling design

3.4 Example: a stratified footprint

- Measurement effort is distributed between strata
- Different sampling scheme in each stratum
3 Spatial and temporal sampling design

3.5 The measurements at a sampling point

- destructive sampling + plate meter + litter collection

![square quadrat](image)

min 25x25 cm
3 Spatial and temporal sampling design

3.5 The measurements at a sampling point

- stubble measurement

min 25x25 cm
3 Spatial and temporal sampling design

3.5 The measurements at a sampling point

- linear ceptometer

three measurements per point
3 Spatial and temporal sampling design

3.5 The measurements at a sampling point

- harvest residue

4x4 m
3 Spatial and temporal sampling design

3.5 The measurements at a sampling point

• grazing cages
4 Calibration of sensors

4.1 Double sampling technique: the plate meter

- plot AGB / GAI from destructive sampling against bulk height
- fit a linear regression
4 Calibration of sensors

4.2 The linear ceptometer

- cross-calibrate probe and external sensor
- recalibration of external sensor at factory
5 Data submission: what and how?

5.1 What data to upload?

- methods, instruments (model + sn), sampling date

For each sampling point:

- metadata: ID, coordinates, area, stubble height, ...
- measurement data: $\text{GAI}_{\text{grass}}$, $\text{GAI}_{\text{leg}}$, $\text{GAI}_{\text{nonleg}}$
  - $\text{AGB}_{\text{gr_grass}}$, $\text{AGB}_{\text{gr_leg}}$, $\text{AGB}_{\text{gr_nonleg}}$, $\text{AGB}_{\text{nongr}}$
  - bulk height
  - litter biomass
  - harvest residue
  - raw ceptometer measurements
5.2 How to upload data?

- fill and send template Excel files (BADM)

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<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
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each column is a sampling point (=‘plot’), each row is a parameter or variable
5 Data submission: what and how?

5.2 How to upload data?

- linear ceptometer: send raw output files

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