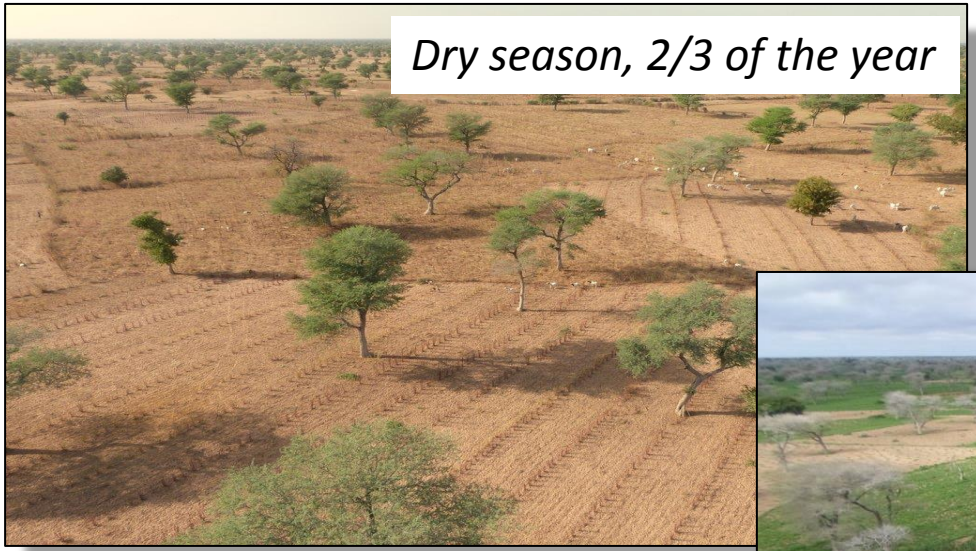
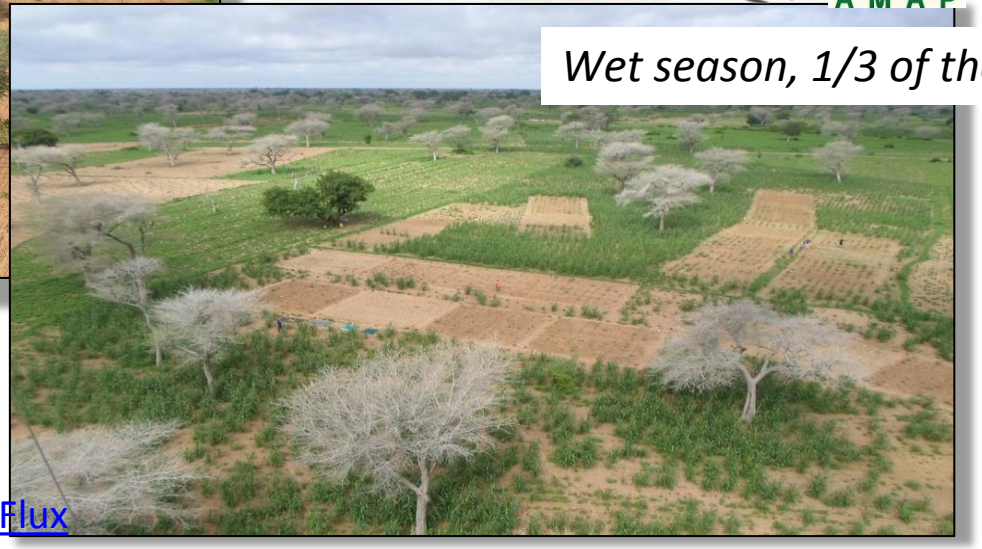
‘‘*Faidherbia-Flux*’’: A long-term Collaborative Observatory on food security, GHG fluxes, ecosystem services, mitigation and adaptation in a semi-arid agro-silvo-pastoral ecosystem (groundnut basin in Niakhar/Sob, Senegal)





“Faidherbia-Flux” Web site :
https://lped.info/wikiObsSN/?Faidherbia-Flux

Contact: olivier.roupsard@cirad.fr

Drone applications for yield, LAI, bio/necro-mass

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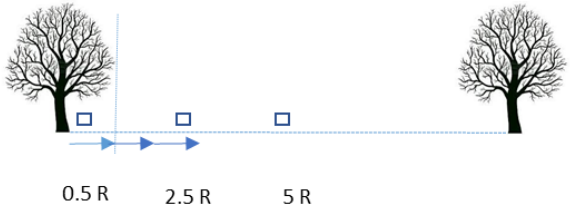
Ortho-image RGB et MS Niakhar 1 (vol aout 2021)

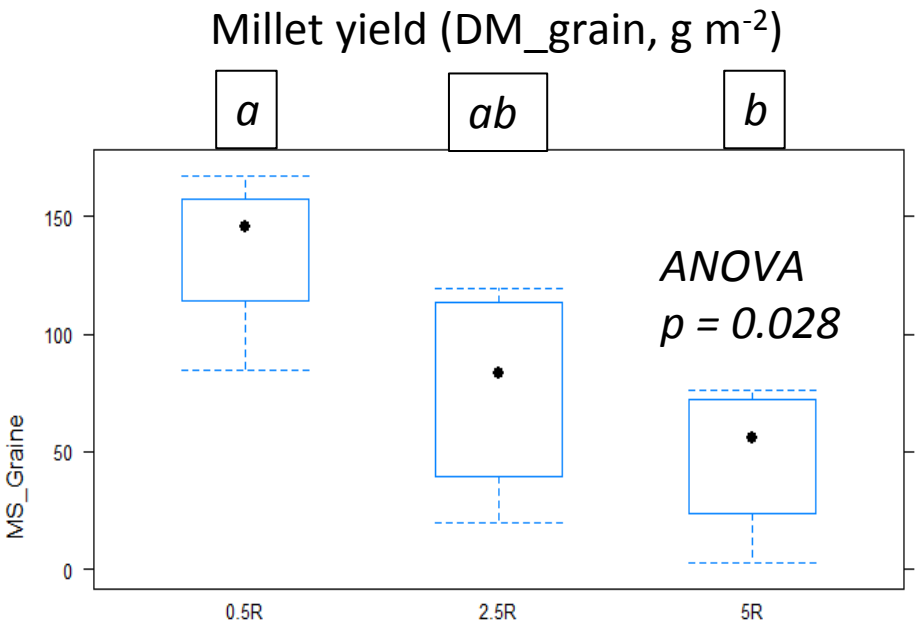
RGB

MS

Ortho-image du terroir de FaidherbiaFlux (30ha)

How much are the "*Faidherbia* effects"?



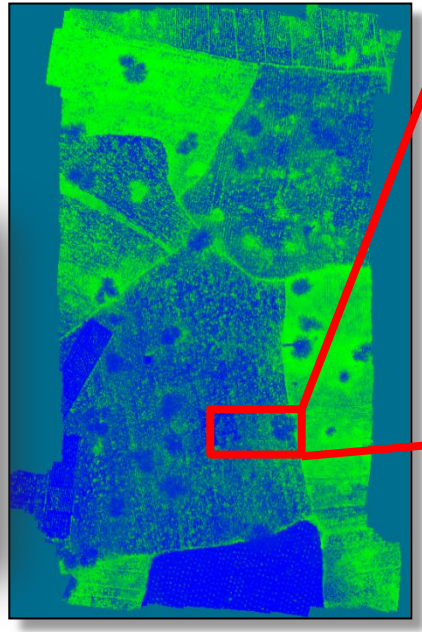


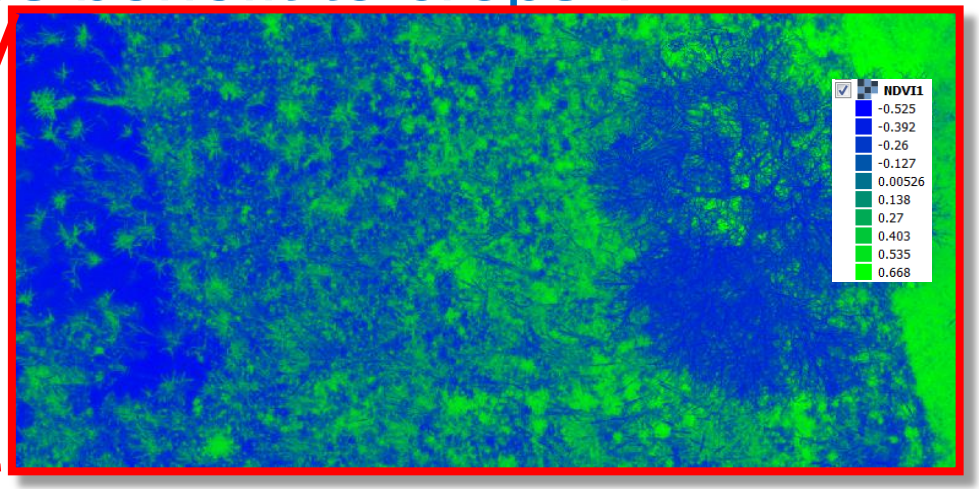
All other positive effects on biomass per compartment and LAI are significant

Effects on root:shoot, SLA, impact of leafminer are NOT significant

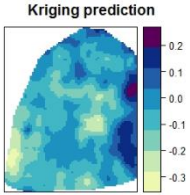
Source: Roupsard et al., AGEE, 2020

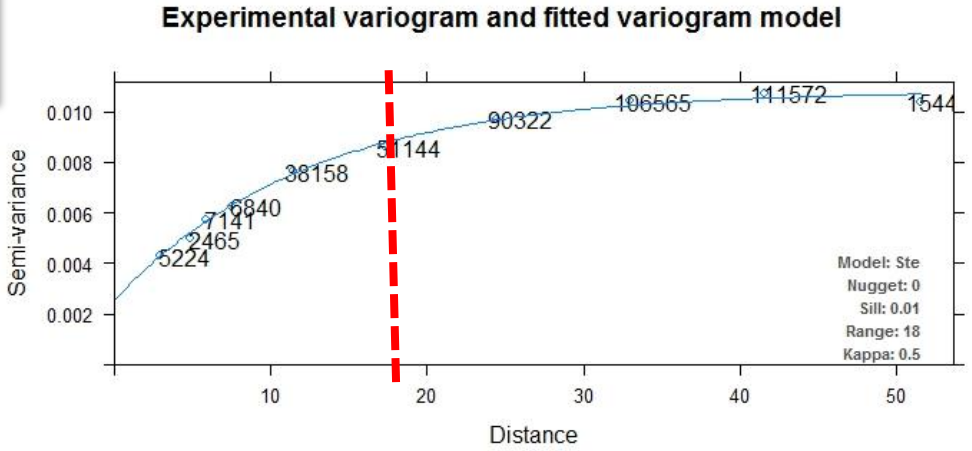
How far do trees benefit to crops ?





Drone NDVI October 2018, just before harvest





Source: Roupsard et al., AGEE, 2020

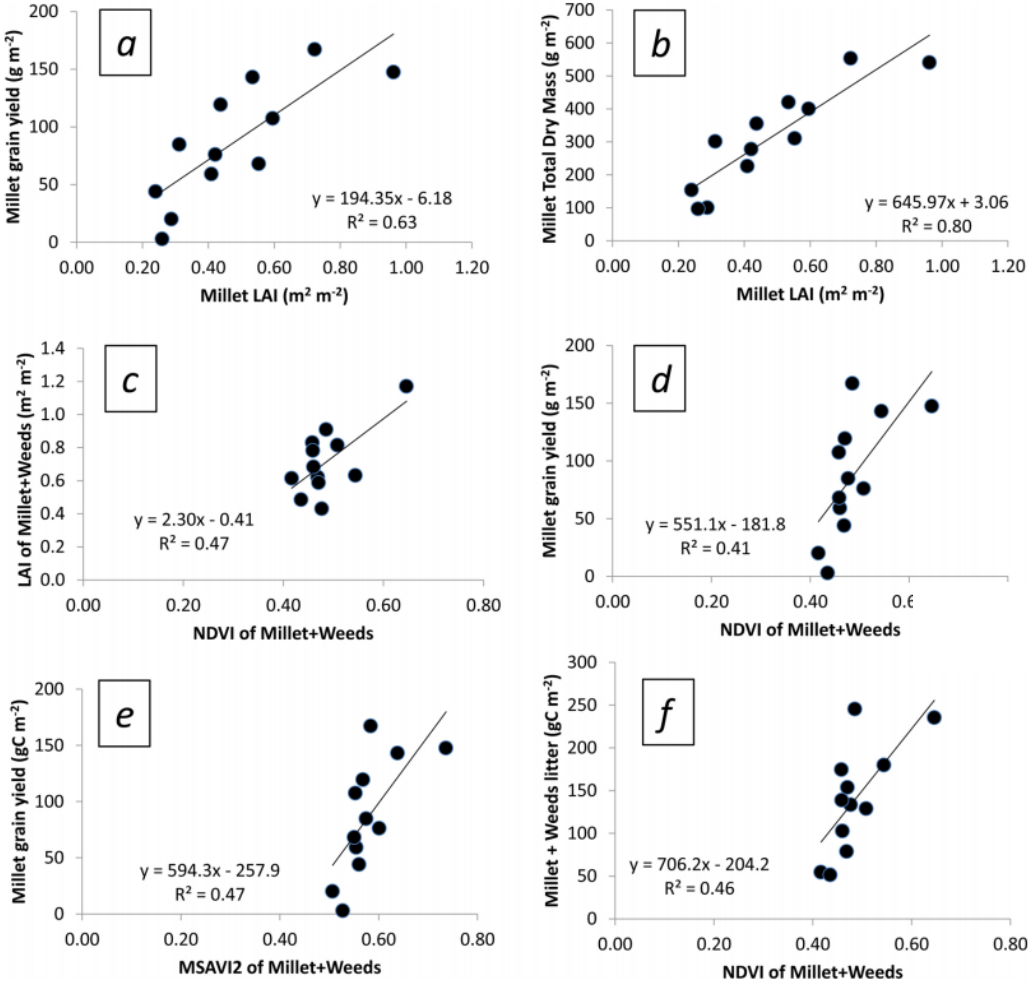
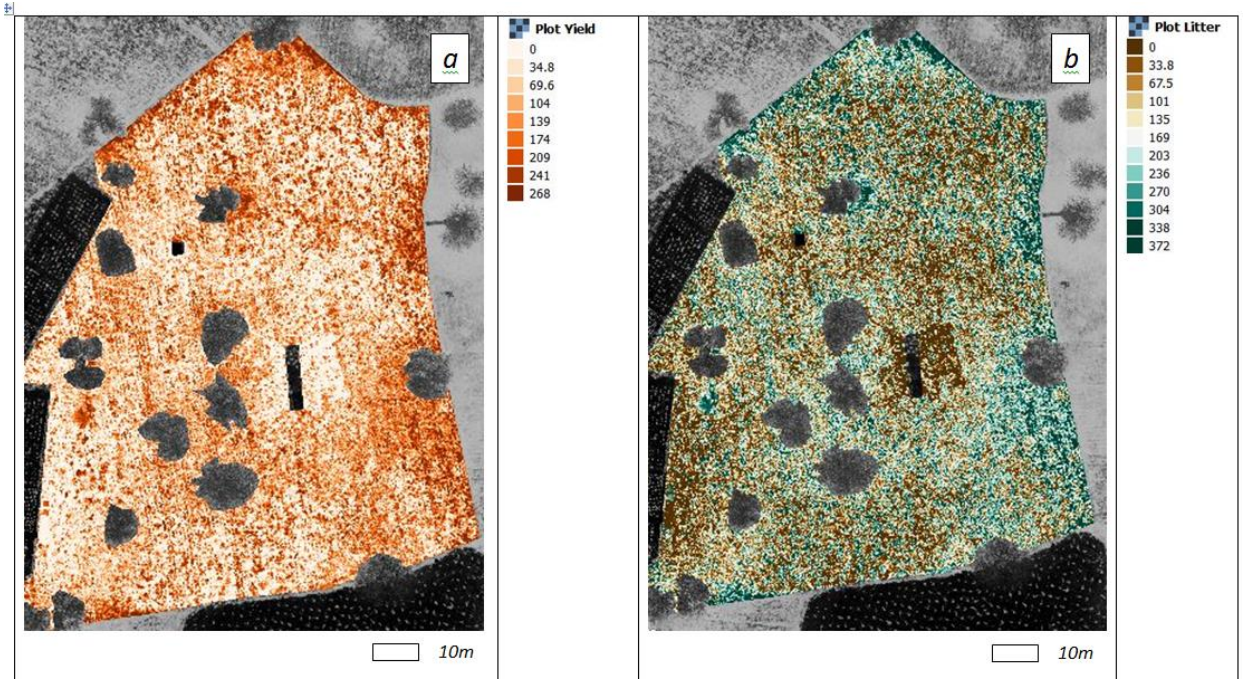


Fig. 7. Correlations between a single reflectance index (NDVI or MSAVI2) and some crop traits within the harvested subplots (N = 12). Because the UAV could not sense the 0.5R plots, we used pixels from the surroundings of the tree where the 0.5R plot had been harvested, as proxy to compute NDVI or MSAVI2.

Can we upscale yield from small plots to the whole stand ?

Source: Roupsard et al., AGEE, 2020

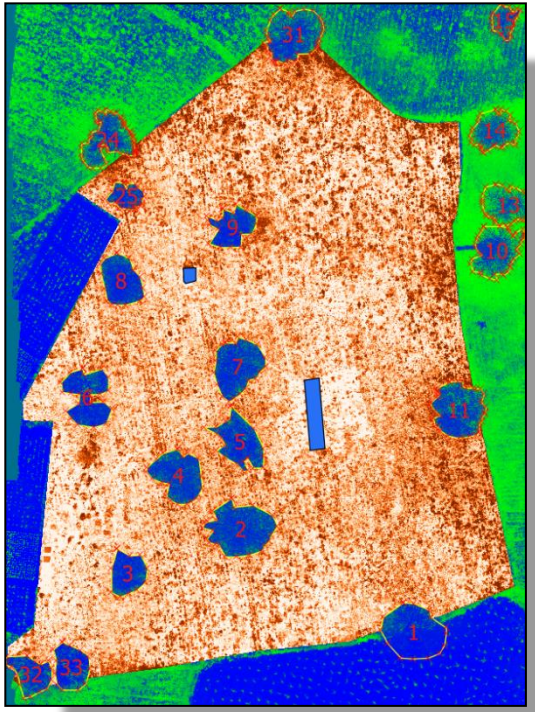
Using UAV (Drone) to upscale yield and litter C to the whole-plot



Maps derived from UAV vegetation indices calibrated with subplot sampling of biomass. a/ Plot millet yield map (g_{grain} m^{-2}); b/Plot millet + weeds litter map (g_C m^{-2})

Source: Roupsard et al., AGEE. 2020

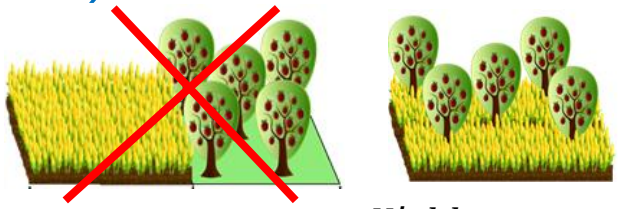
A new method to estimate whole-stand yield and LER (with drone & without sole crop field)



Millet yield map (DM_grain, g m^{-2})

Source: Roupsard et al., AGEE, 2020

Millet yield



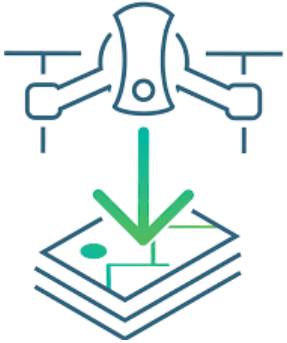
$$LER_{(millet\ only)} = \frac{Yield_{AFS}}{Yield_{sole}}$$

Table 3
Computation of pearl-millet yield and crop-partial Land Equivalent Ratio (LER_{cp}) from subplots to the whole-plot scale; comparison (error) between measurements (in subplots and at the whole-plot scale) and estimations via UAV-NDVI product. *Yi* is the yield in agroforestry used to compute LER_{cp}.

	Method	Variable of interest	Value	Unit
Whole-plot characteristics	QGIS	Whole plot area	8994	m^2
	QGIS	Shelter area	62	m^2
	QGIS	Trunk basal area	2.4	m^2
	QGIS	Whole plot effective area	8929	m^2
	Manual	Subplots area	226	m^2
	QGIS	*F. albida* canopy projected area	862	m^2
	QGIS	*F albida* canopy cover	9.6	%
Harvest	Measured	Subplots harvest	17.6	kgDM grain
	Measured	Whole-plot bundle harvest (without subplots)	52.0	# bundles
	Measured	Whole-plot bundle harvest (without subplots)	1214.6	kgDM bundles
	Measured	Rate of conversion bundle-to-grain	0.52	/
	Measured	Whole-plot grain harvest (without subplots)	632.0	kgDM grain
	Measured	Whole-plot harvest	650	kgDM grain
	UAV-NDVI (Estimated)	Estimated Whole-plot harvest	811	kgDM grain
Yield	Measured	Millet yield as sole crop (5R)	0.48	tDM grain ha^{-1}
	Measured	Millet yield half-distance (2.5R)	0.76	tDM grain ha^{-1}
	Measured	Millet yield under tree crown (0.5R)	1.36	tDM grain ha^{-1}
	Measured	Whole-plot Yield	0.73	tDM grain ha^{-1}
	UAV-NDVI (Estimated)	Estimated Millet yield sole crop (dist > Range)	0.82	tDM grain ha-1
	UAV-NDVI (Estimated)	Estimated Millet yield agroforestry (Crown < dist < Range)	0.92	tDM grain ha-1
	UAV-NDVI (Estimated)	Estimated Millet yield agroforestry (dist < Crown)	1.21	tDM grain ha-1
	UAV-NDVI (Estimated)	Estimated Whole-plot Yield	0.91	tDM grain ha-1
	Error	Yield Error	19.9	%
LER_{cp}	UAV-NDVI (Estimated)	LER_{cp} with *Yi* = actual whole plot yield	1.10	/
	UAV-NDVI (Estimated)	LER_{cp} with *Yi* = whole plot yield for dist < Range	1.16	/
Millet + Weeds litter	UAV-NDVI (Estimated)	Estimated Litter (Crop + weeds)	1.05	tC ha-1

Millet dynamics August-> October

- Drone



- Estimation of biophysical parameters

- Estimation of yield, biomass, litter, LAI etc.

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NIAKHAR - SOB

Allometry

Hemispherical Photo

Pocket LAI

Drone

LAI_METER

Harvest

… every 10 days

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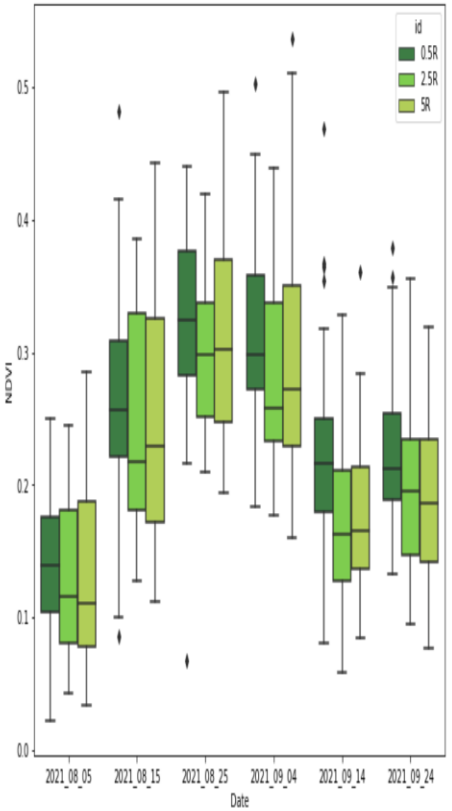
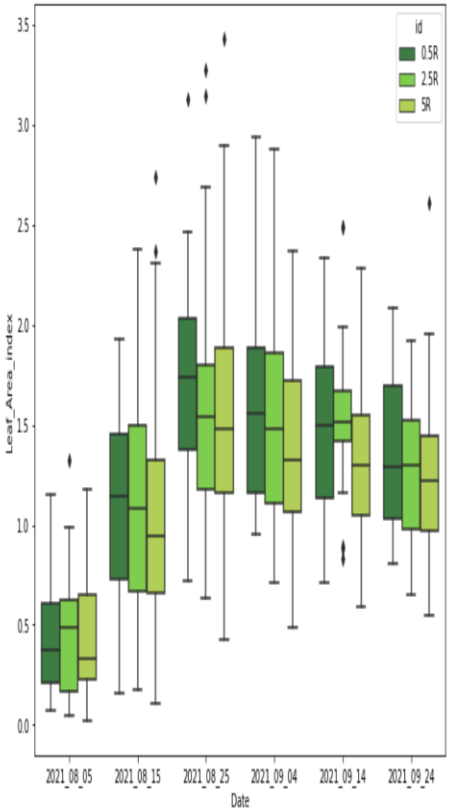
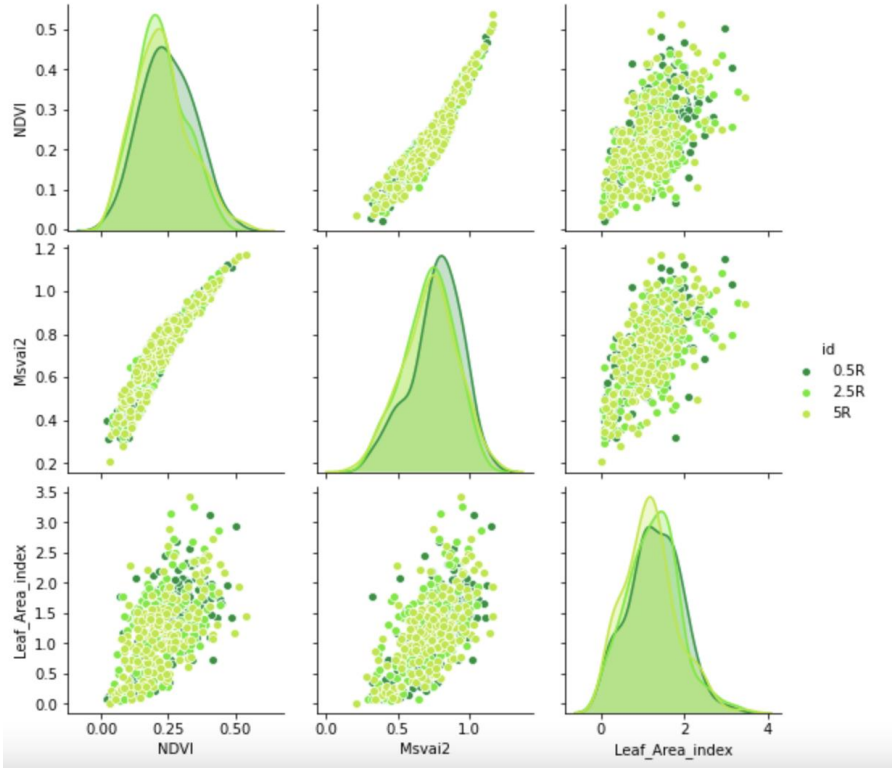
Time-course of Millet MSAVI2, NDVI and LAI_meter during the wet season







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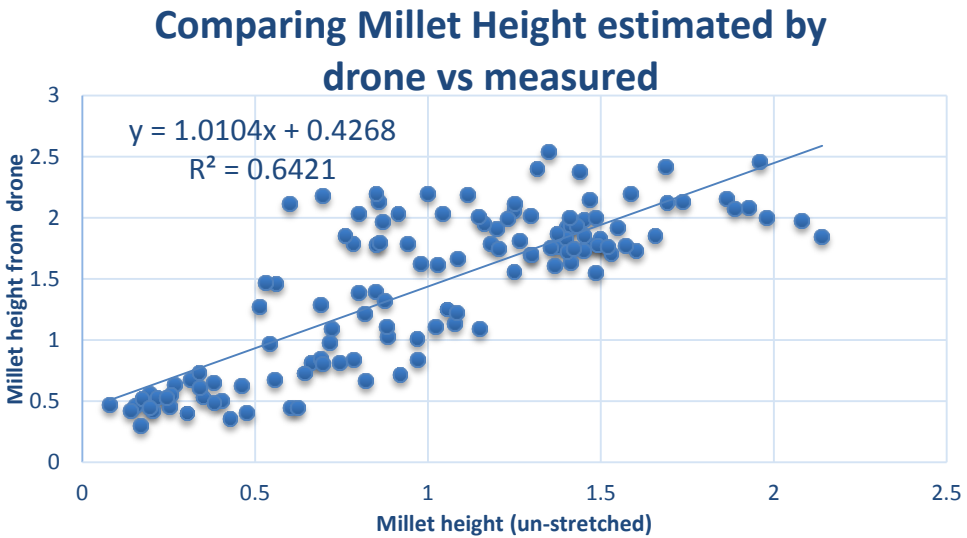
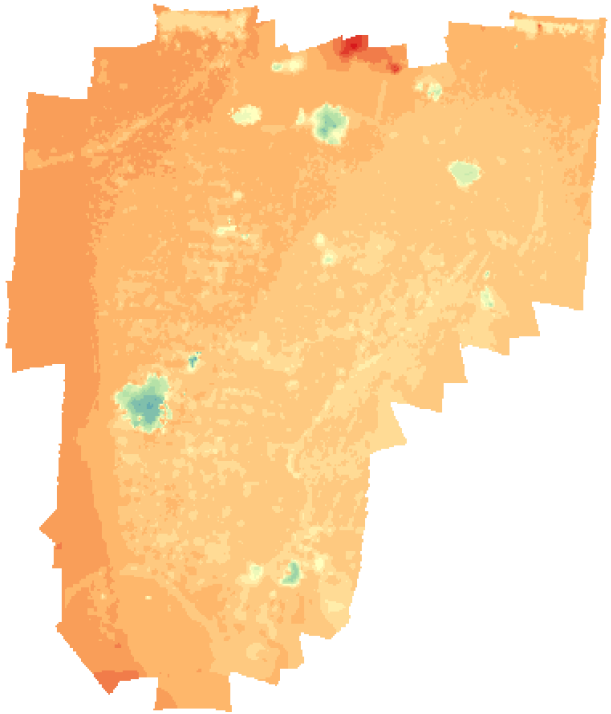


- Max = 95th percentile
- Min = 5th percentile
- H_{UAV} = Max - Min



Numerical Elevation Model

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Articles

- Roupsard, O., Audebert, A., Ndour, A.P., Clermont-Dauphin, C., Agbohessou, Y., Sanou, J., Koala, J., Faye, E., Sambakhe, D., Jourdan, C., le Maire, G., Tall, L., Sanogo, D., Seghieri, J., Cournac, L., Leroux, L., 2020. How far does the tree affect the crop in agroforestry? New spatial analysis methods in a Faidherbia parkland. **Agriculture, Ecosystems & Environment** 296, 106928. https://www.sciencedirect.com/science/article/pii/S0167880920301134

Communications

- Agbohessou YFU, Roupsard O, Clermont-Dauphin C, et al. 2019. Using drones to upscale yield and land-equivalent-ratio from plot to stand in an agro-silvo-pastoral system: the "Faidherbia-Flux" collaborative observatory (groundnut basin, Senegal). Conférence Intensification Durable (CID) 2019: Leviers d'intensification pour une transition agroécologique des systèmes de production en Afrique Subsaharienne. 08-09 Octobre 2019. Hotel Ngor Diarama, Dakar, Sénégal. Oral Presentation. https://sites.google.com/site/cidintensificationdurable/home/cid-2019.
- Roupsard, O. et al., 2019. "Faidherbia-Flux": adapting crops to climate changes in a semi-arid agro-sylvo-pastoral open observatory (Senegal). Oral Presentation, 4rth World Congress on Agroforestry. , 20-22 of May 2019. Le Corum Conference Centre, Montpellier, France. Oral presentation. Session 2: Agroforestry and adaptation to climate change.

Academic reports

- Agbohessou, Y.F.U., 2020. Effets du Faidherbia albida (Del.) A. Chev. sur la productivité aérienne et souterraine de la culture associée (arachide) : Utilisation des drones pour l'estimation du rendement et du Land-Equivalent-Ratio (LER), depuis les placettes à tout le système agro-sylvo-pastoral à la parcelle entière. Senegal, 31rd of October 2020. Master en Agroforesterie, Ecologie et Adaptation (AFECA), UCAD-Faculté des Sciences et Techniques, Département de Biologie Végétale, Dakar, Senegal. Félicitations du jury, p. 60 pp + Annexes.

Shared database in R

Faidherbia-Flux_Collaboratif\Database

https://baobab.sedoo.fr/