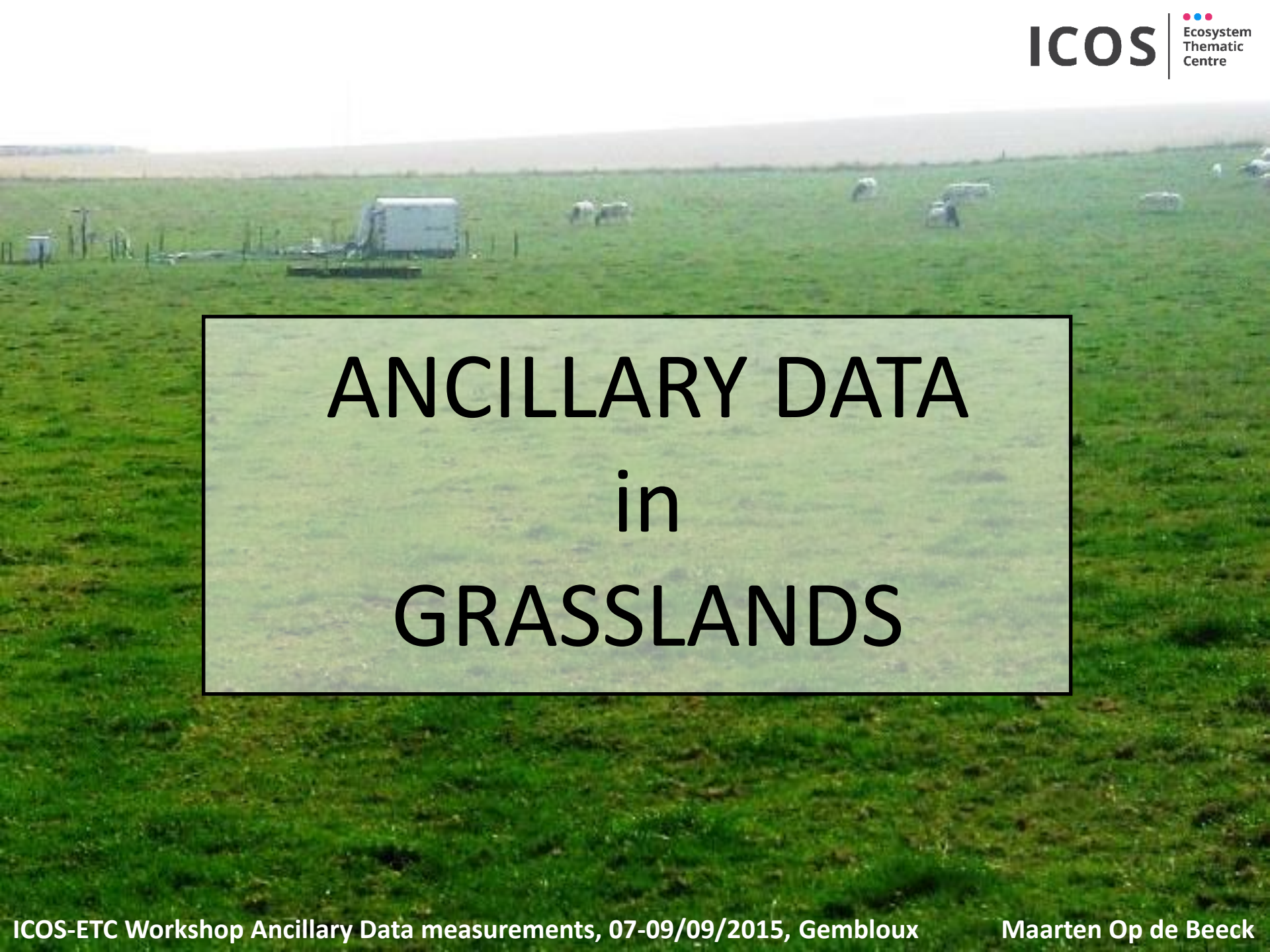


ICOS Ecosystem Thematic Centre

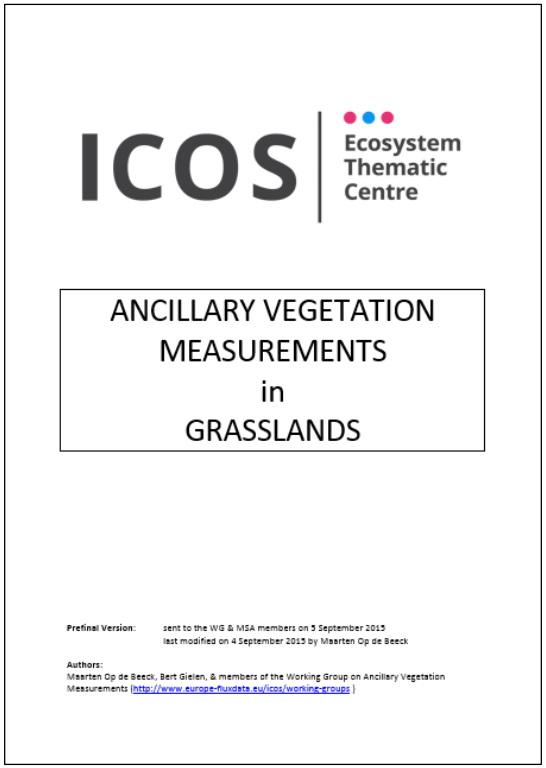
ANCILLARY DATA in GRASSLANDS

Maarten Op de Beeck

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.


ICOS Ecosystem Thematic Centre

ANCILLARY VEGETATION MEASUREMENTS in GRASSLANDS

Prefinal Version: sent to the WG & MSA members on 5 September 2015
last modified on 4 September 2015 by Maarten Op de Beeck

Authors:
Maarten Op de Beeck, Bert Gielen, & members of the Working Group on Ancillary Vegetation Measurements (http://www.europe-fluxdata.eu/icos/working-groups)

Content

ICOS Ecosystem Thematic Centre

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

1 Measured variables

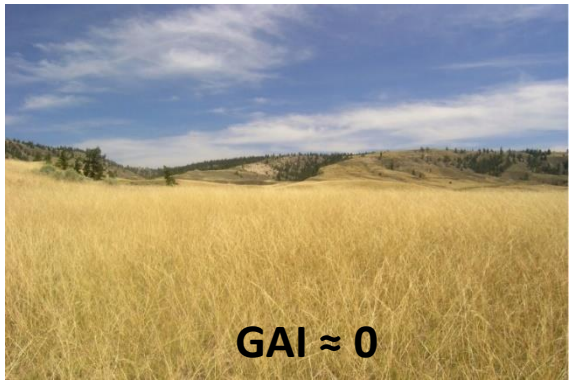
ICOS Ecosystem Thematic Centre

1.1 Green Area Index (GAI)

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

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

- 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”)

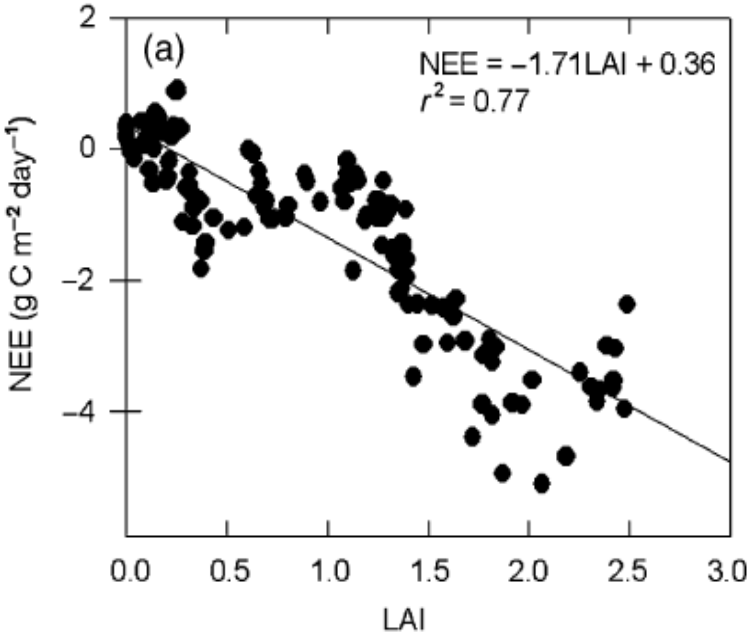
1 Measured variables

ICOS Ecosystem Thematic Centre

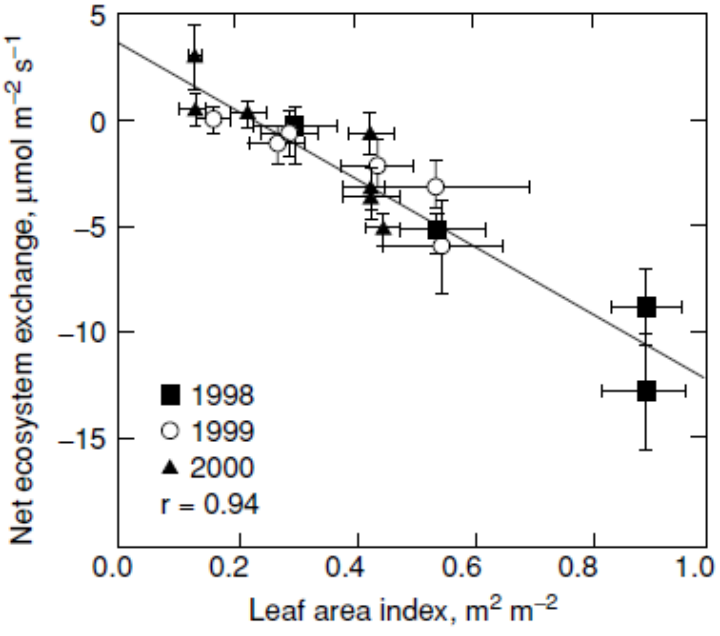
1.1 Green Area Index (GAI)

Why measuring?

- explain variability of observed ecosystem fluxes



Aires et al., 2008



Flanagan et al., 2002

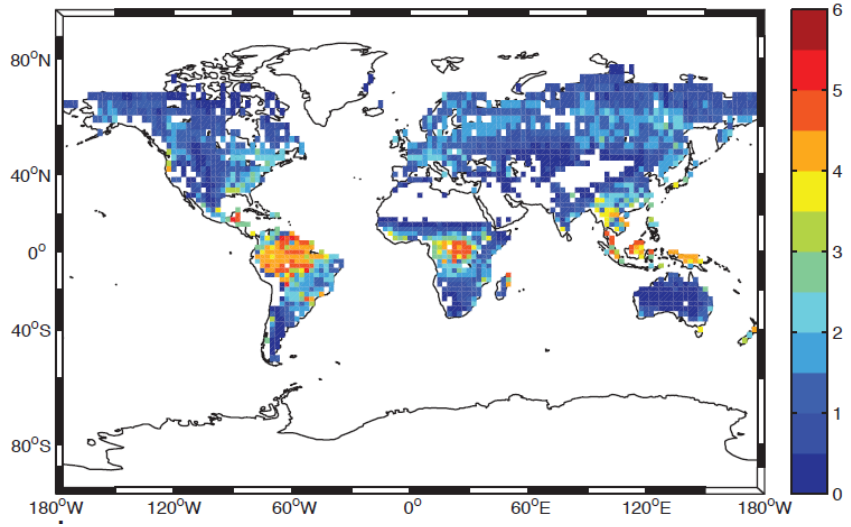
1 Measured variables

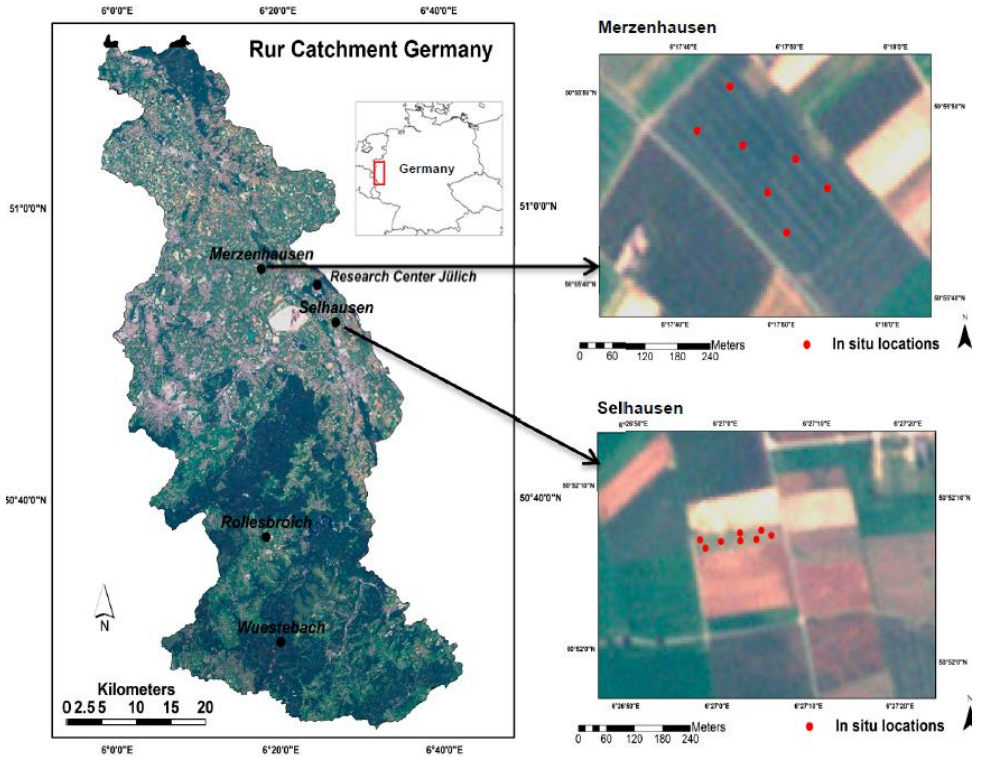
ICOS Ecosystem Thematic Centre

1.1 Green Area Index (GAI)

Why measuring?

- provide key data to end users (modellers, remote sensors,…)





1 Measured variables

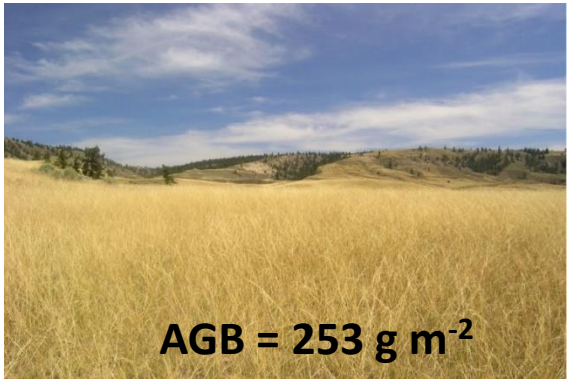
ICOS Ecosystem Thematic Centre

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



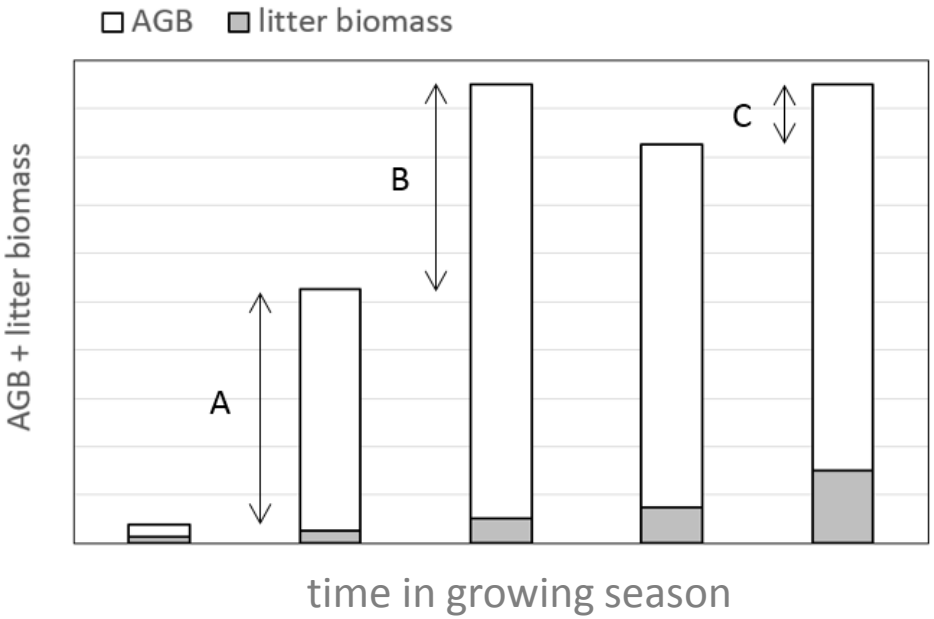
- not detached plant parts (= litter)

1 Measured variables

1.2 Aboveground biomass (AGB)

Why measuring?

- estimate yearly aboveground primary production (ANPP)



yearly ANPP ≈ A + B + C

(decomposition ignored)

+ estimate harvest biomass and grazed biomass

- provide key data to end users (modellers, remote sensors,…)

1 Measured variables

ICOS Ecosystem Thematic Centre

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

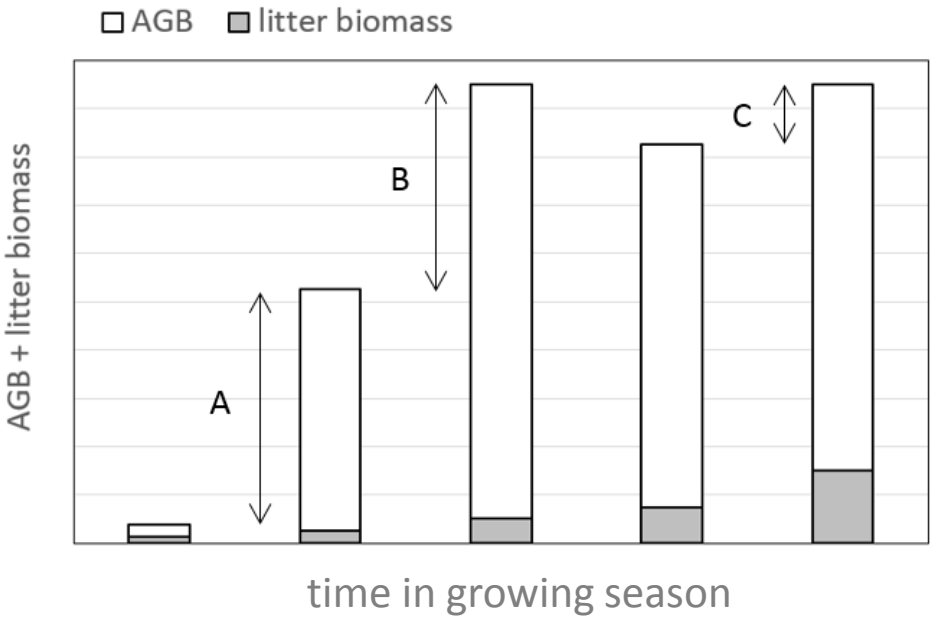
1 Measured variables

ICOS Ecosystem Thematic Centre

1.3 Litter biomass

Why measuring?

- estimate yearly aboveground primary production (ANPP)



yearly ANPP ≈ A + B + C

(decomposition ignored)

- estimate fraction of AGB that can enter the soil cycle
- *harvest residue*: correct harvest biomass estimated from AGB

2 Selected methods

ICOS Ecosystem Thematic Centre

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

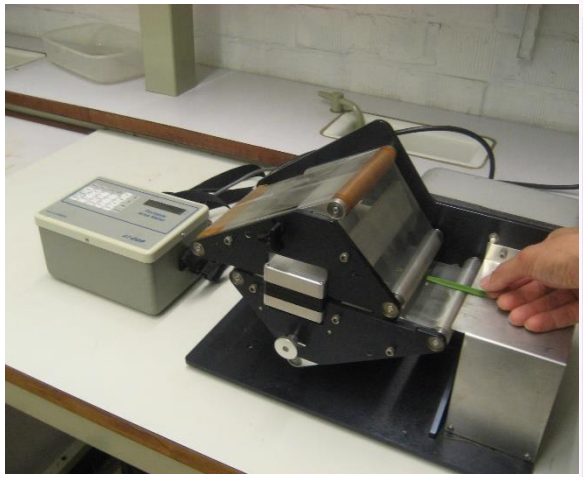
- litter biomass: (4) litter collection

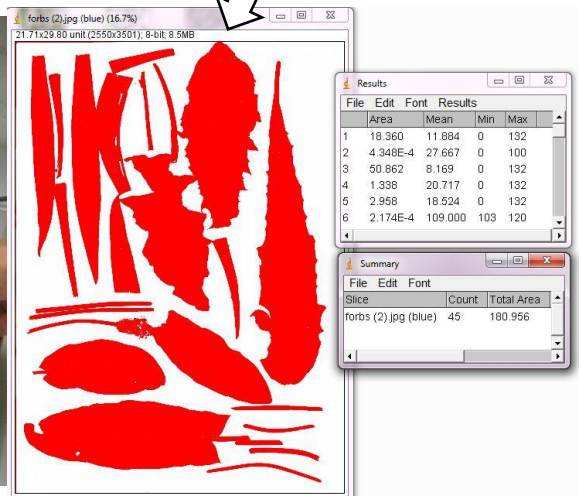
2 Selected methods

ICOS Ecosystem Thematic Centre

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

ICOS Ecosystem Thematic Centre

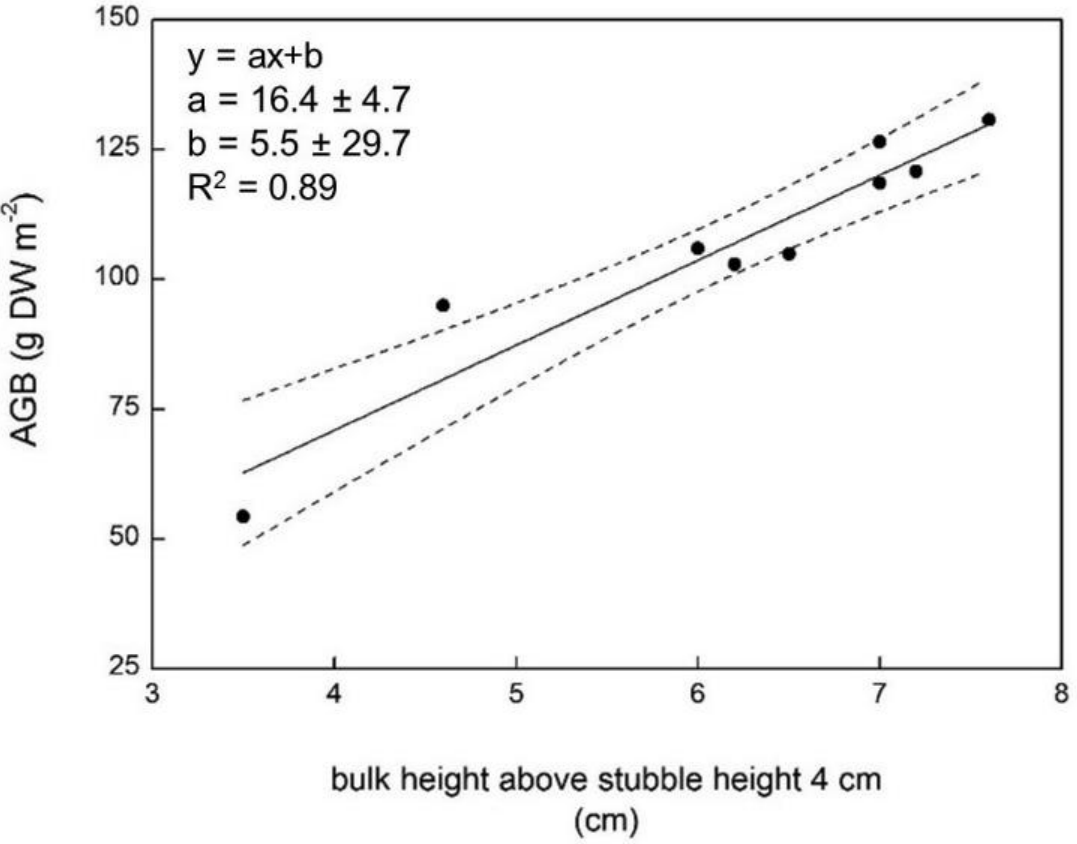
2.2 The plate meter: bulk heigth of vegetation

= height of a weighted plate resting on compressed vegetation beneath

2 Selected methods

2.2 The plate meter: bulk heigth of vegetation

- correlates well with AGB



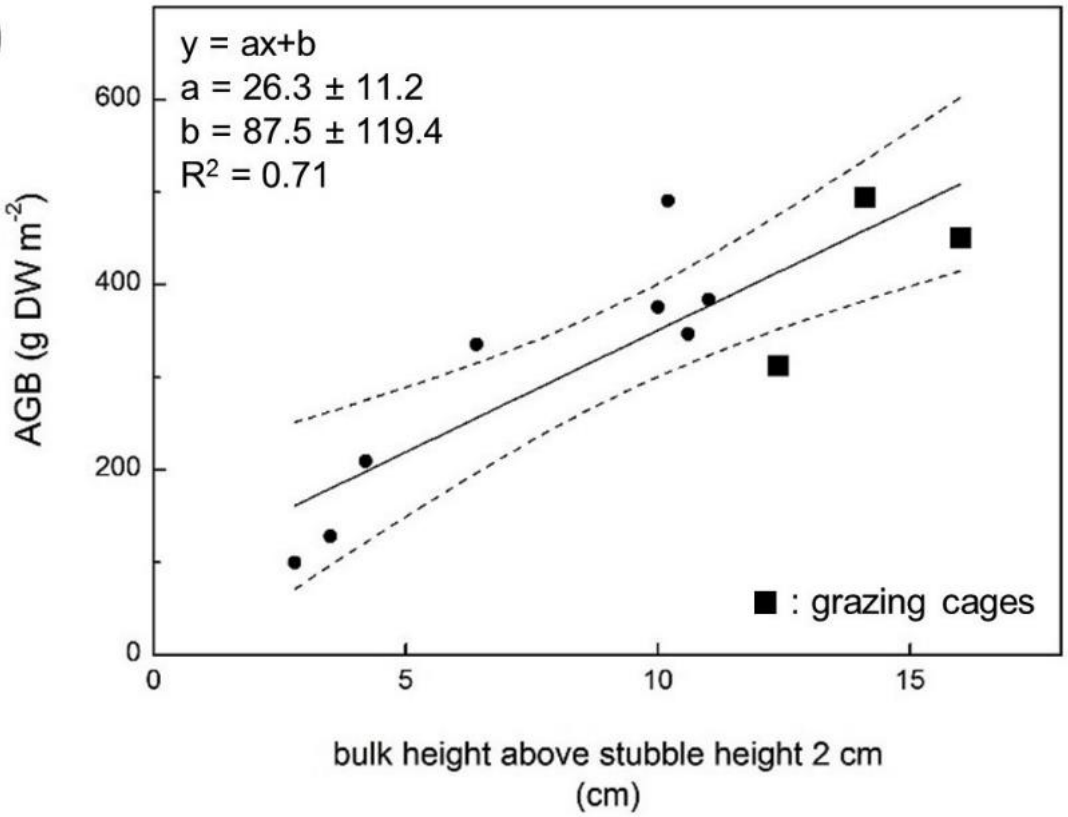
sown *L. perenne* grassland (Wilrijk, BE)

2 Selected methods

ICOS Ecosystem Thematic Centre

2.2 The plate meter: bulk heigth of vegetation

- correlates well with AGB

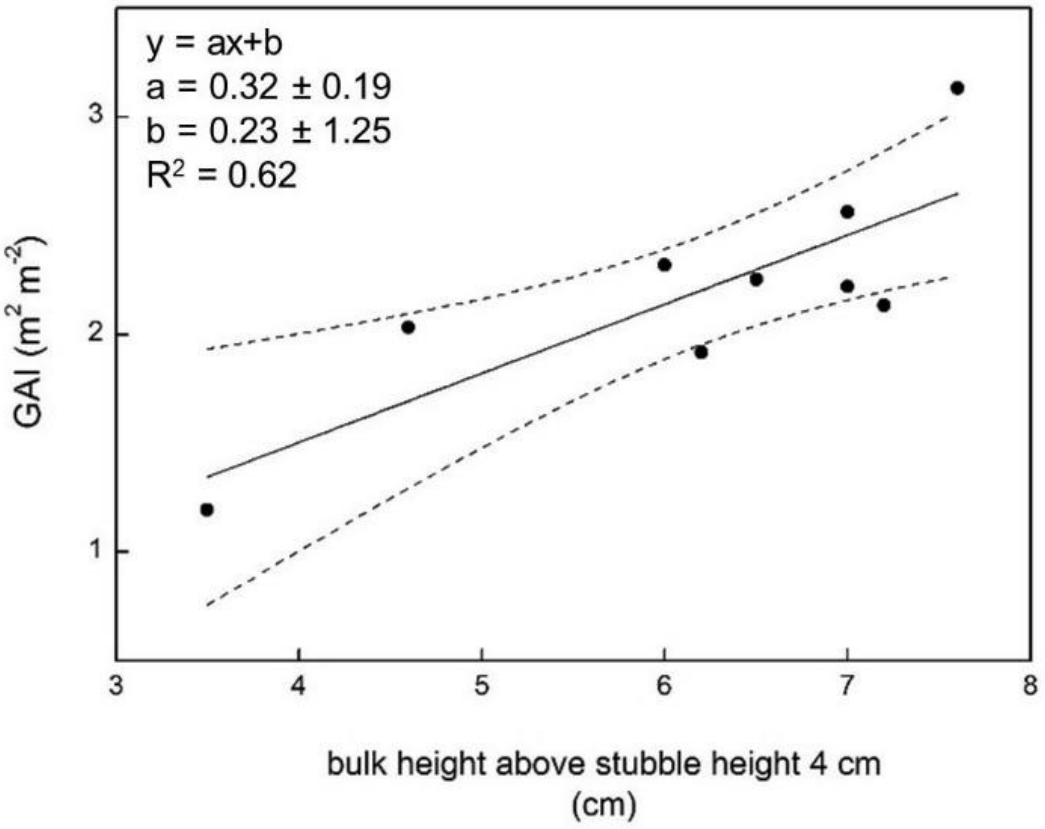


grazed grassland (Dorinne, BE)

2 Selected methods

2.2 The plate meter: bulk heigth of vegetation

- ... and with GAI



sown *L. perenne* grassland (Wilrijk, BE)

2 Selected methods

ICOS Ecosystem Thematic Centre

2.3 The linear ceptometer

- GAI is calculated from measured PAR transmittance

a)

SS1 Sunscan Canopy Analyzer

b)

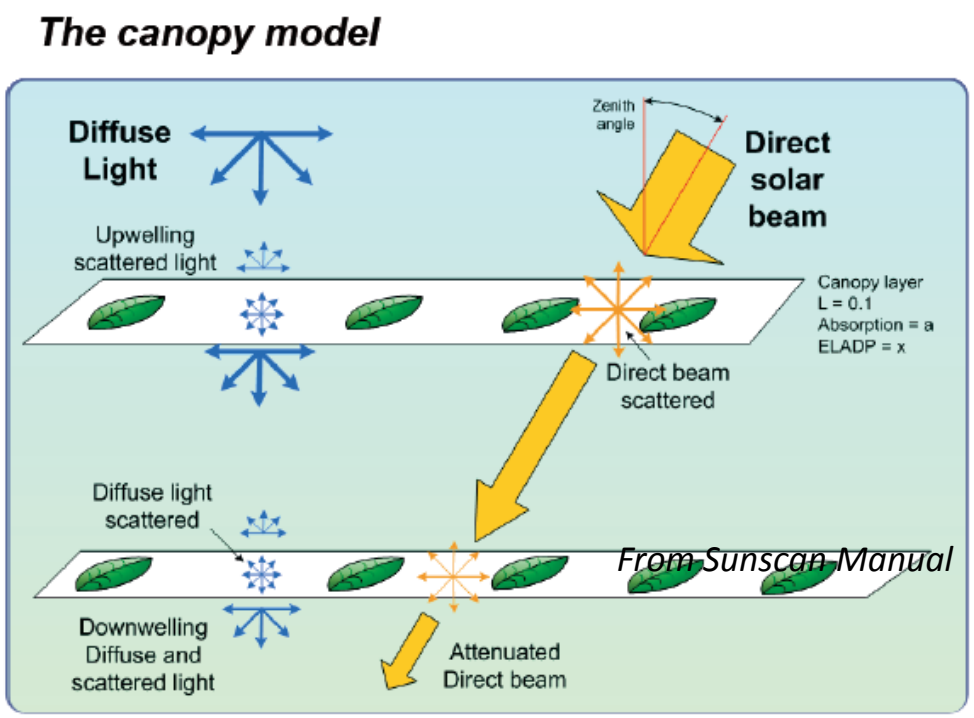
AccuPAR LP-80

2 Selected methods

ICOS Ecosystem Thematic Centre

2.3 The linear ceptometer

- GAI is calculated from measured PAR transmittance



$$GAI = f(PAR_{below}/PAR_{above}, \ldots)$$

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

ICOS Ecosystem Thematic Centre

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

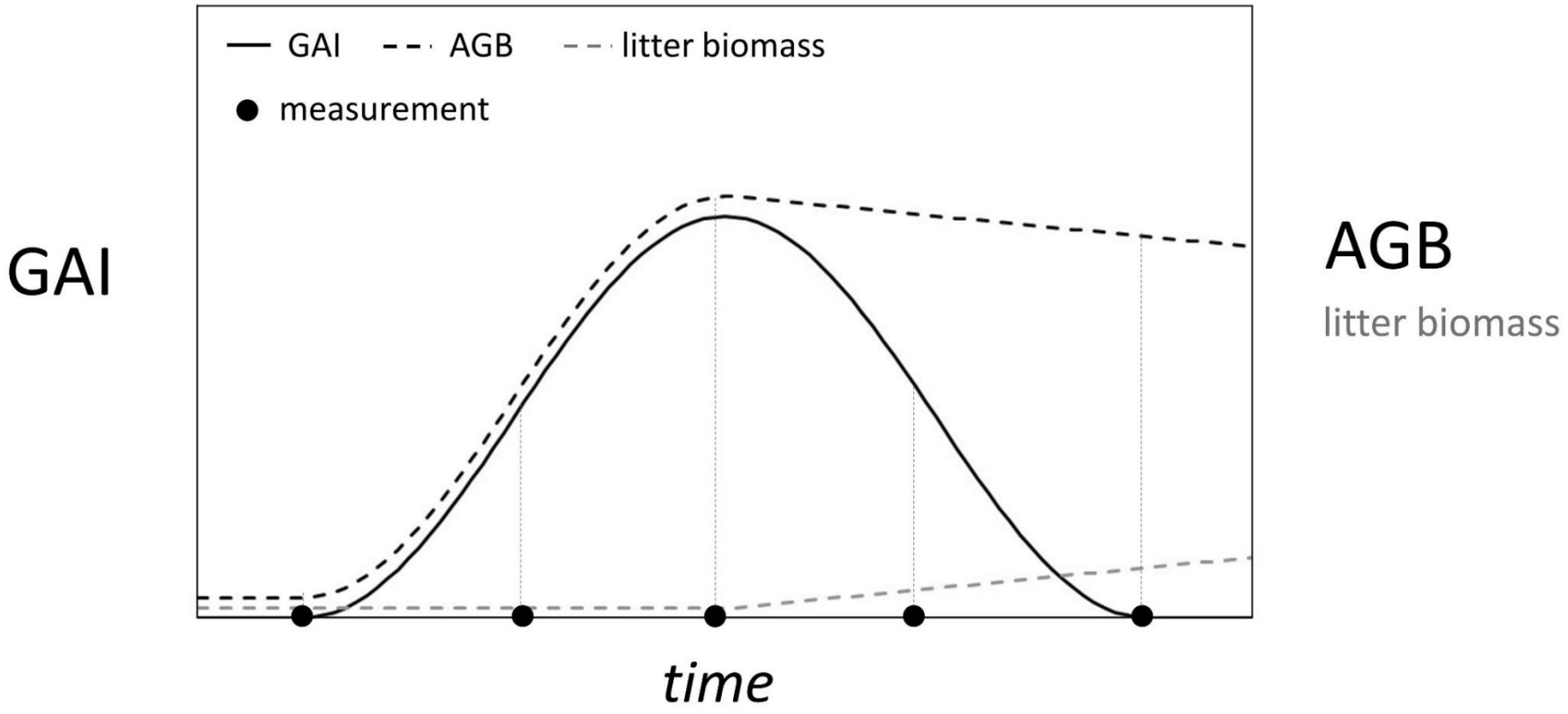
measurements of GAI, AGB and litter biomass are integrated into one sampling design

3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

3.2 Example: an unmanaged grassland

- indicative timing of measurements: one vegetation peak

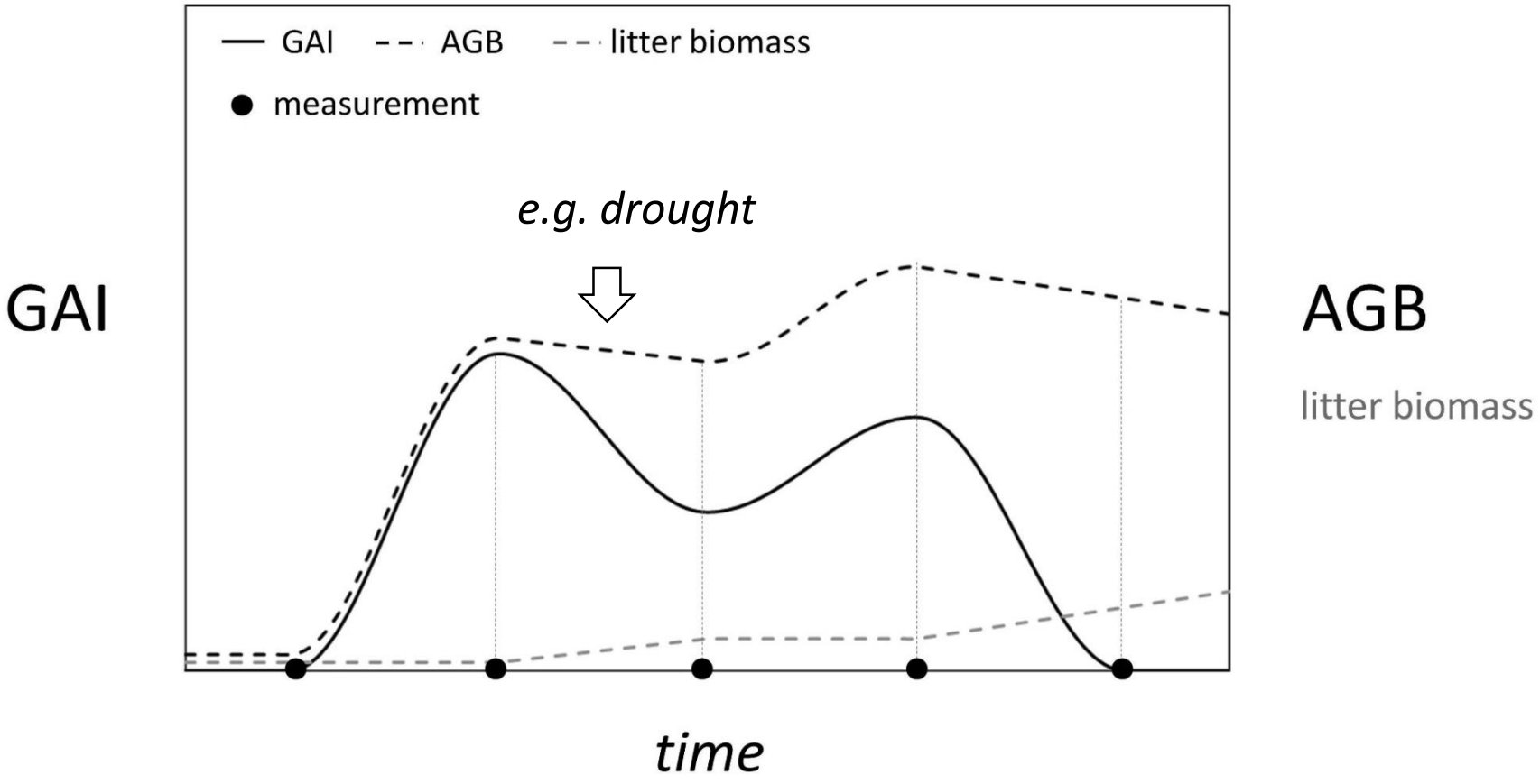


3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

3.2 Example: an unmanaged grassland

- indicative timing of measurements: two vegetation peaks

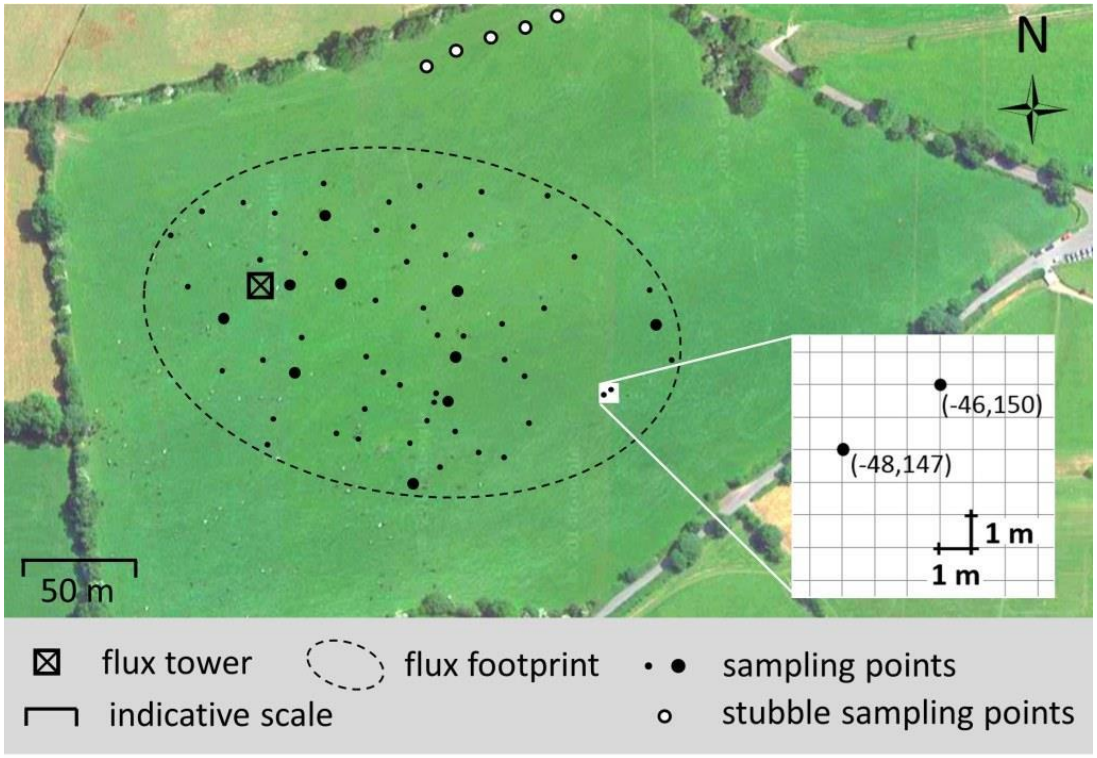


3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

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

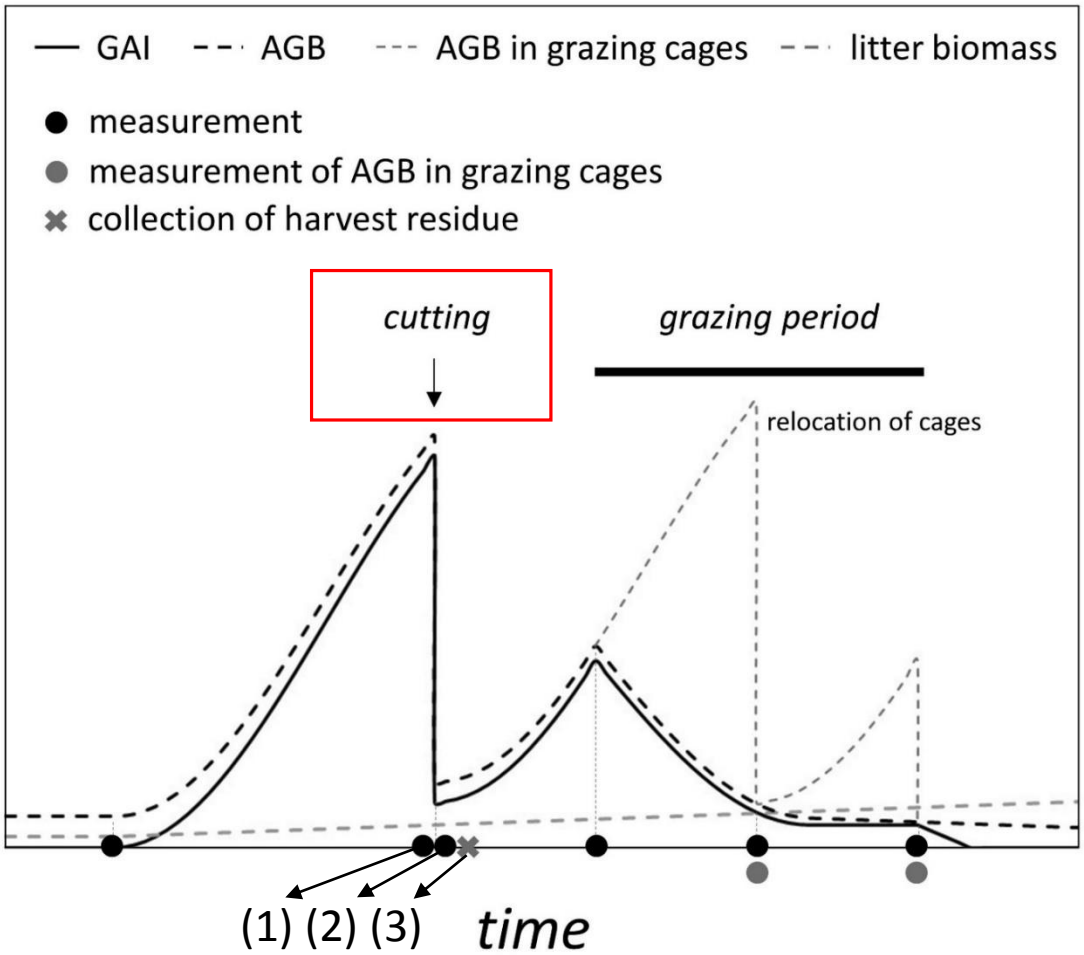
  (not at each date, though)

3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

3.3 Example: a managed grassland - cutting

- timing of measurements



GAI

AGB

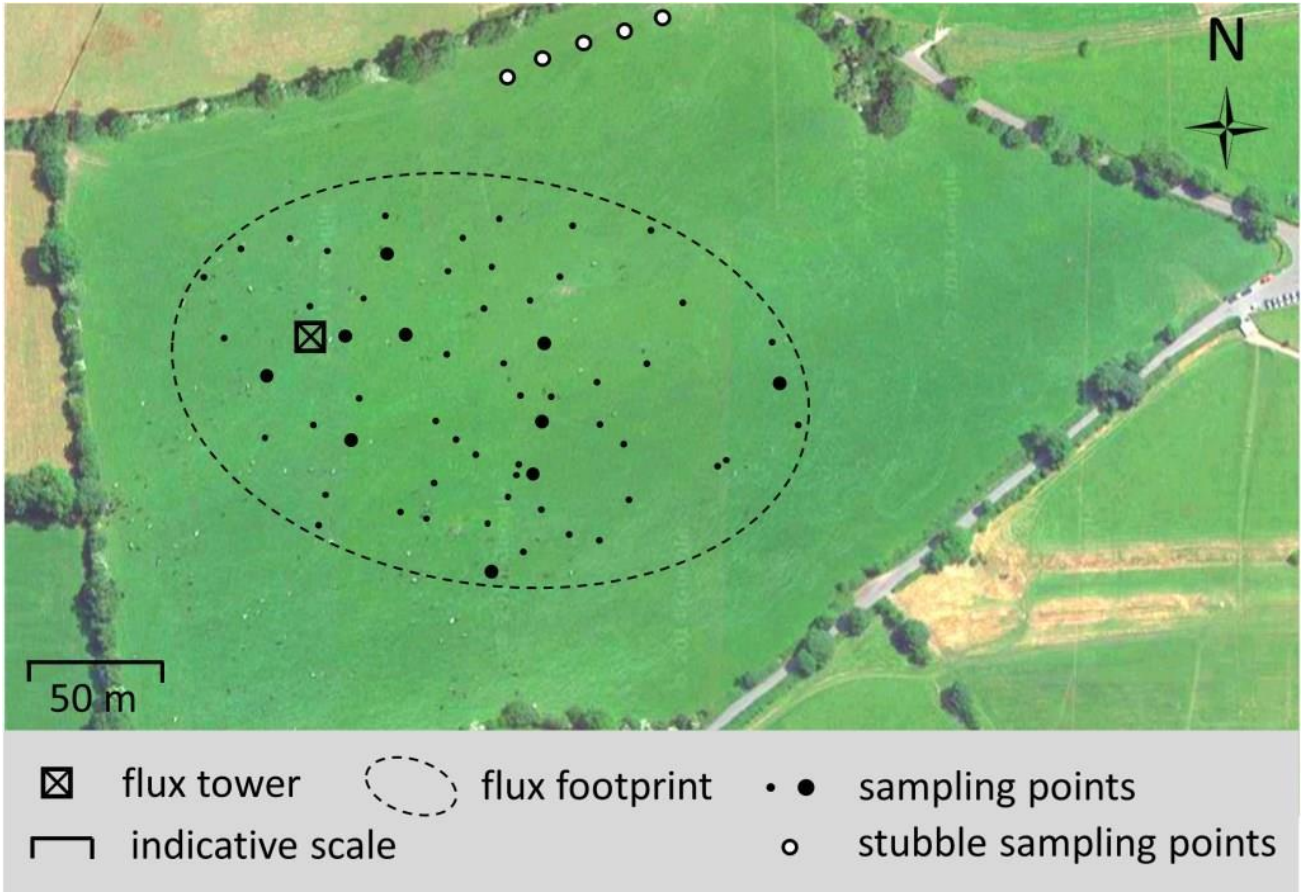
litter biomass

3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

3.3 Example: a managed grassland - cutting

(1) a measurement of GAI, AGB and litter just before the cutting

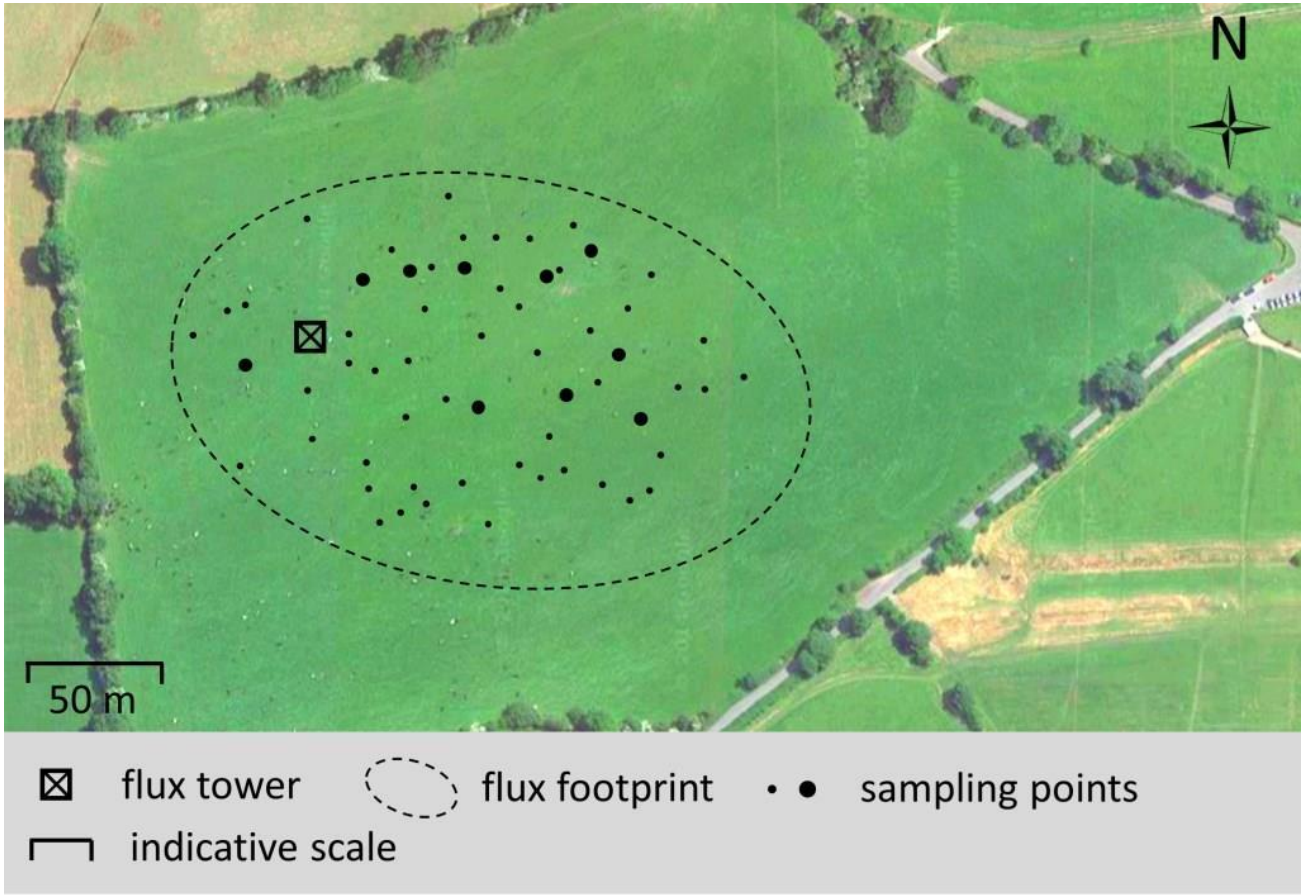


3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

3.3 Example: a managed grassland - cutting

(2) a new measurement of GAI, AGB and litter just after the cutting

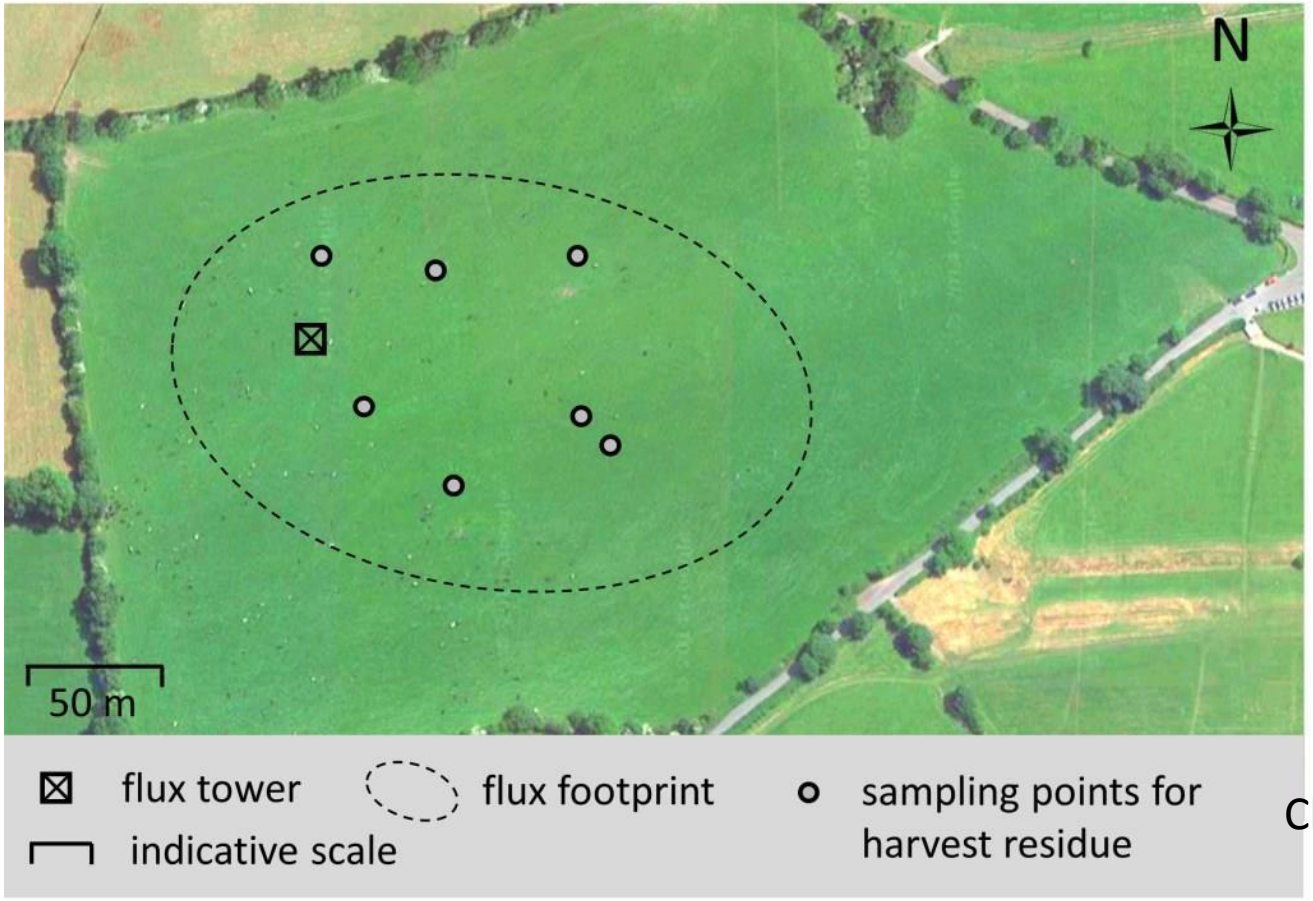


3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

3.3 Example: a managed grassland - cutting

(3) a measurement of harvest residue after harvest collection



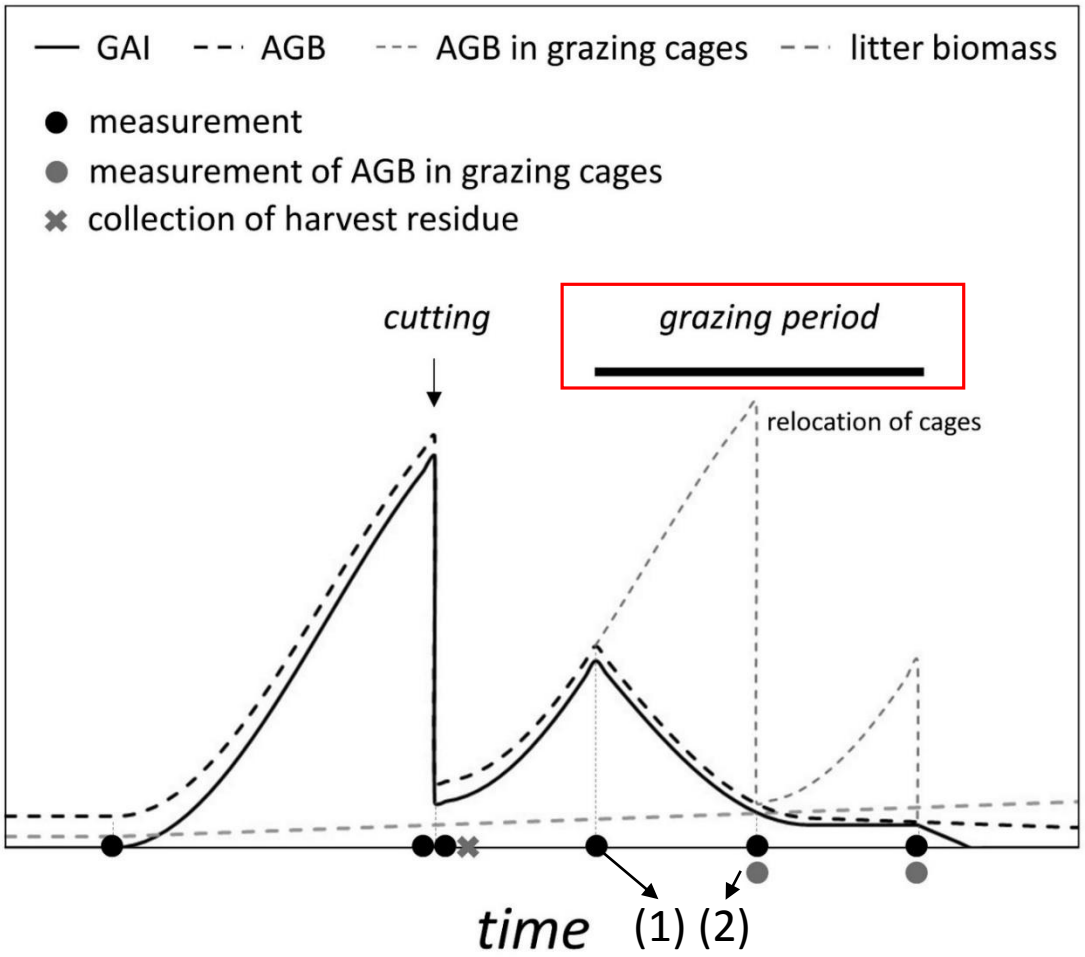
Class I (II): 5-10 (3-5)

3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

3.3 Example: a managed grassland – continuous grazing

- timing of measurements



GAI

AGB

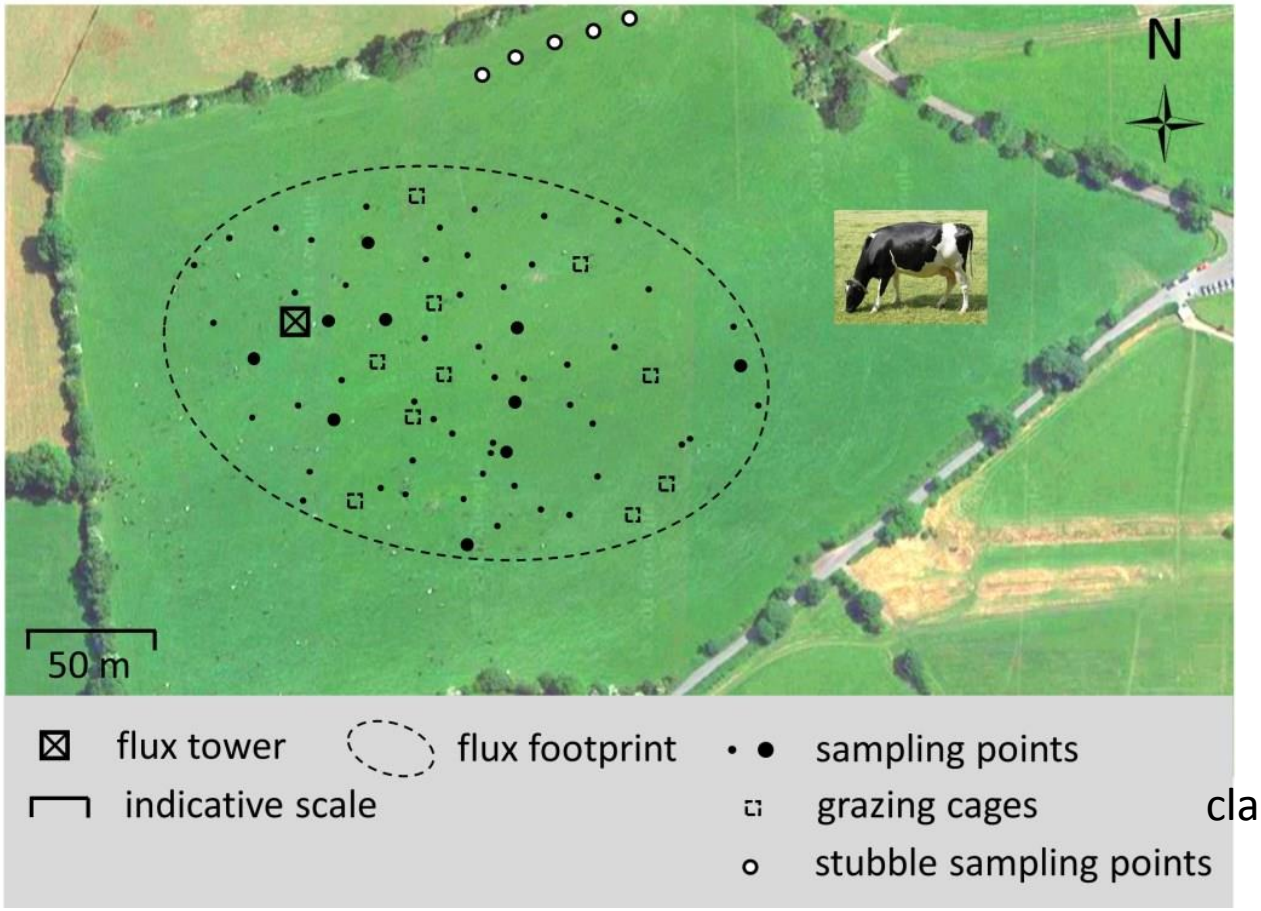
litter biomass

3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

3.3 Example: a managed grassland – continuous grazing

(1) a measurement of GAI, AGB and litter
+ installation of cages



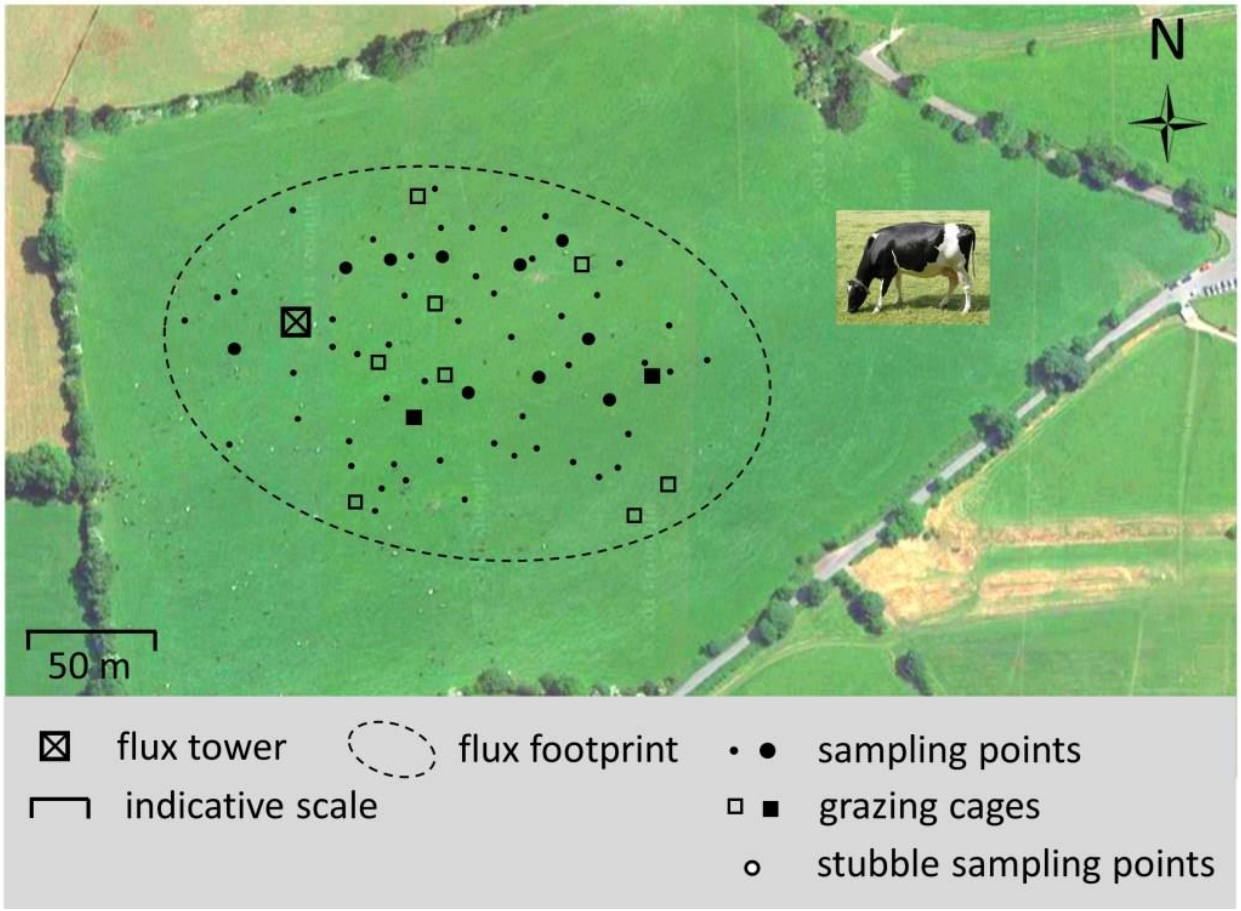
class I (II): 10 (5)

3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

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



□ & ■ : plate meter

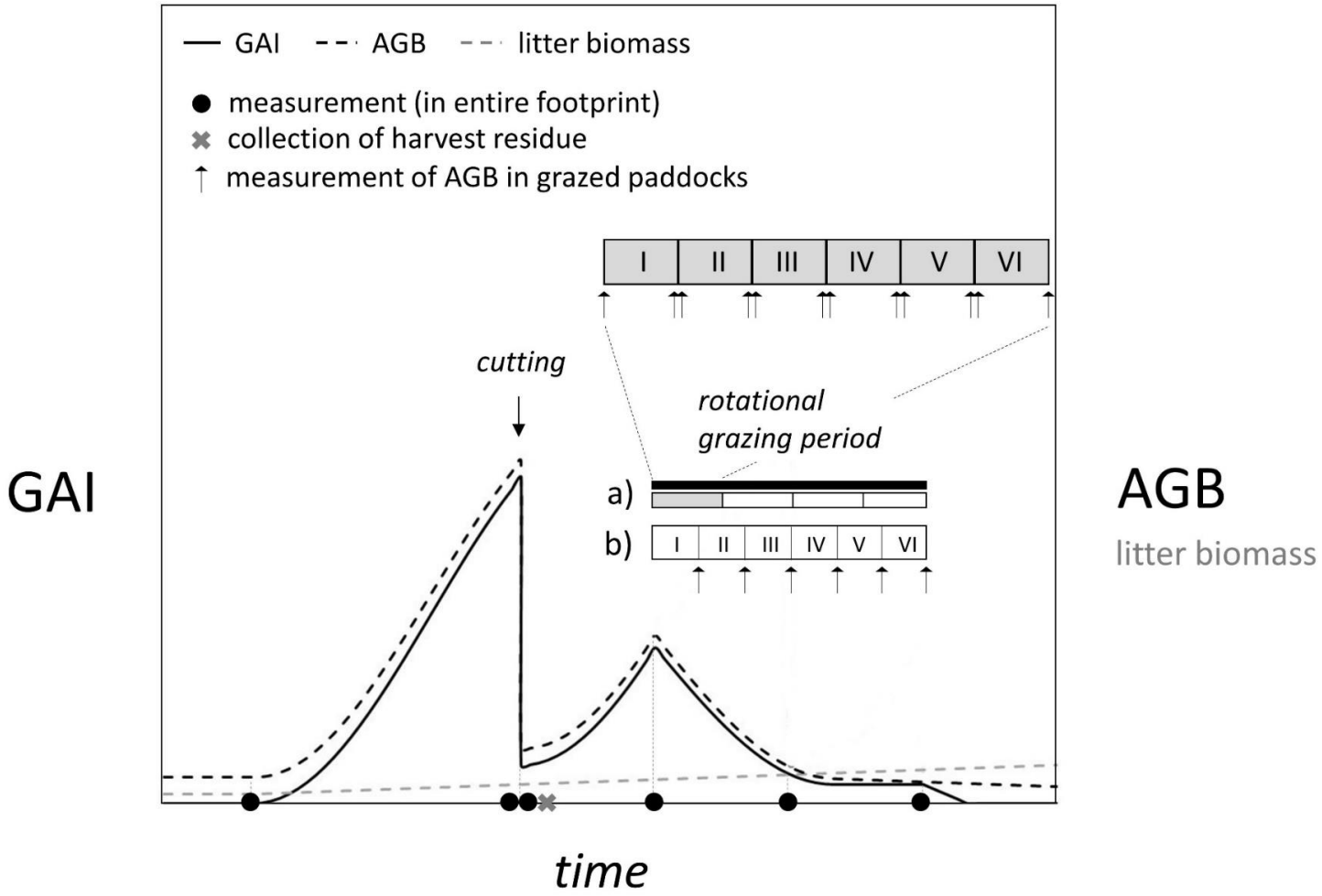
■ : destructive sampling

3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

3.3 Example: a managed grassland – rotational grazing

- timing of measurements

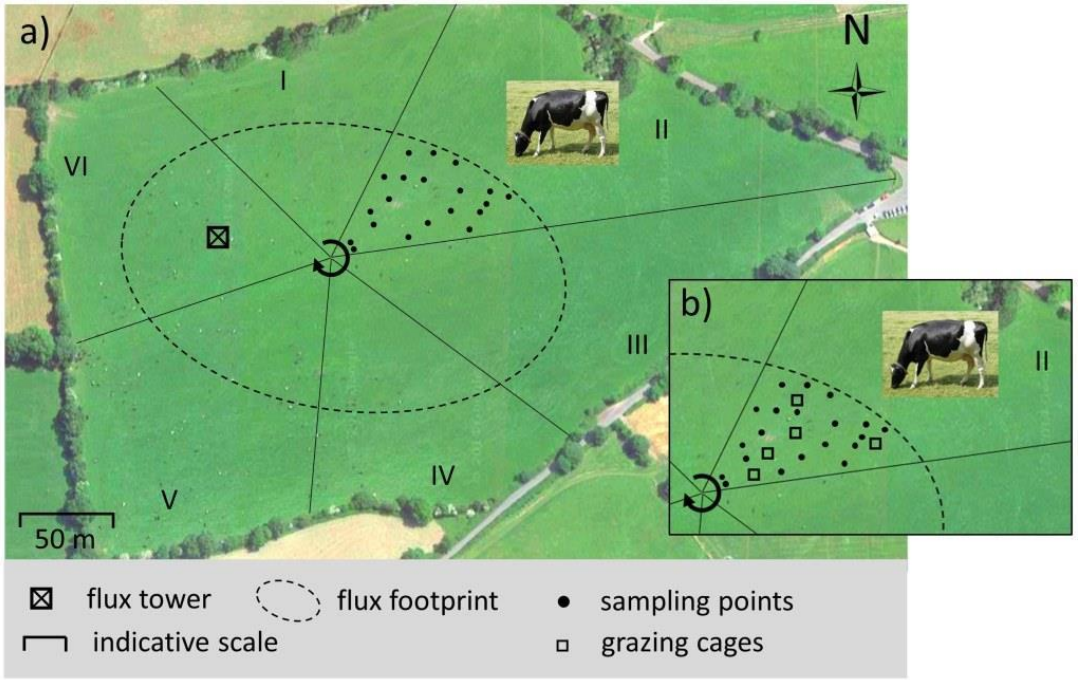


3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

3.3 Example: a managed grassland – rotational grazing

- measurements for estimating grazed biomass



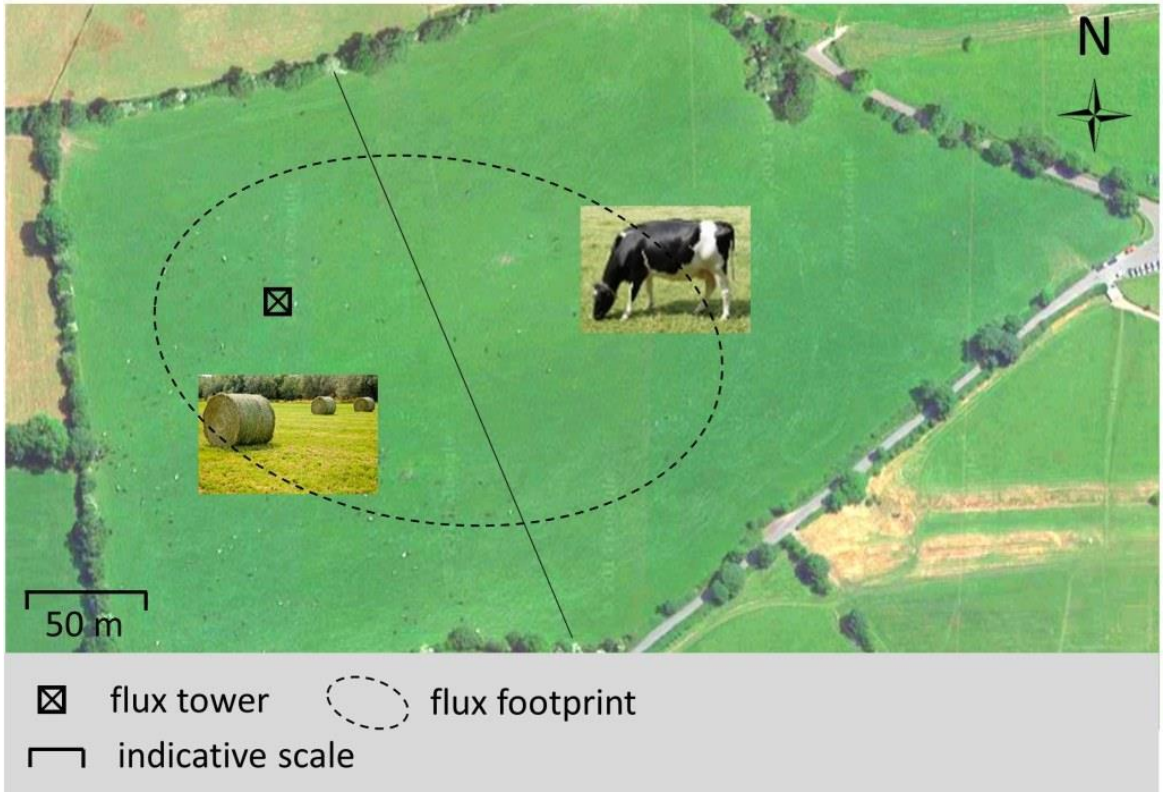
a) short grazing time in paddocks: AGB measurement before and after grazing of paddock
b) longer grazing time in paddocks: AGB measurement in- and outside grazing cages* after grazing of the paddock

* installed at start of grazing

3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

3.4 Example: a stratified footprint



- measurement effort is distributed between strata
- different sampling scheme in each stratum

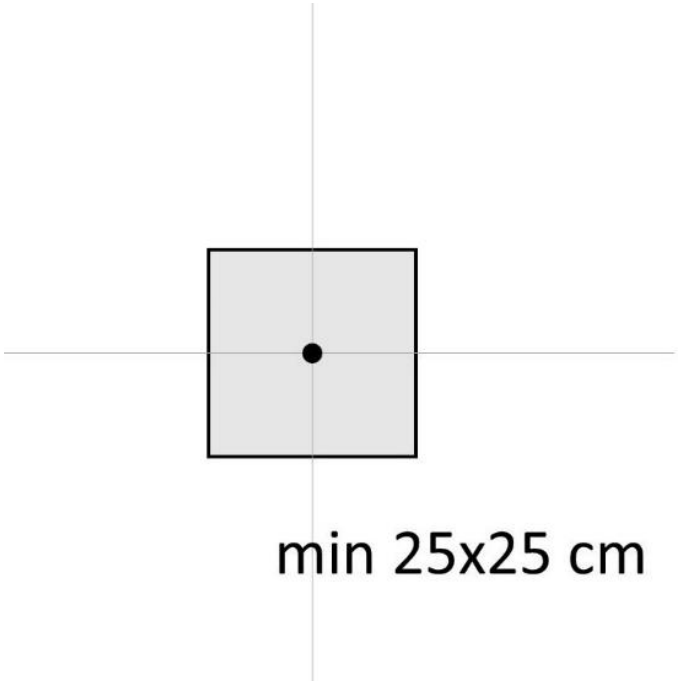
3 Spatial and temporal sampling design

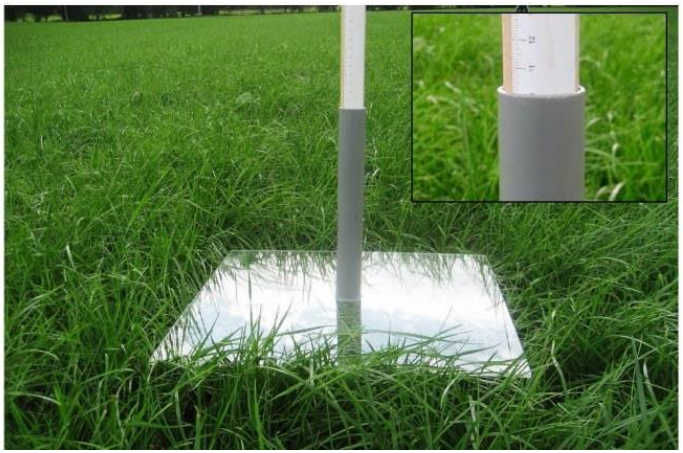
ICOS Ecosystem Thematic Centre

3.5 The measurements at a sampling point

- destructive sampling + plate meter + litter collection

square quadrat





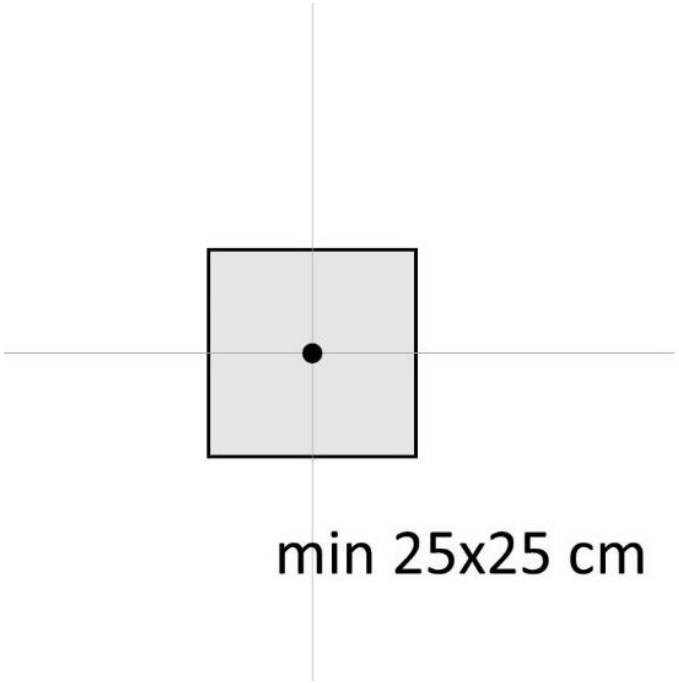
3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

3.5 The measurements at a sampling point

- stubble measurement

square quadrat

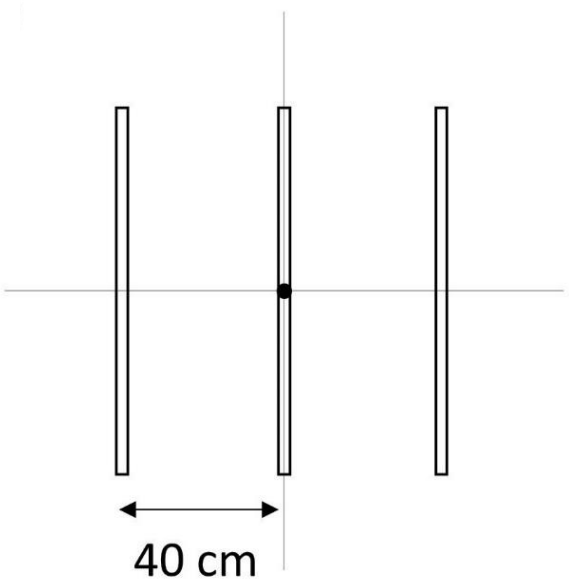


3 Spatial and temporal sampling design

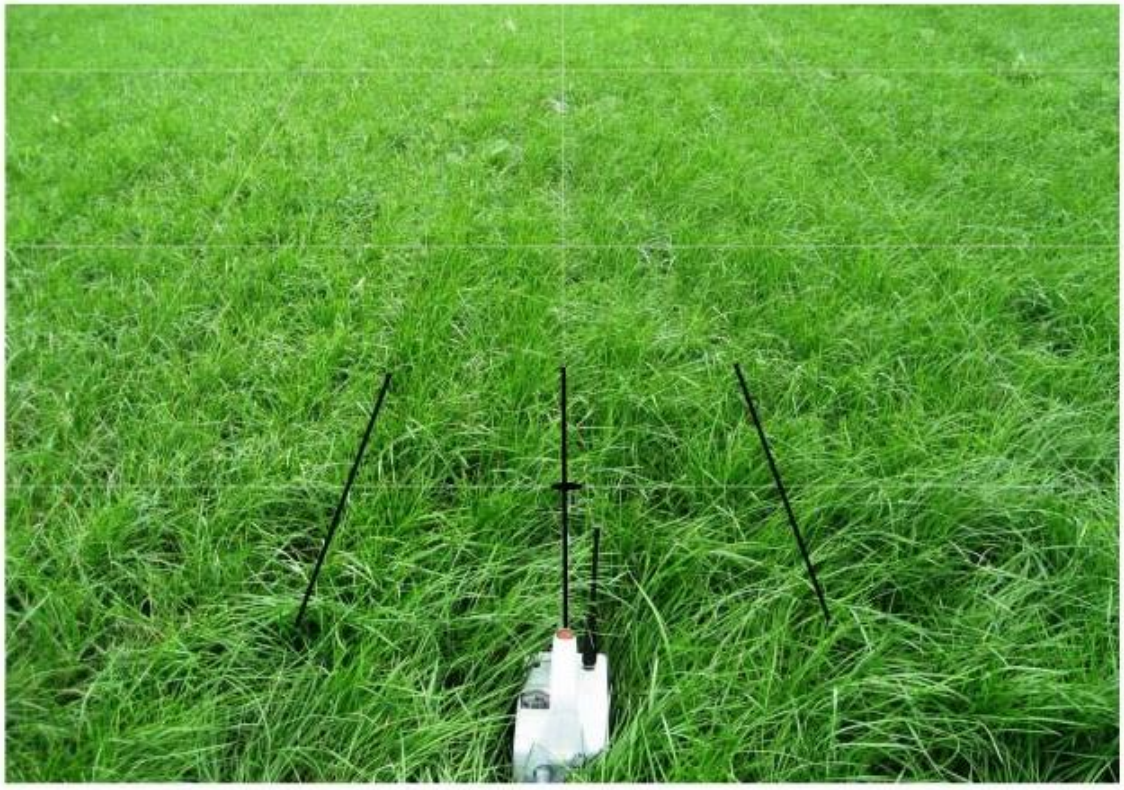
ICOS Ecosystem Thematic Centre

3.5 The measurements at a sampling point

- linear ceptometer



three measurements per point

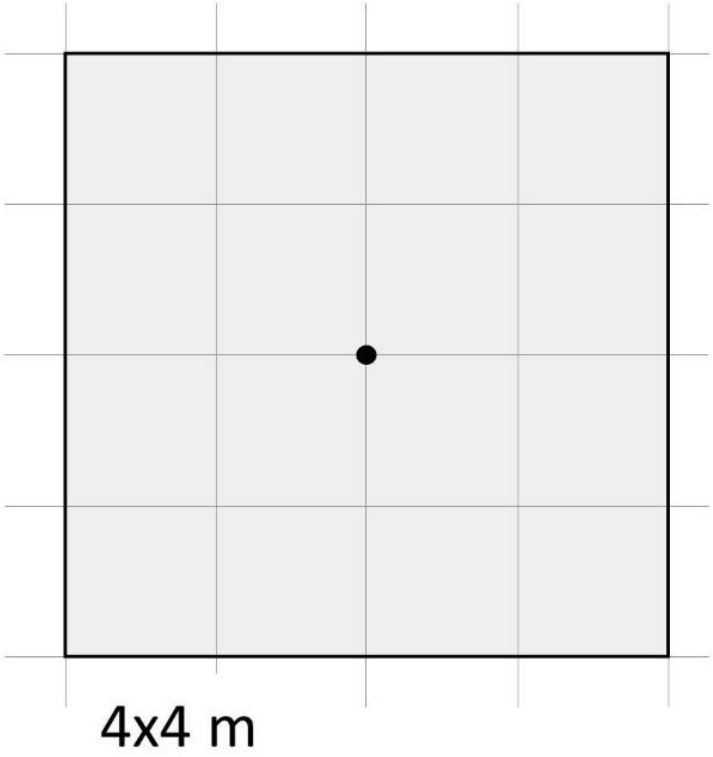


3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

3.5 The measurements at a sampling point

- harvest residue

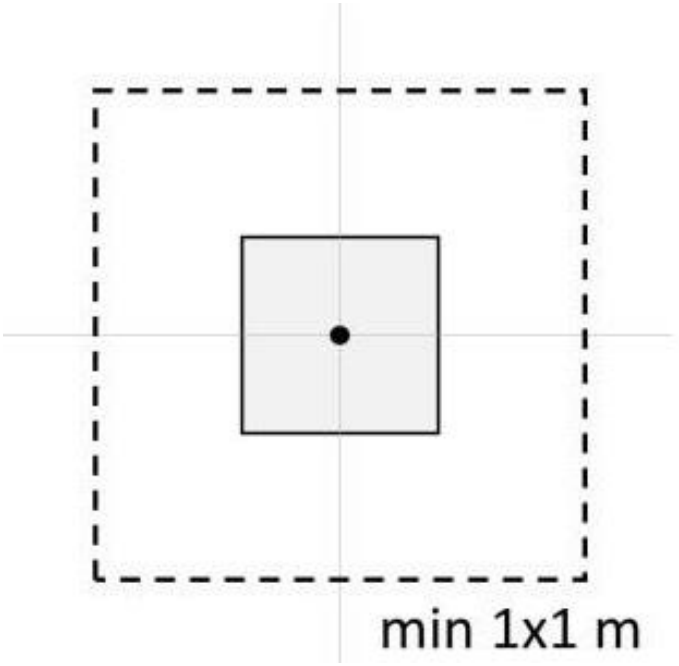


3 Spatial and temporal sampling design

ICOS Ecosystem Thematic Centre

3.5 The measurements at a sampling point

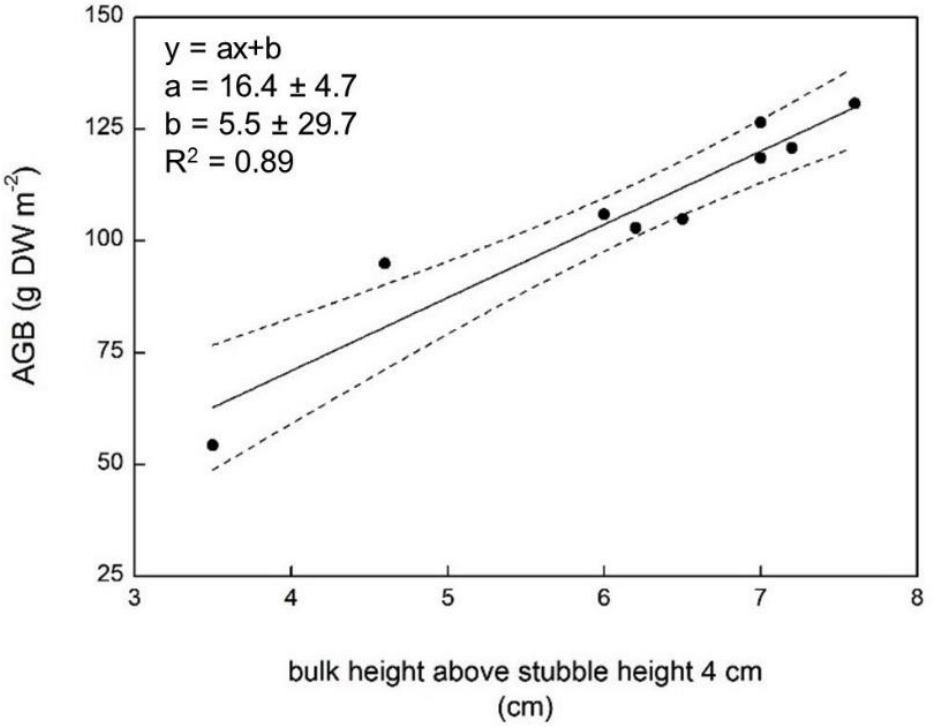
- grazing cages

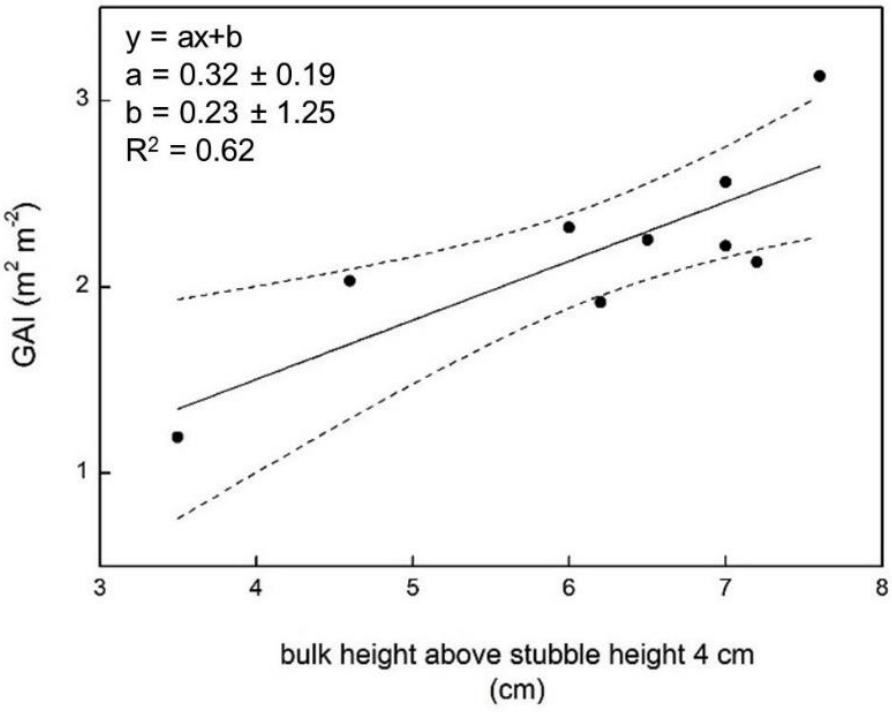


ground surface area

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

ICOS Ecosystem Thematic Centre

4.2 The linear ceptometer

a)

SS1 Sunscan Canopy Analyzer

b)

AccuPAR LP-80

- cross-calibrate probe and external sensor
- recalibration of external sensor at factory

5 Data submission: what and how?

ICOS Ecosystem Thematic Centre

5.1 What data to upload?

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

for each sampling point:

- metadata: ID, coordinates, area, stubble height, ...
- measurement data: - GAI_{grass}, GAI_{leg}, GAI_{nonleg}
  - AGB_{gr_grass}, AGB_{gr_leg}, AGB_{gr_nonleg}, AGB_{nongr}
  - bulk height
  - litter biomasss
  - harvest residue
  - raw ceptometer measurements

5 Data submission: what and how?

ICOS Ecosystem Thematic Centre

5.2 How to upload data?

- fill and send template Excel files (BADM)

	A	C	D	E	F	G	H
1	***Variable***	***Units***	***dataValue***				
2	**SITE_ID**	**CC-Xxx**	**Be-Dor**				
3	**SITE_NAME**	**free text**	**Dorinne**				
4	**SUBMISSION_CONTACT_NAME**	**free text**	**Maarten Op deBeeck**				
5	**SUBMISSION_CONTACT_EMAIL**	**free text**	maarten.opdebeeck@uantwerpen.be				
6	**SUBMISSION_DATE**	**YYYYMMDD**	**20150908**				
7	PLOT_ID	integer number	1	2	61	66	1
8	PLOT_EASTWARD_DIST	m	55	58	67	-35	
9	PLOT_NORTHWARD_DIST	m	-12	24	30	22	
10	PLOT_AREA	m2	0.16	0.16	0.16	0.16	16
11	PLOT_TYPE	LIST(PLOT_TYPE)	Regular	Regular	Cage	Stubble	
12	PLOT_AG_BIOMASS_GRASS	gDW m-2	104			25.23	
13	PLOT_AG_BIOMASS_GRASS_SPP	Scientific name or vegetation group	Grass			Grass	
14	PLOT_AG_BIOMASS_GRASS_PHEN	LIST(ORGAN_PHEN)	Green			Green	
15	PLOT_AG_BIOMASS_GRASS_ORGAN	LIST(ORGAN_NON_WOOD)	Total			Total	
16	PLOT_AG_BIOMASS_METHOD	LIST(AG_BIOMASS_METHOD)	Direct			Direct	
17	PLOT_AG_LIT_BIOMASS	g DW m-2	4.36			4.36	78.34
18	PLOT_AG_LIT_TYPE	LIST(LIT_TYPE)	Natural			Natural	Residues
19	PLOT_LAI_GRASS	m2 m-2	1.12			0.35	
20	PLOT_LAI_GRASS_SPP	Scientific name or vegetation group	grass			grass	
21	PLOT_LAI_TYPE	LIST(LAI_TYPE)	GAI			GAI	
22	PLOT_LAI_METHOD	LIST(LAI_METHOD)	Direct	SunScan		Direct	
23	PLOT_STUBBLE_HEIGHT	cm	4.0		4.0	4.0	
24	PLOT_BULK_HEIGHT	cm	5.4	6.2			
25	PLOT_DATE	YYYYMMDD	20150908	20150908	20150908	20150908	20150908
26	PLOT_DATE_UNC	days					
27	PLOT_COMMENT	free text					

each column is a sampling point (=‘plot’), each row is a parameter or variable

5 Data submission: what and how?

ICOS Ecosystem Thematic Centre

5.2 How to upload data?

- linear ceptometer: send raw output files

Created by SunData for Windows Mobile v2.0.0.2

Title : GAI_20150707
Location : BE_Dor
Latitude : 51.15N Longitude : 4.42E
7/07/2015 Local time is GMT+2 Hrs
SunScan probe v1.02R (C) JGW 2004/01/19

Ext Sensor: BFS Leaf Angle Distn Parameter: 1 Leaf Absorption: 0.85
Group 1 :

Time	Plot	crop	Trans-mitted	Spread	Incid-ent	Beam frac	Zenith Angle	LAI	Notes
10:07:53	1	1	120.4	0.16	474.4	0.14	50.7	1.9	
10:08:13	1	2	133.9	0.12	463.4	0.14	50.7	1.7	
10:08:38	1	3	100.1	0.19	438.4	0.12	50.6	2.1	
10:09:04	2	1	114.7	0.18	436.6	0.13	50.5	1.9	
10:09:32	2	2	101.2	0.19	542.1	0.31	50.5	2.4	
10:09:54	2	3	106.5	0.09	420.1	0.11	50.4	1.9	
10:10:33	3	1	82.1	0.21	444.5	0.16	50.3	2.4	
10:11:08	3	2	164.5	0.19	477.4	0.21	50.2	1.5	
10:11:28	3	3	142.4	0.27	477.4	0.21	50.2	1.7	
10:12:08	4	1	173.2	0.17	714.3	0.46	50.1	2	

Aires, L.M.I., Pio, C.A., Pereira, J.S. (2008) Carbon dioxide exchange above a Mediterranean C3/C4 grassland during two climatologically contrasting years. Global Change Biology 14, 539–555.

Flanagan, L.B., Wever, L.A., Carlson, P.J. (2002) Seasonal and interannual variation in carbon dioxide exchange and carbon balance in a northern temperate grassland. Global Change Biology 8, 599–615.