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Interdisciplinary Assessment of Market Oriented Yam Cultivation in Semi-arid Burkina Faso

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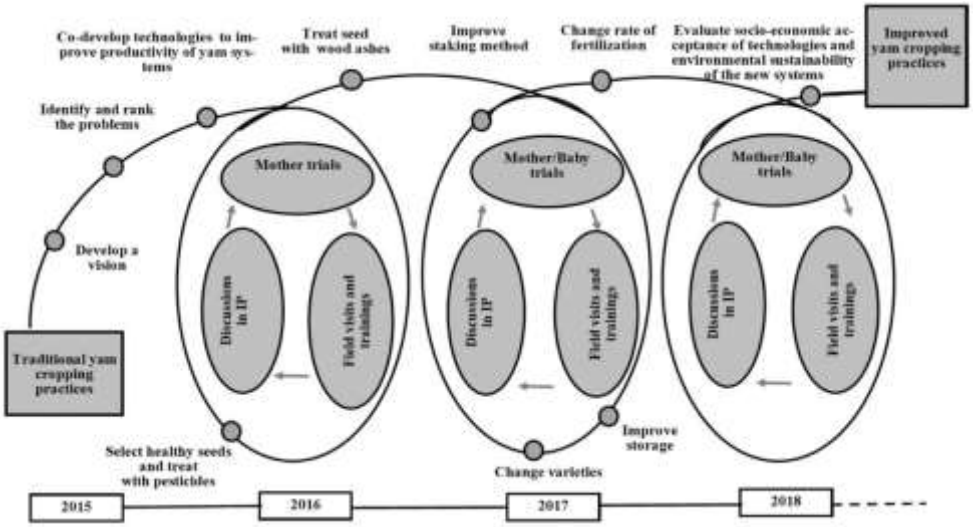
YAMSYS

Introduction: YAMSYS Project

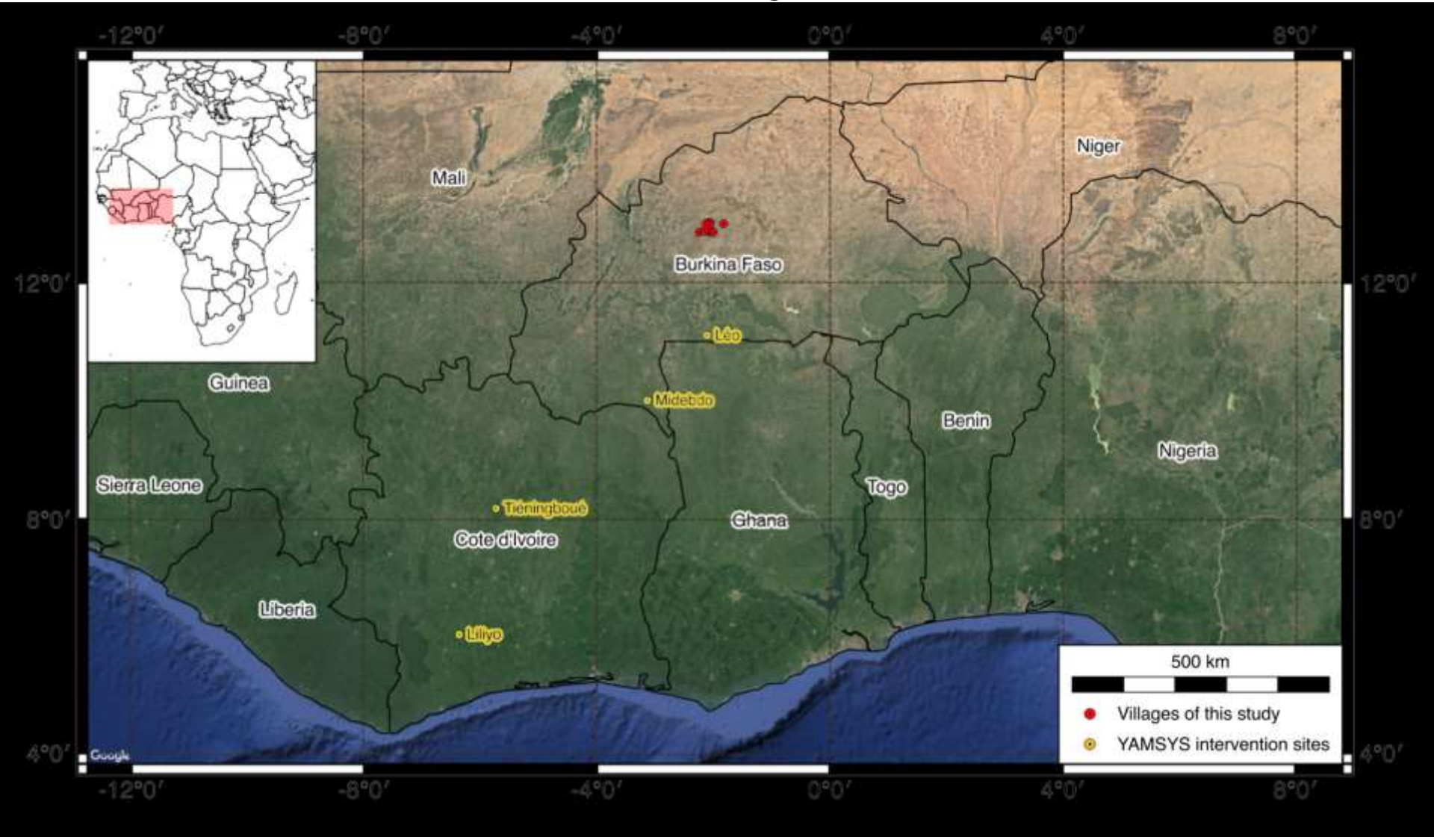
YAMSYS

Swiss Programme for Research on Global Issues for Development

- R4D Project from 2014 to 2021
- **develop** biophysically, institutionally, and economically acceptable **soil management innovations** for increased crop productivity, food security, profitability, and environmental sustainability of **yam systems in West Africa (BF,CI,BJ,NG,CH)**
- 4 mother trials + baby trials
- Innovation platforms
- 3 PostDoc, 5 PhD, 24 MSc, 16 BSc + Ing.



Introduction: YAMSYS Project



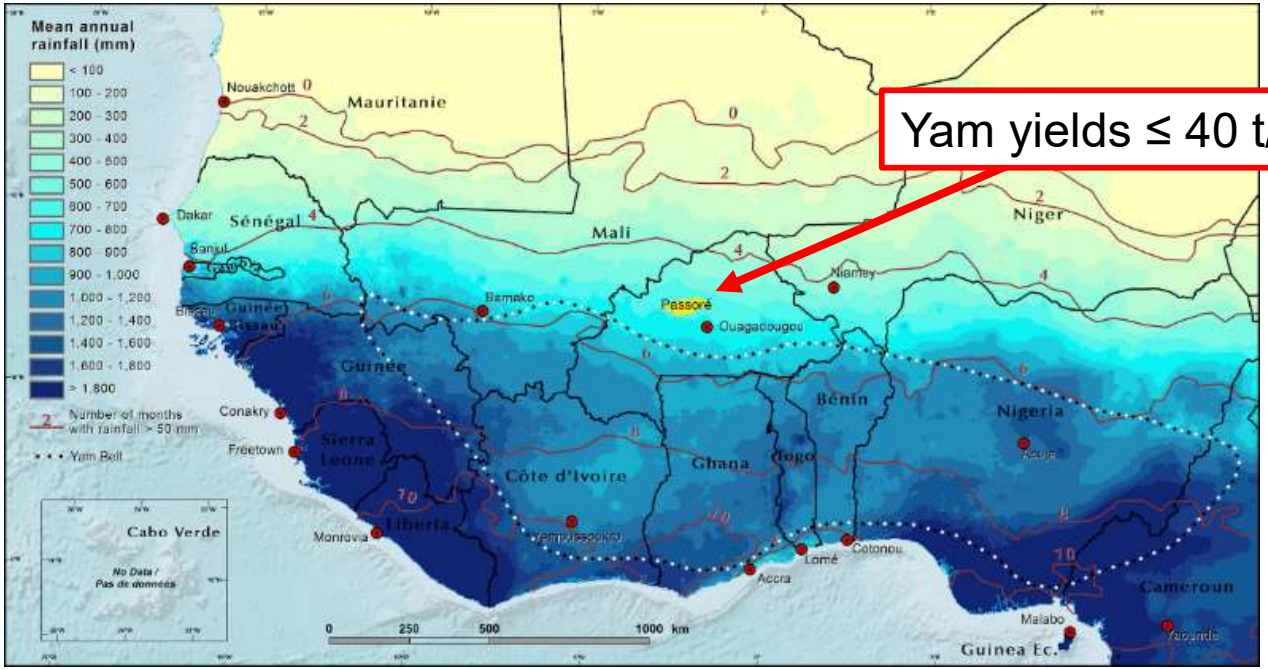
Introduction: Yam (Dioscorea spp.)

- Tropical tuber crop
- Increasing production (FAOSTAT, 2020)
  - 1986: 10 M t -> 2019: 69 M t
  - 1986: 1.5 M ha -> 8.2 M ha
- Stagnating yields
- Yield gap
  - Potential: 50 t/ha (Diby et al., 2011)
  - Realistic expectation: 20 – 25 t/ha
  - Average: 10.7 t/ha (FAOSTAT, 2020)
- Reasons
  - High soil fertility need (Diby et al., 2009; Kassi et al., 2017)
  - H_2O > 1'500 mm in 6-7 month (Lebot, 2009; Sonder et al., 2010)
  - Unimproved varieties and systems (Abdoulaye et al., 2015)
  - Lack of capital and labour (Ekanayake & Asiedu, 2013)
  - Driver of and affected by soil degradation (Frossard et al., 2017)

Image: Lebot (2009)

Introduction: Improving Yam Systems

- Need to improve yam cropping systems, yields and soil fertility management (Frossard et al., 2017)
- Find and describe best-practices (Kiba et al., 2020)
- Yam in Passoré, Burkina Faso
  (Dumont, 1977; Dumont & Hamon, 1985; Dumont et al., 1994; Tiama et al., 2016-2018)



Yam yields ≤ 40 t/ha (Tiama et al., 2016b)

Map: CILISS (2016); Yam Belt: Dumont et al. (2005)

Study Area: bio-physical and socio-economic conditions

- Climate
  - hot semi-arid, 4 month of rains (June – Sept.) (Climate-data, 2019)
  - High temporal and spatial variability (Nicholson, 2013)
  - 682 mm in 42 days in 2017 (MAAH Passoré, 2019)
- Soils (Sib & Sinkondo, 2002)
  - Plateau: shallow soils with petroplinthic horizons
  - Lowlands: deep soils
- Livelihoods (Hien et al., 2012)
  - Rain fed cereal production, livestock, irrigated fields in lowlands
  - Craftsmanship, seasonal migration, trade, artisanal gold mining
  - Food deficitary
- Increasing insecurity (Eizenga, 2019)

Study Area: Impressions

Aim and Approach

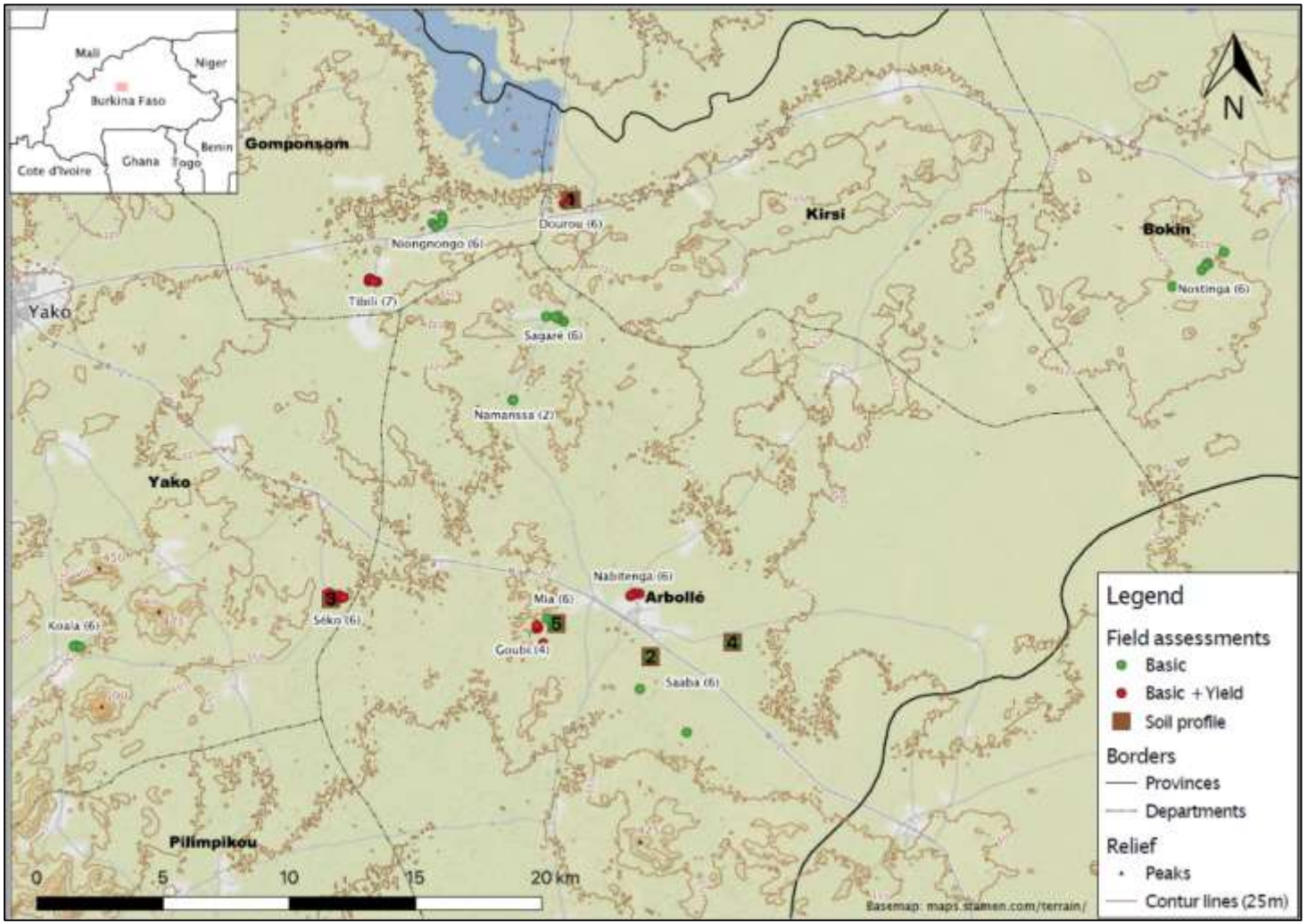
What to learn?

- How to grow yam under adverse conditions?
- How are soil fertility and nutrient needs met?
- Can yam provide a chance for development?

Approach:

- 3 Field visits in 2017 (N = 67)
- Socio-economic and agronomic survey (N = 67)
- Soil sampling (N = 67)
- Yield and tuber assessment (N = 25)
- Nutrient balances (N = 25)

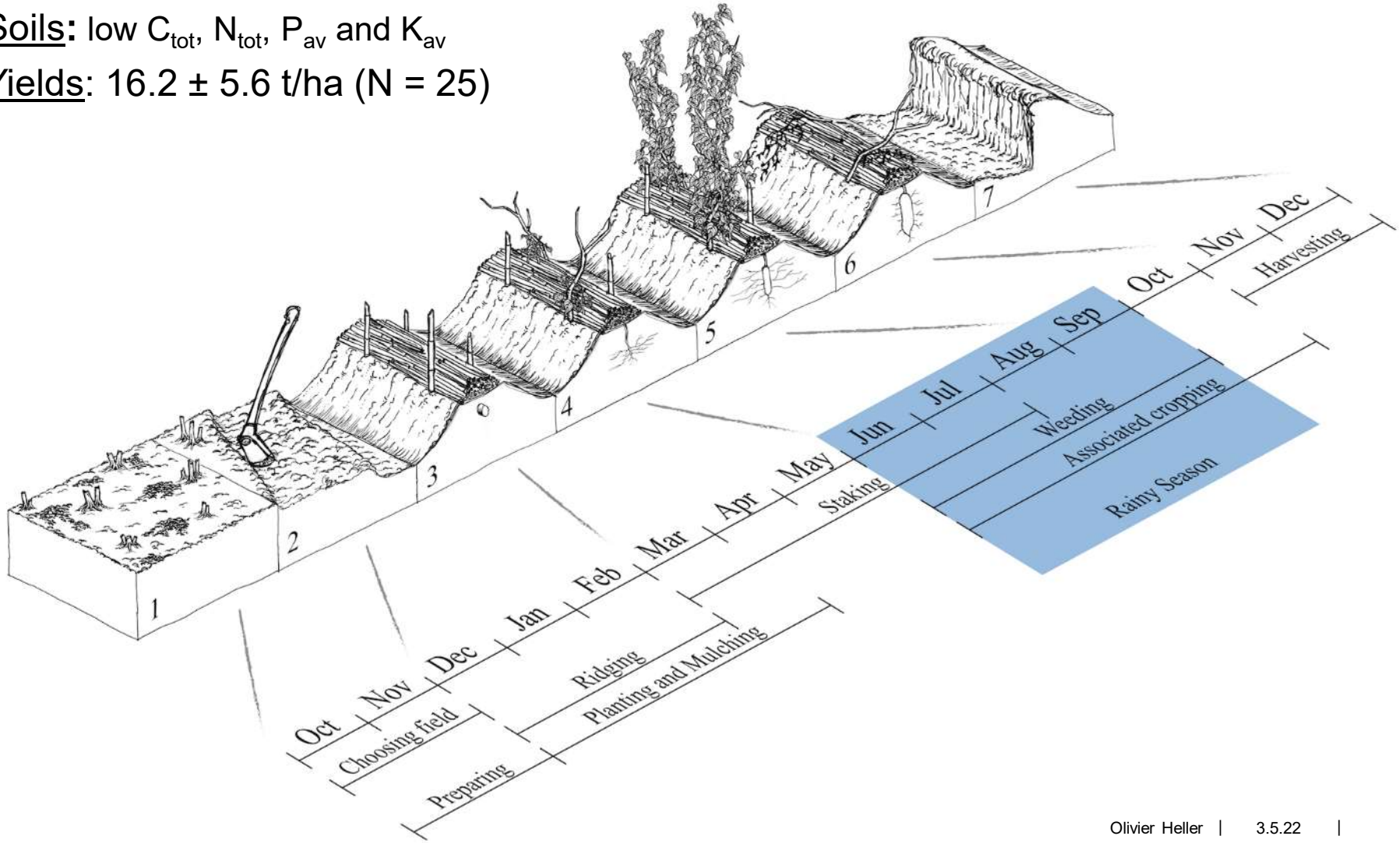
Map


Mali
Niger
Burkina Faso
Benin
Cote d'Ivoire
Ghana
Togo
Gomponsom
N
Kirsi
Bokin
Yako
Yako
Pilimpikou
Dourou (6)
Noongnongo (6)
Tibili (7)
Sagaré (6)
Namanssa (2)
Nostinga (6)
Nabitenga (6)
Arbollé
Mia (6)
Séko (6)
Koala (6)
Goubi (4)
Saaba (6)
1
2
3
4
5
0
5
10
15
20 km
Basemap: maps.stamen.com/terrain/
Legend
Field assessments
Basic
Basic + Yield
Soil profile
Borders
Provinces
Departments
Relief
Peaks
Contur lines (25m)

Results: Yam Cropping System

Soils: low C_{tot}, N_{tot}, P_{av} and K_{av}

Yields: 16.2 ± 5.6 t/ha (N = 25)



Discussion: Adaptations to the environment

- No fallows: low land availability
- Fertilization with manure (C + nutrients)
- Concentration of nutrients where plants can use it
- High planting density (42'700 ha^{-1})
- Small tubers (0.45 kg)
- Morphotype with short vegetative period (Dumont et. al., 1985)
- Ridges: water harvesting, easier harvest
- Mulch: water conservation, erosion, weed control

Results & Discussion: Fertilization

- Fertilization:
  - Manure (16.2 ± 9.8 t/ha, N = 67)
  - MIN (435 ± 264 kg/ha, N = 21)
- Manure since 20 - 40 years: counter soil fertility loss
- MIN since 4 - 20 years: increase tuber size and yields

Manure

Urea

NPK

Results & Discussion: Nutrient Balance

Table. 3: Soil Surface Nutrient Balance alance of yam Fields. All values in kg ha-1 except for the nutrient use efficiency (NUE). The notation indicates AVG ± SD. Contributions of seed tubers (AVG for all fields: N: 32 ± 4, P: 4 ± 0, K: 40 ± 5) and atmospheric deposition (for all fields: N: 4, P: 1, K: 7) are not reported.

	Manure only (N = 17)			**Manure + MIN (N = 8)**			**Potatoes** (GRUD)	
	Fert.	Harv.	**Bal.**	Fert.	Harv.	**Bal.**	Fert.	Harv.
N	257 ± 136	132 ± 62	**162 ± 152**	384 ± 245	186 ± 73	**235 ± 260**	80 - 160	135
P	40 ± 21	17 ± 6	**27 ± 21**	74 ± 42	22 ± 8	**58 ± 44**	36	26
K	106 ± 56	170 ± 66	**-17 ± 78**	146 ± 84	205 ± 60	**-11 ± 112**	372	202

- Net import of P and N
- Net export of K
- K deficitary?

Results & Discussion: Socio-Economics

Yam producers

- Few, relatively old farmers (53 ± 14) with families (24.6 ± 1.8 Pers)
- Low production expenditures: 0.00 – 0.141 $/kg (M: 0.04 $/kg)
- Increasing yam prices (2017: 0.59 $/kg)
- Yam Income relatively more important for poorer families (ca. 33% of 880 ± 93 $/year)

Motivation to grow yam

- Family tradition
- Income, especially for poorer families

Conclusions

What to learn?

- How to grow yam under adverse conditions?
- How are soil fertility and nutrient needs met?
- Can yam provide a chance for development?

- Adapted cropping systems allows yam cultivation.
- High manure application ensures yam yields on low quality soils.
- Resources (e.g., manure) are allocated to valuable crops.
- Yam is a valuable crop and provides income for some farmers.

If you want to know more…

frontiers | Frontiers in Agronomy

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Thank you






Impressions

Add-On: Figure 3

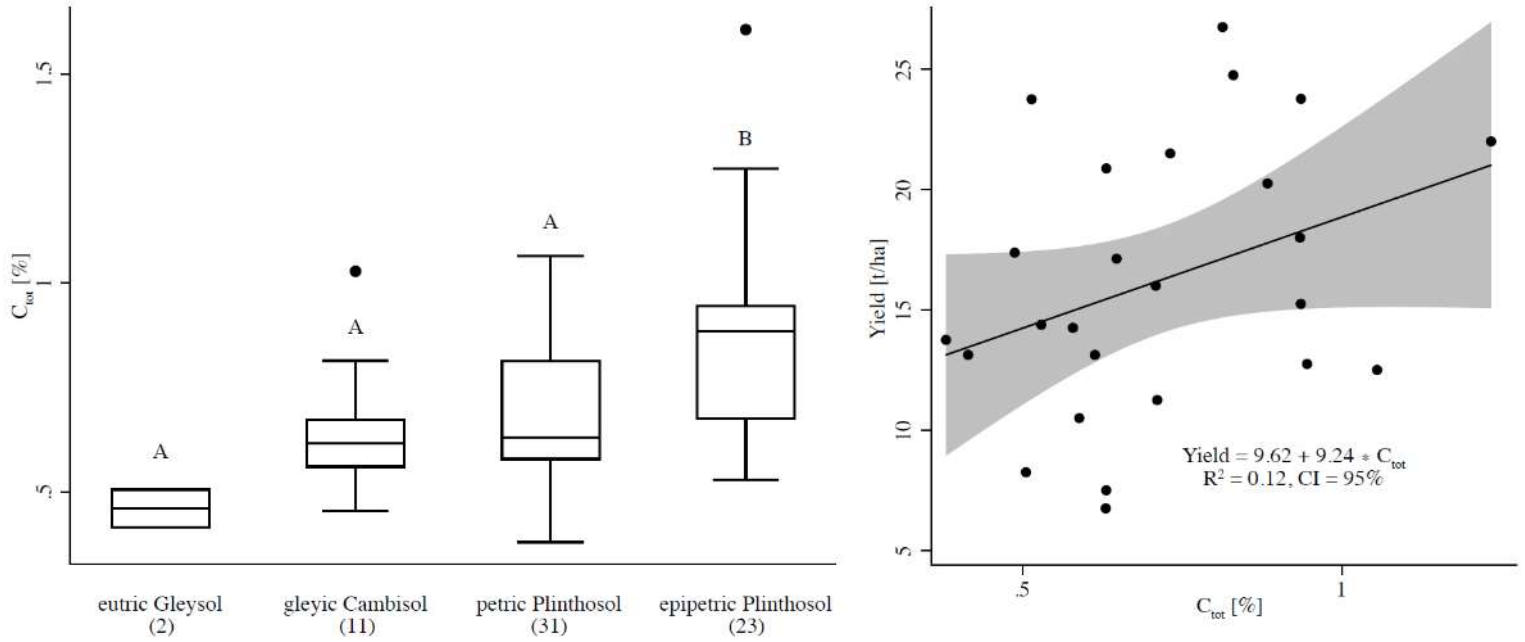

Figure 3: (left) topsoil (0-30cm) carbon of yam fields grouped by soil type, (right) yam yield vs. topsoil (0-30cm) carbon

Left: Soil organic carbon levels increased with increasing position of a field in the landscape and with decreasing soil depth. The letters (A,B) indicate the tukey groups of a pairwise comparison of the means (level of significance: 5%). The number below the soil type indicates the number of observations.

Right: Yam yields were in average increasing with increasing levels of organic carbon in the topsoil of yamfields. The grey area indicates the 95% confidence interval of the linear regression.

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