Integration of yam in cover crop-based cropping system: constraints and potential

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Presentation content

- West African context
- Description of the cover crop system
  - *Pueraria phaseoloides*
  - Cover crop establishment
  - Competition management
  - Experimental design
  - Observations
- Main results
- Conclusions and perspectives

Context

- 90% of the worldwide production comes from the "yam belt" in WA

Context

- *"yam belt"*
- Yams' production annual growth rate (AGR) : >3% during the past 30 years

Context

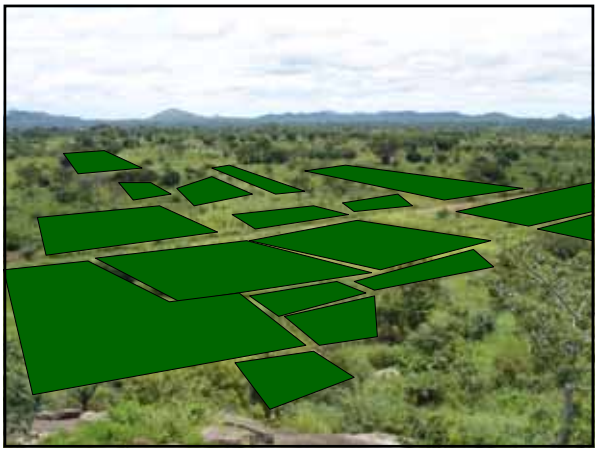
- *"yam belt"*
- *AGR >3%*
- yam expansion is due mostly to clearing of more and more land for cultivation

Context

- *"yam belt"*
- *AGR >3%*
- *land clearing*
- slash and burn practices have been shown to be very damaging for the soil and not ecologically sustainable

Context

- *"yam belt"*
- *AGR >3%*
- *land clearing*
- *slash and burn*
- Developing alternative cropping systems leading to sustainable yam production is one of the major challenges of agronomical research.



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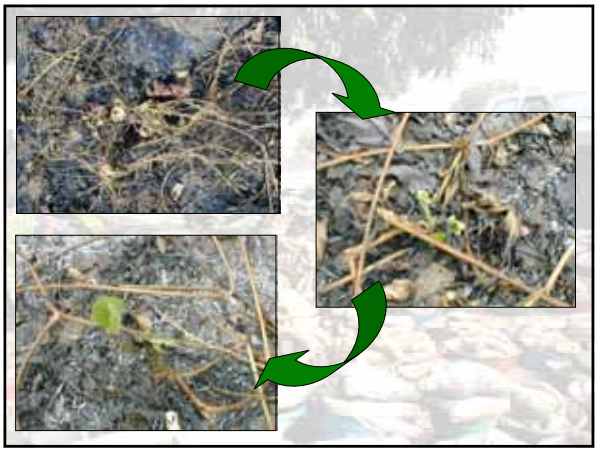
Pueraria phaseoloides

- Perennial herbaceous legume
- Vegetative reproductive organs under ground
- Small seeds
- Deep rooting system (up to 2m)
- Adapted to large climatic conditions (up to 5-6 month of dry season)
- Tolerant to bush fires
- Dry biomass between 6 to 9 $t.ha^{-1}$
- Accumulating between 150 to 250 kg $N.ha^{-1}$ within 4 to 18 months of growth (Tian *et al.* 2000)
- Encouraging preliminary experiments with yam in Ivory Coast (CIRAD – IDESSA)



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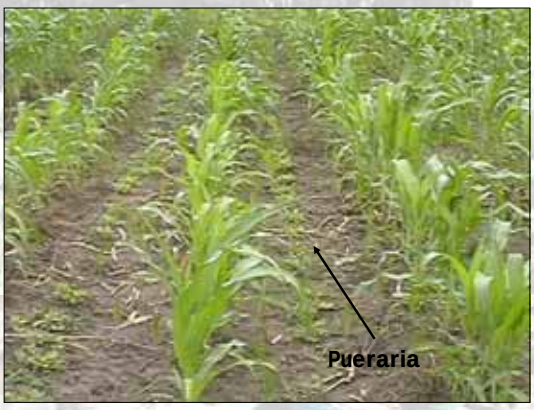
Cover crop establishment

- At the beginning of the rainy season
- 2 years before yam cultivation
- on a land abandoned by farmers
- on ridges spaced 60 to 90 cm
- 8-10 kg of seeds per ha
- maize is planted in-between

Once established, the Pueraria is kept alive, alternating years with and without control of the cover allowing or not yam cultivation



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Jab-planter

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Competition management

- **The cover crop is slashed at the beginning of the rainy season and herbicides are sprayed one week later.**
- **2 mulch management options (live or dead mulch)**

Type of mulch	Application	Herbicide
Live-mulch	After slashing	Low dose of no selective herbicides : Diuron (400g.ha^{-1}) + 2,4-D (720g.ha^{-1})
	During yam growth	localised spraying : Paraquat (200g.ha^{-1})
Dead-mulch	After slashing	Glyphosate (1130g.ha^{-1})

Competition management

- The cover crop is slashed at the beginning of the rainy season and herbicides are applied one week later.
- 2 mulch management options (live or dead mulch)
- Two to three weeks later the cover is squashed and yam could be planted.
- Soil is loosened with a pitchfork or a spade to create planting holes (each 30 x 30 x 30 cm).

Type of mulch	Application	Herbicide
Live-mulch	After slashing	Low dose of no selective herbicides : Diuron (400g.ha^{-1}) + 2,4-D (720g.ha^{-1})
	During yam growth	localised spraying : Paraquat (200g.ha^{-1})
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Experimental design

- Comparison of 3 juxtaposed trials :
  - TC : traditional cropping system (mound, low density, long fallow)
  - DM : dead mulch cropping system
  - LM : live mulch cropping system
- For each trial :
  - 2 species (*D. rotundata* and *D. alata*)
  - 25 plants per experimental unit
  - 4 replications
- 2 years (2004 and 2005)
- 2 ecological zones

Experimental design

Year	Region	Rainfall pattern	Site	Trial	Density (plants.ha^{-1})
2004	Northern Benin	Monomodal	Fo Boure	TC	5 600
				DM	10 000
				LM	10 000
	Central Benin	Bimodal	Kpakpazoume	TC	5 600
				DM	10 000
				LM	10 000
2005	Northern Benin	Monomodal	Fo Boure	TC	5 600
				DM	6 500
				LM	6 500
	Central Benin	Bimodal	Kpakpazoume	DM	6 500
				LM	6 500
			Sowe	TC	5 600
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Observations

- Pueraria above ground dry matter biomass
- Yam yield (tubers number, weight) and marketable yield
- *Weed and pest pressure*
- *Economic data (labour requirement, input price, yam value on main markets, …)*

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Results : 2004

Region	Cropping system	Genotype	Germination rate	Gross Yield (t.ha^{-1})	Marketable yield (t.ha^{-1})	Percentage of marketable tubers
Central		Florido	0,85	5.3^{A}	3.1^{A}	46^{A}
		Kpouna	0,86	5.1^{A}	3.5^{A}	62^{B}
Northern		Florido	0,74	2.1^{B}	0.6^{B}	24^{C}
		Kpouna	0,78	$5.1a^{A}$	4.0^{A}	76^{D}
Central	Dead-mulch		0.89^{a}	7.4^{c}	5.1	65^{a}
	Live-mulch		0.75^{b}	5.5^{a}	3.8	58^{ab}
	Traditional		0.91^{a}	2.7^{b}	1.1	39^{c}
Northern	Dead-mulch		0.66^{c}	3.2^{b}	2.0	46^{bc}
	Live-mulch		0.79^{ab}	4.7^{ab}	2.9	47^{bc}
	Traditional		0.83^{a}	3.0^{b}	1.9	57^{ab}

- Yield were very poor due mainly to late planting
- Both varieties yielded more in the mulch-based cropping system (5.3 and 5.1 t.ha^{-1}) than in the traditional one (2.9 t.ha^{-1}).
- Marketable yield follows the same trend

Results : 2005

Region	Cropping system	Genotype	Gross Yield (t.ha^{-1})	Marketable yield (t.ha^{-1})	Percentage of marketable tubers
Central			7.6^{a}	6.7^{a}	87^{a}
Northern			13.8^{b}	13.2^{b}	94^{b}
	Dead-mulch		11.9^{c}	11.3^{c}	94
	Live-mulch		13.3^{c}	12.7^{c}	94
	Traditional		6.8^{d}	5.9^{d}	85
		Kpouna	8.8^{e}	8.4^{e}	87
		Florido	12.5^{f}	11.5^{f}	94

- Despite poor rainfall, 2005 yields were much better
- Significant differences occurred for yield between regions, cropping systems and varieties without any interaction.
- Marketable yield follows exactly the same trends.
- *D. alata* yielded better than *D. rotundata*

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Conclusions

- Late planting in 2004 could explain the lower yields. Delay in planting has impacted *D. alata* more than *D. rotundata*.
- Despite important differences in rainfall pattern the yield parameters show a close relation with the date of planting.
- Mulch-based cropping systems significantly increased both total and marketable yields in all location and years except in Northern Benin in 2004.
- The best results were achieved with live-mulch.

Future : at farmers level

- For now, this cropping system seems the most suitable for zones with **scarcity of long duration fallows** where soil fertility problems, weed and pest pressure are heavy. These zones may constitute lands that would benefit most from the adoption of the new technologies.
- **Full economic analysis** is yet to be done. Moreover, there is now a need to identify environments in which farmers are likely to adopt the Pueraria system and what management needs to be implemented to make it a success. A **participatory approach** to adapt and improve the system is needed.

Future : at researchers level

For better understanding of the capacity of Pueraria for nutrient recycling, further research work is needed on :

- **Long term assessment of soil status** under the Pueraria systems
- **Characterization of the rooting systems**
- **Monitoring litter-fall and root turnover**
- **Determination of soil fertility indicators** to calculate a realistic alternation between cultivation and fallow periods.


Thank you