

Faculty of Geo-Information Science and Earth Observation, ITC

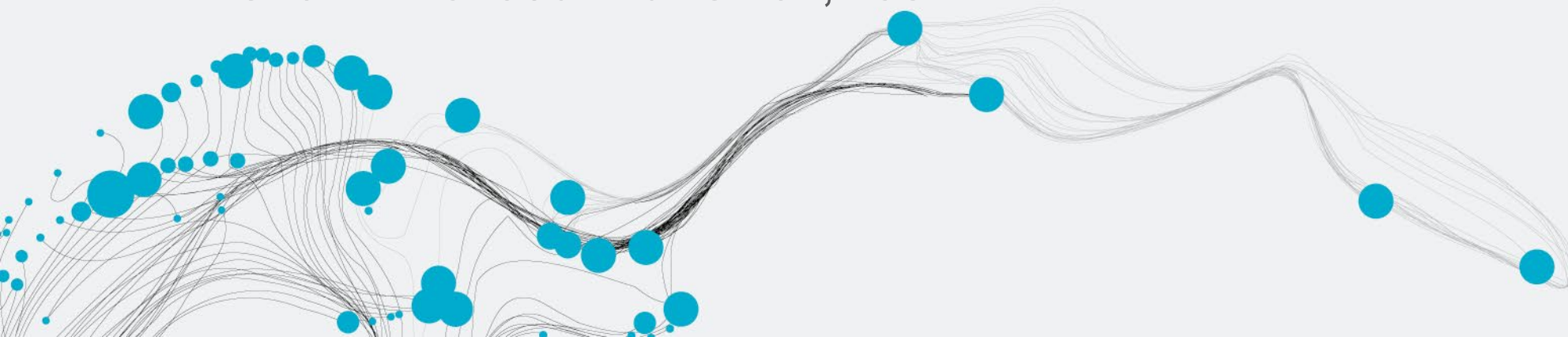
This HE Teaching Material was supported by the EGU Higher Education Teaching Material Grant 2023



UNIVERSITY
OF TWENTE.

CROP WATER PRODUCTIVITY

AN ONLINE SHORT COURSE BY
DR. EGOR PRIKAZIUK
WITH SUPPORT OF
THE EUROPEAN GEOSCIENCE UNION, EGU



YOU WILL LEARN TO

1. **Explain** the link between **crop yield** and **crop water demand** (reading, lecture)
2. **Link** the **components** of crop water productivity (CWP), plant productivity, evapotranspiration, with the respective **Earth Observation (EO) based modelling techniques** (reading, lecture)
3. **Calculate crop yield** from EO-based **gross primary productivity** (GPP) estimates (exercise, Excel)
4. Identify **phenological metrics** (start, end of the growing season) from EO data (exercise, Excel)
5. Produce **meaningful**, growing season-related **estimates** of CWP (exercise, WaPOR)
6. Conclude on the **efficiency of the water management scheme** in the study area (case study)

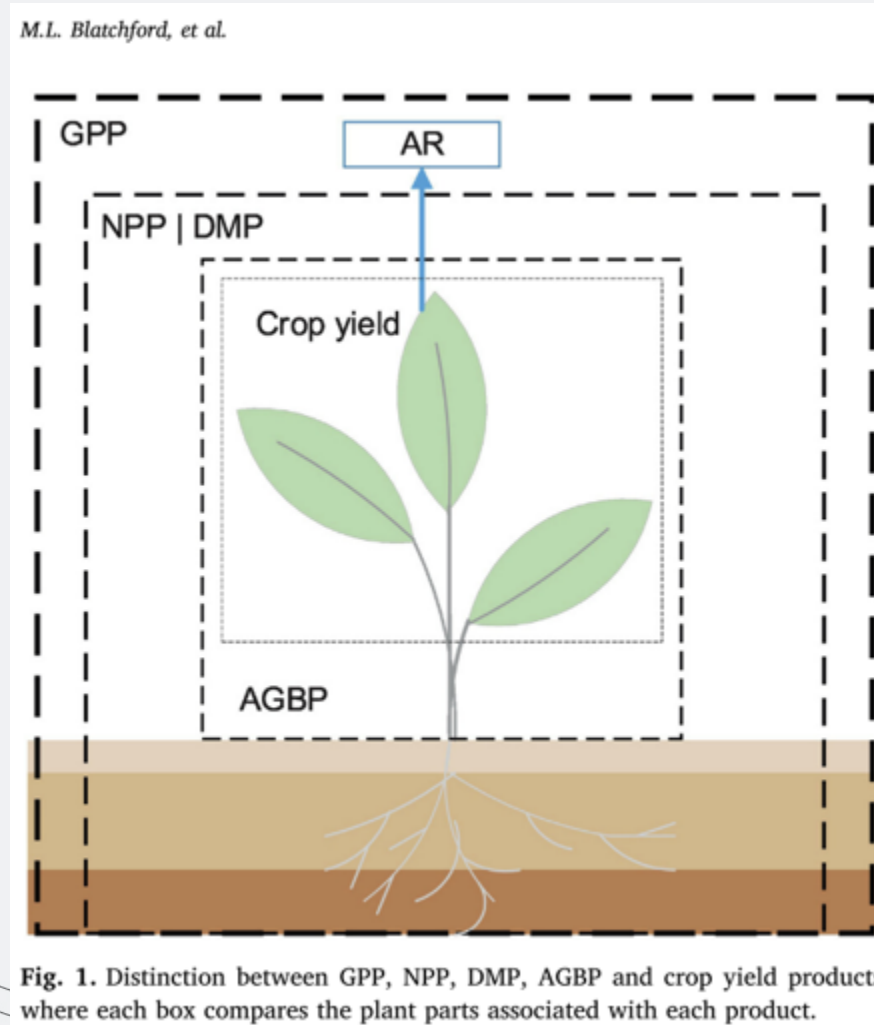
GPP TO YIELD

$$yield = \Sigma_{SOS}^{EOS} DMP \cdot AGBF \cdot HI \cdot \frac{1}{1 - \text{moisture content}}$$

- DMP – dry matter productivity (NPP after unit conversion to mass)
- AGBF – above-ground biomass fraction

$$\frac{\text{stem} + \text{leaves} [+ \text{harvest}]}{\text{stem} + \text{leaves} + \text{harvest} + \text{roots}}$$
- HI - harvest index (harvest / AGB)

$$\frac{\text{harvest}}{\text{stem} + \text{leaves} + \text{harvest}}$$
- Moisture content of harvestable material (commercial value)



Ask a farmer or use FAO tables

GPP TO YIELD

$$yield = \sum_{SOS}^{EOS} DMP \cdot AGBF \cdot HI \cdot \frac{1}{1 - moisture\ content}$$

Productivity

quantile	meaning	units
GPP	Gross primary productivity	$\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$
AR	Autotrophic (plant) respiration	$\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$
NPP	Net primary productivity	$\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$
DMP	Dry matter productivity	$\text{kg DM ha}^{-1} \text{ day}^{-1}$
AGBP	Aboveground biomass productivity	$\text{kg DM ha}^{-1} \text{ day}^{-1}$
yield	crop yield	$\text{kg FW ha}^{-1} \text{ season}^{-1}$

DM - dry matter – CH_2O or $\text{C}_6\text{H}_{12}\text{O}_6$

FW – fresh matter (weight)

Shortcuts

$\text{NPP} = 50\% \text{ of GPP}$

$\text{DMP (g DM m}^{-2}\text{)} = 2.5 * \text{NPP (g C m}^{-2}\text{)}$

M.L. Blatchford, et al.

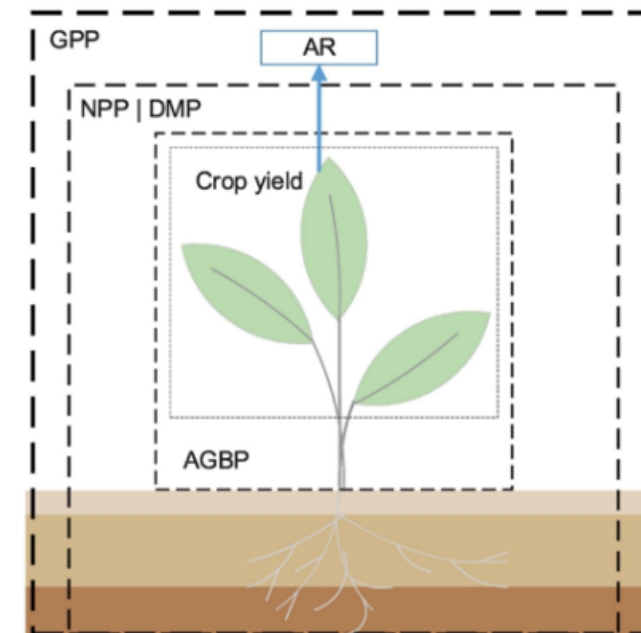


Fig. 1. Distinction between GPP, NPP, DMP, AGBP and crop yield products, where each box compares the plant parts associated with each product.

GPP TO YIELD EXERCISE

$$yield = \Sigma_{SOS}^{EOS} DMP \cdot AGBF \cdot HI \cdot \frac{1}{1 - moisture\ content}$$

	A	B	C	D	E	F	G
1	decade_end	NPP	season		name	value	units
2	2021-01-10	0.012	FALSE		start_of_season	2021-09-10	
3	2021-01-20	0.004	FALSE		end_of_season	2022-02-20	
4	2021-01-31	0.012	FALSE		length_of_season	163	day
5	2021-02-10	0.009	FALSE				
6	2021-02-20	0.005	FALSE		NPP_averaged	0.46	g C m-2 day-1
7	2021-02-28	0.01	FALSE				
8	2021-03-10	0.011	FALSE		NPP_aggregated	75.7	g C m-2
9	2021-03-20	0.008	FALSE				
10	2021-03-31	0.003	FALSE		gC_to_gDM_factor	2.5	g DM (g C)-1
11	2021-04-10	0.004	FALSE		DMP_aggregated	189.3	g DM m-2
12	2021-04-20	0.01	FALSE				
13	2021-04-30	0.088	FALSE		crop	rice	
14	2021-05-10	0.308	FALSE		AGBF	0.75	kg DM (kg DM)-1
15	2021-05-20	0.088	FALSE		HI	0.43	kg DM (kg DM)-1
16	2021-05-31	0.121	FALSE		moisture	0.15	kg DM (kg FM)-1
17	2021-06-10	0.054	FALSE				
18	2021-06-20	0.073	FALSE		AGB	142.0	g DM m-2
19	2021-06-30	0.039	FALSE		grains_dry	61.1	g DM m-2
20	2021-07-10	0.05	FALSE		grains_wet (yield)	71.8	g FM m-2
21	2021-07-20	0.037	FALSE				
22	2021-07-31	0.014	FALSE				
23	2021-08-10	0.009	FALSE		g_to_kg	0.001	kg g-1
24	2021-08-20	0	FALSE		m2_to_ha	0.0001	ha m-2
25	2021-08-31	0	FALSE		crop_yield	718.39	kg FM ha-1

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