

Integrated microdose and rain water harvesting to improve crop productivity in low fertility and eroded soils in sub-saharan west Africa

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The microdose technique

Concept

- Microdosing - Microfertilising
 - Strategic application of small amount of fertiliser to hills at sowing or 10 days after emergence
 - Fertilizer may be mineral (urea, NKP, DAP, ...) or organic (manure; FYM)
 - Crop may be cereals (millet, sorghum, maize) or legumes (groundnut, cowpea, etc), vegetables
 - Placement strategy
 - Three people from the beginning (1st-opening hills, 2nd-seeding 3rd-microfertilizer and closing the hills)
 - Now, only one person



The microdose technique

Rationales

- Poor soils (mainly P deficient)
- Scarce organic input (manure, or residues)
- Low mineral fertiliser availability
- Poor farmers who cannot afford buying high amount of fertiliser (which limits adoption of recommended doses)
- Recommended doses often results in low yield in dry years, increasing vulnerability

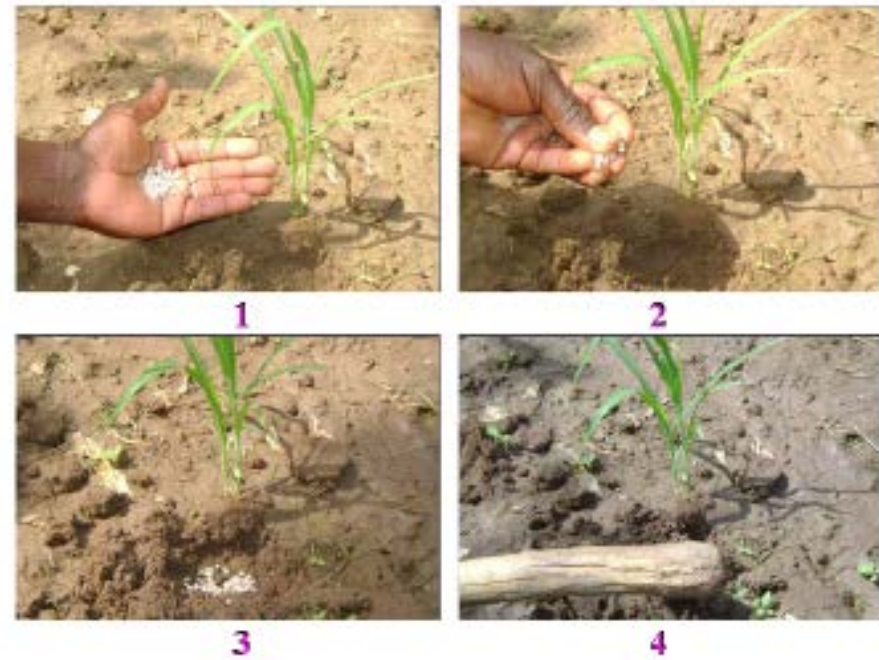
The microdose technique

Principle and implementation

- Millet
 - 3g/hill (80 x 60 cm) or 2g/hill (80 x 40 cm) of NPK

Sowing

After emergence



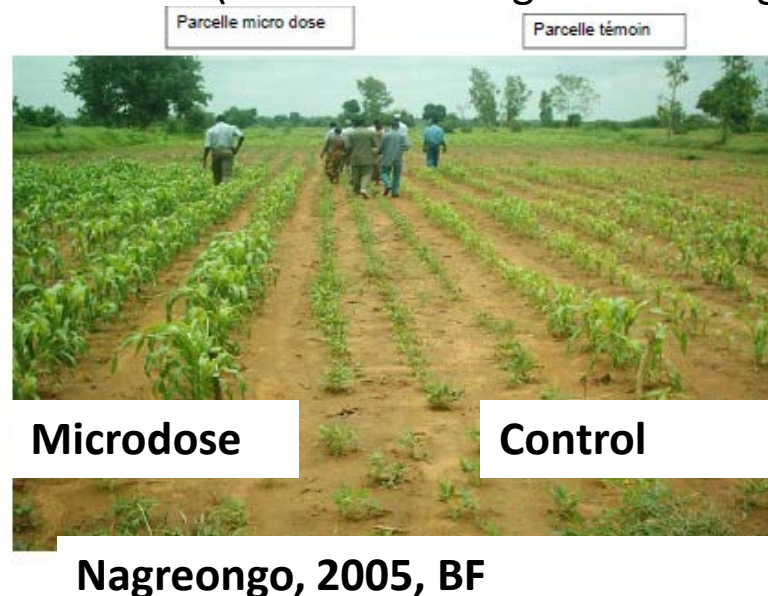
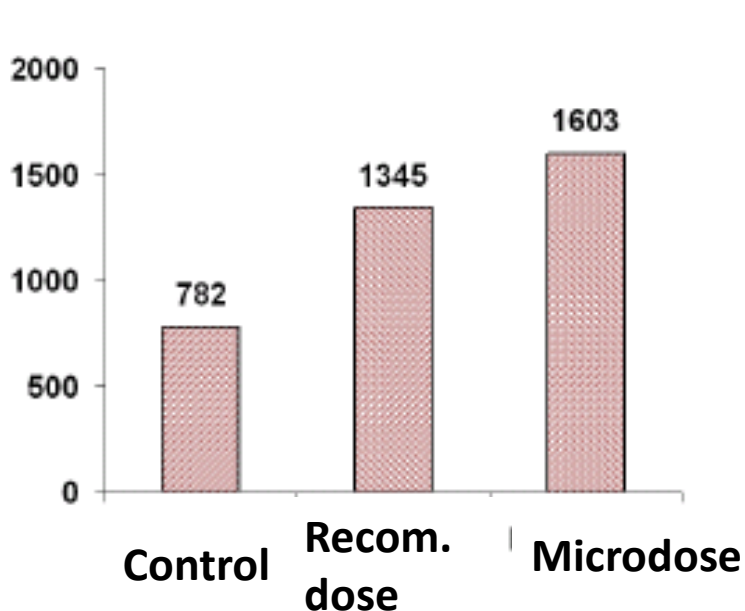
The microdose technique

Reviewed performance

- Burkina Faso

- Sorghum

- Grain yield > 1.5 t/ha
 - 110 % > control (no input farmer option)
 - 20 % > Recommended dose (broadcast 75 kg NPK + 50 Kg urea /ha)



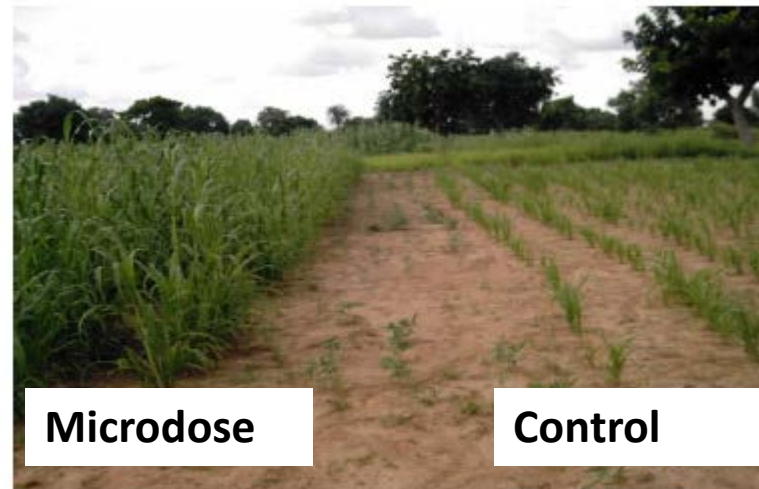
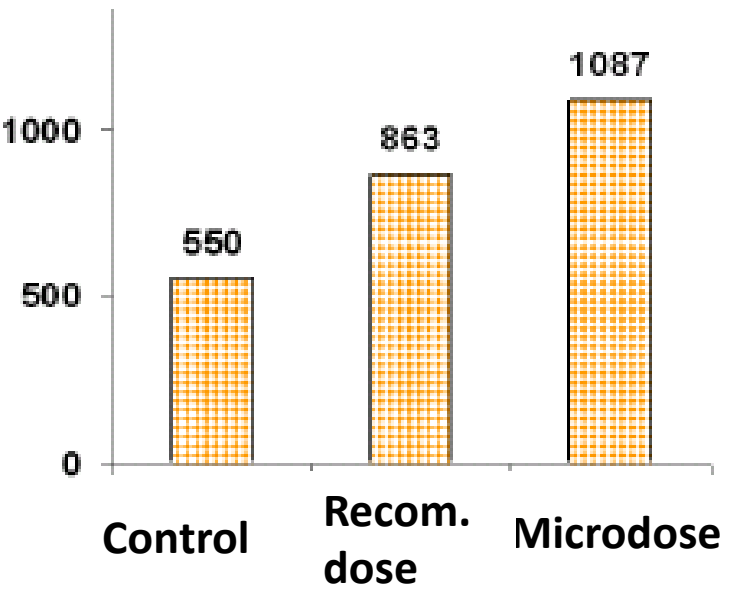
The microdose technique

Reviewed performance

- Burkina Faso

- Millet

- Grain yield > 1.0 t/ha
 - 100 % > control (no input farmer option)
 - 30 % > Recommended dose (broadcast 75 kg NPK + 50 Kg urea /ha)



Nagreongo, Sept 2007, BF

Combined microdose and RWH

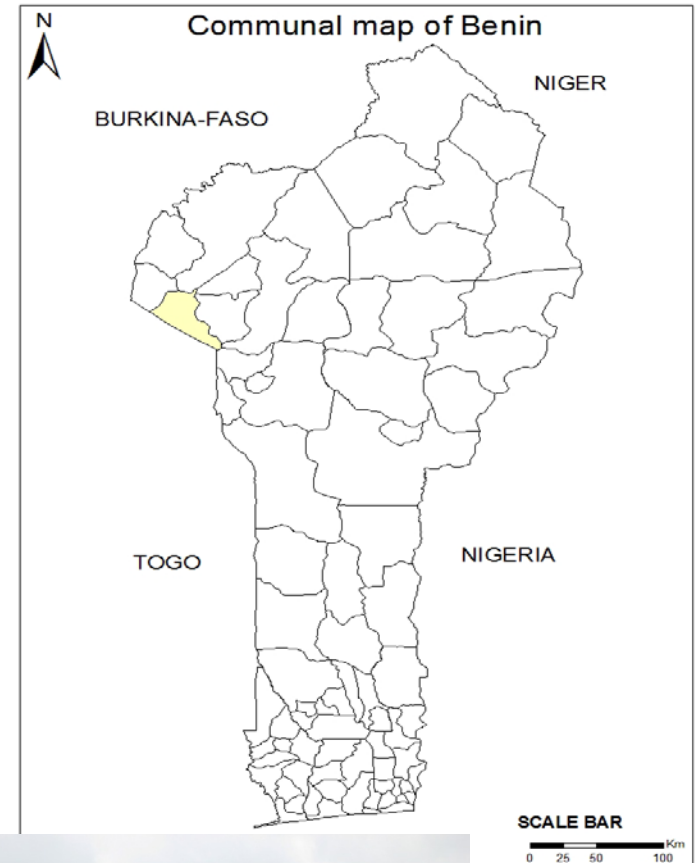
- The IDRC-CIDA microdose Project No 106510-003
 - 2011-2014: Integrated Nutrient and Water management for sustainable food production in the Sahel (<http://www.inuwam.org>)
 - 4 countries (Benin, Burkina, Mali and Niger) and Canada (Uof Saskatchewan)
 - Improvement through synergy with SWC tech.
 - Diffusion through warrantage
 - Refinement (soil mining nutrient leaching)



On farm experiment-Benin

Context

- Farmer conditions
 - Boukombé, most vulnerable district
 - Low income
- Harsh environment
 - Hilly topography
 - Poor soils, prone to water erosion



On farm experiment-Benin

Objectives

- Effects of the integrated water and nutrient managements on Sorghum performance;

Hillside



Plain



On farm experiment-Benin

Experimental setup: 2012

- Two factors in split plot design (3 replications)

- Factor 1: Soil and water conservation techniques (3 variants):

- Hillside

- Rectangular honey comb
- Circular honey comb
- Stone row



- Plain

- Perpendicular ploughing
- Simple tied ridging
- Staggered tied ridging



On farm experiment-Benin

Experimental setup: Hillside

Hillside

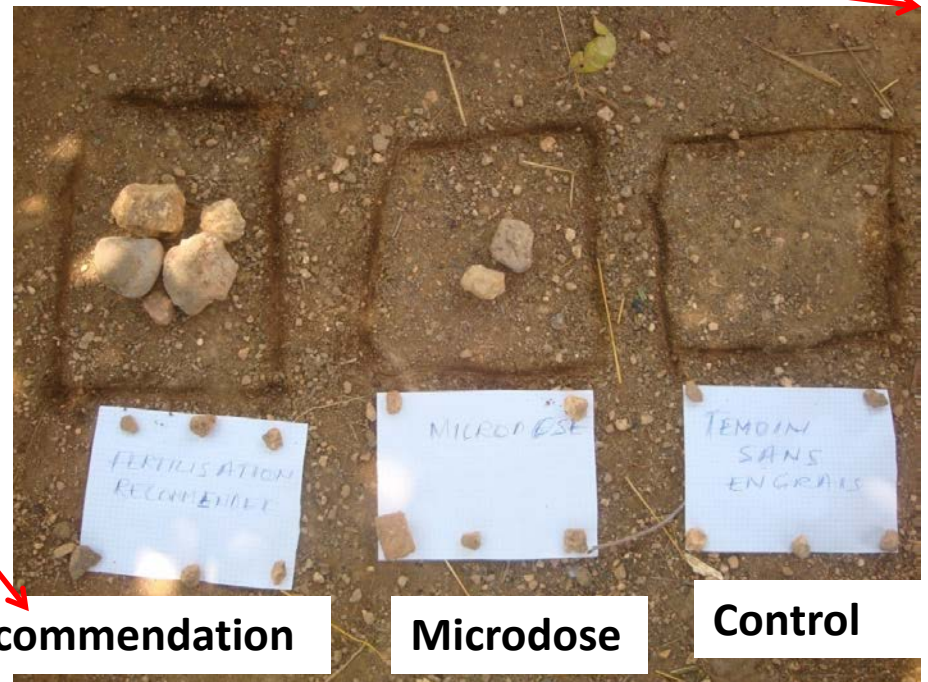


Plain



Farmer field demonstrations

Strategy



Recommendation

Microdose

Control

Farmer field demonstrations

Strategy

- Harvesting and yield comparison with farmers



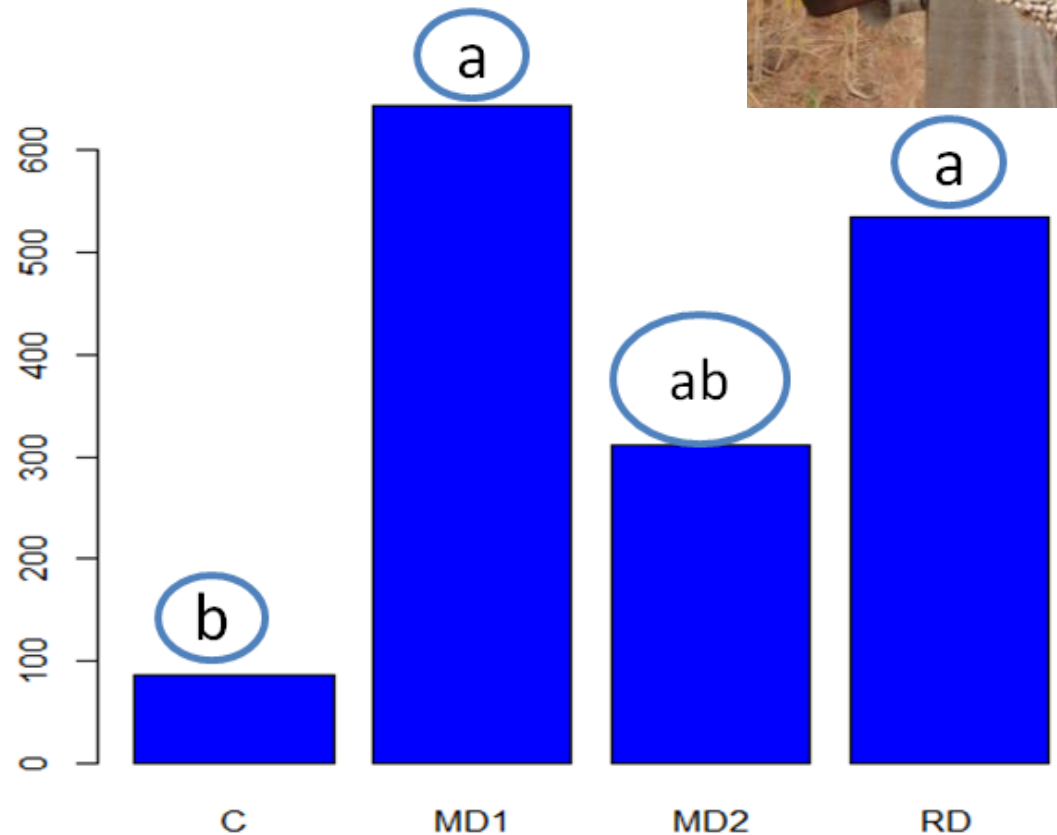
On farm experiment-Benin

Findings: Yield



- Plain

Grain yield (Kg/ha)



60 DAS

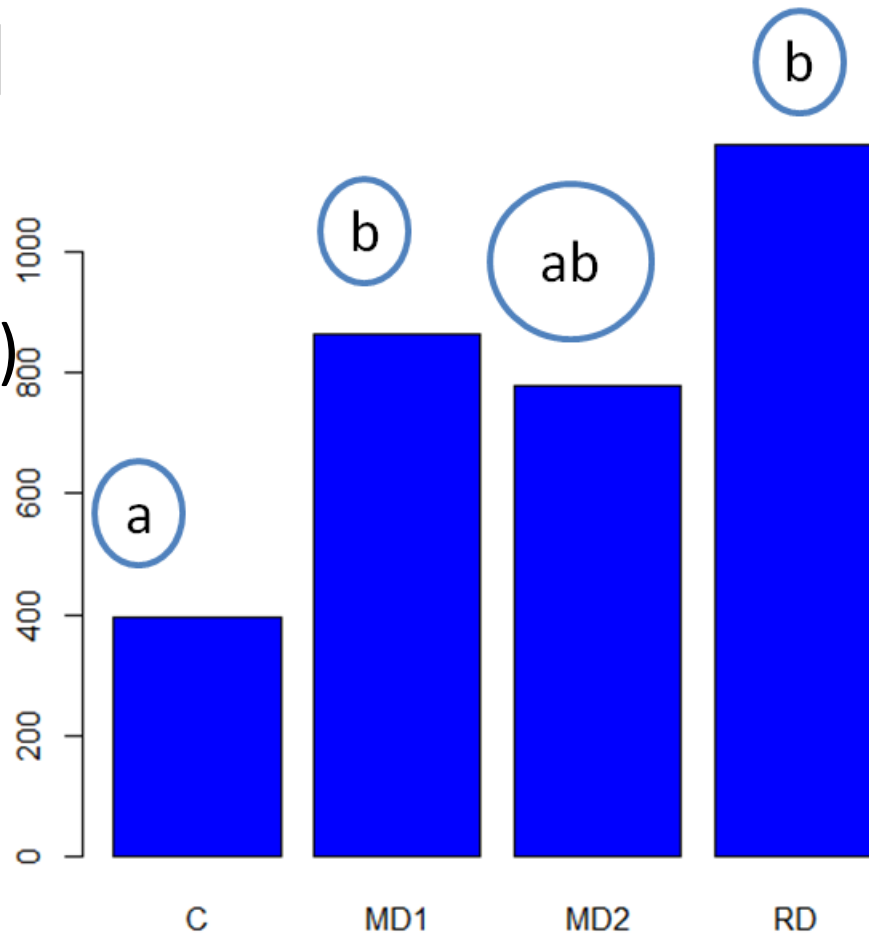


On farm experiment-Benin

Findings: Yield

- Hillside

Grain yield (Kg/ha)



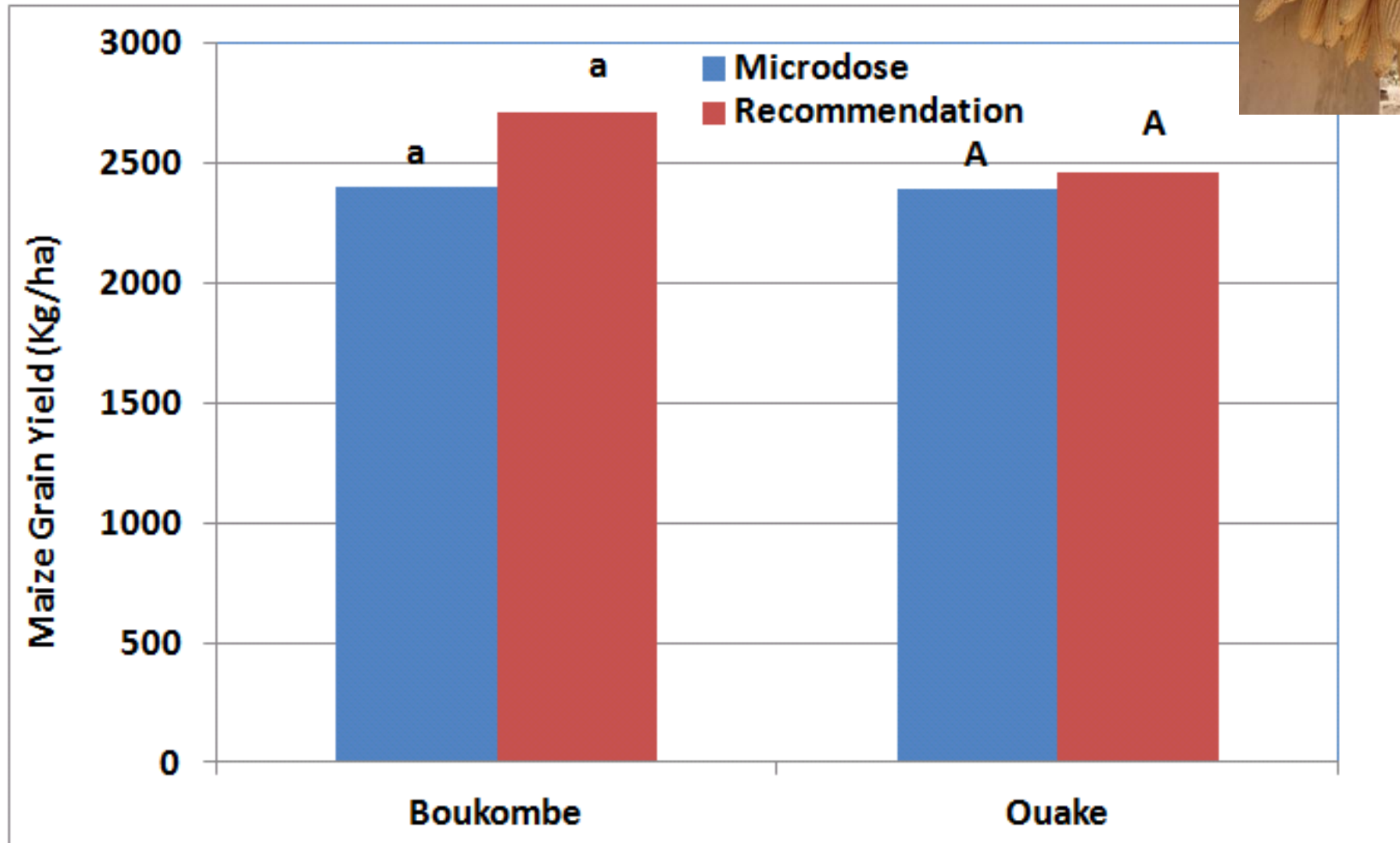
60 DAS



Farmer field demonstrations-Benin

Findings

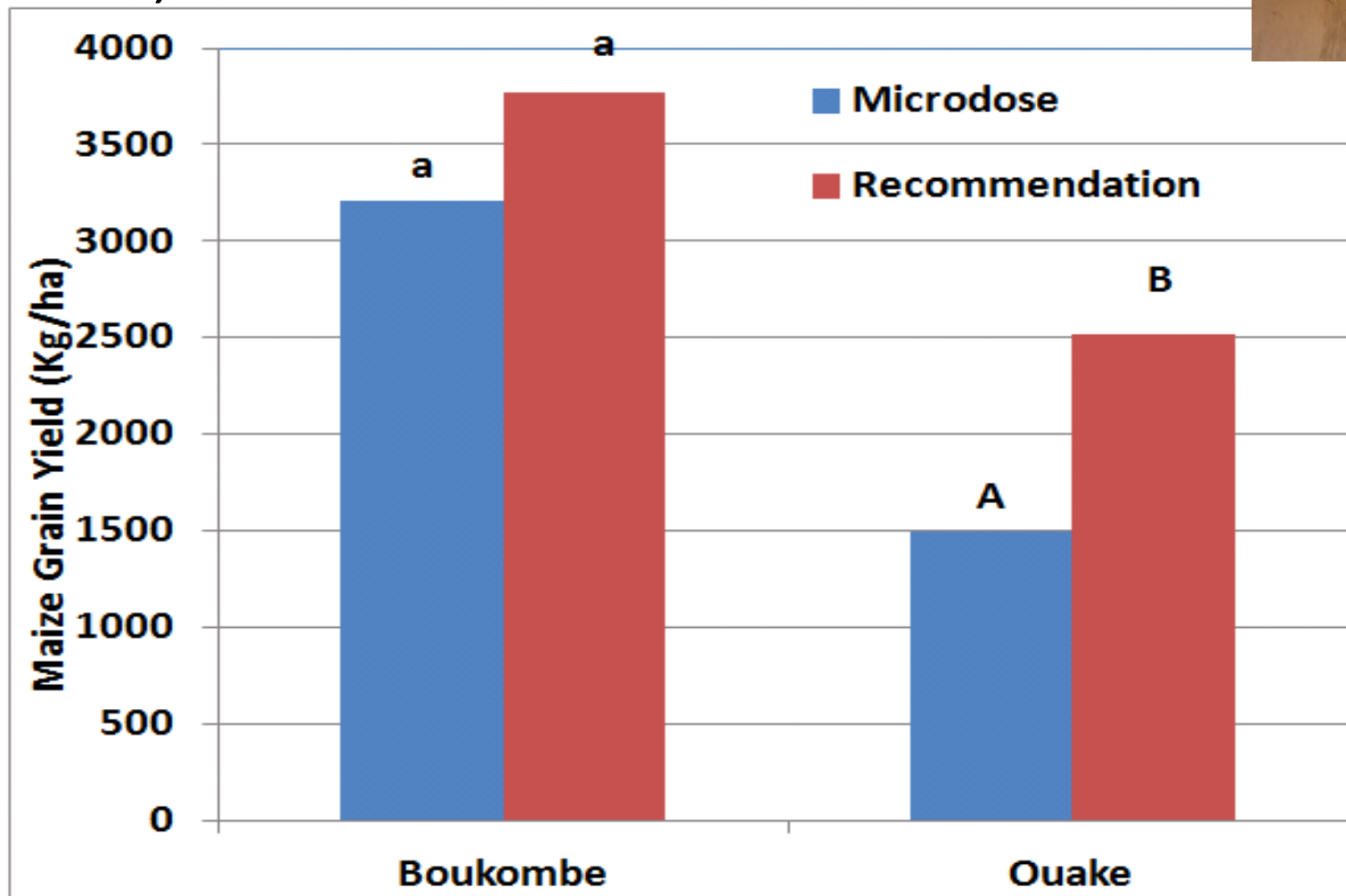
- Yield, 2011



Farmer field demonstrations-Benin

Findings

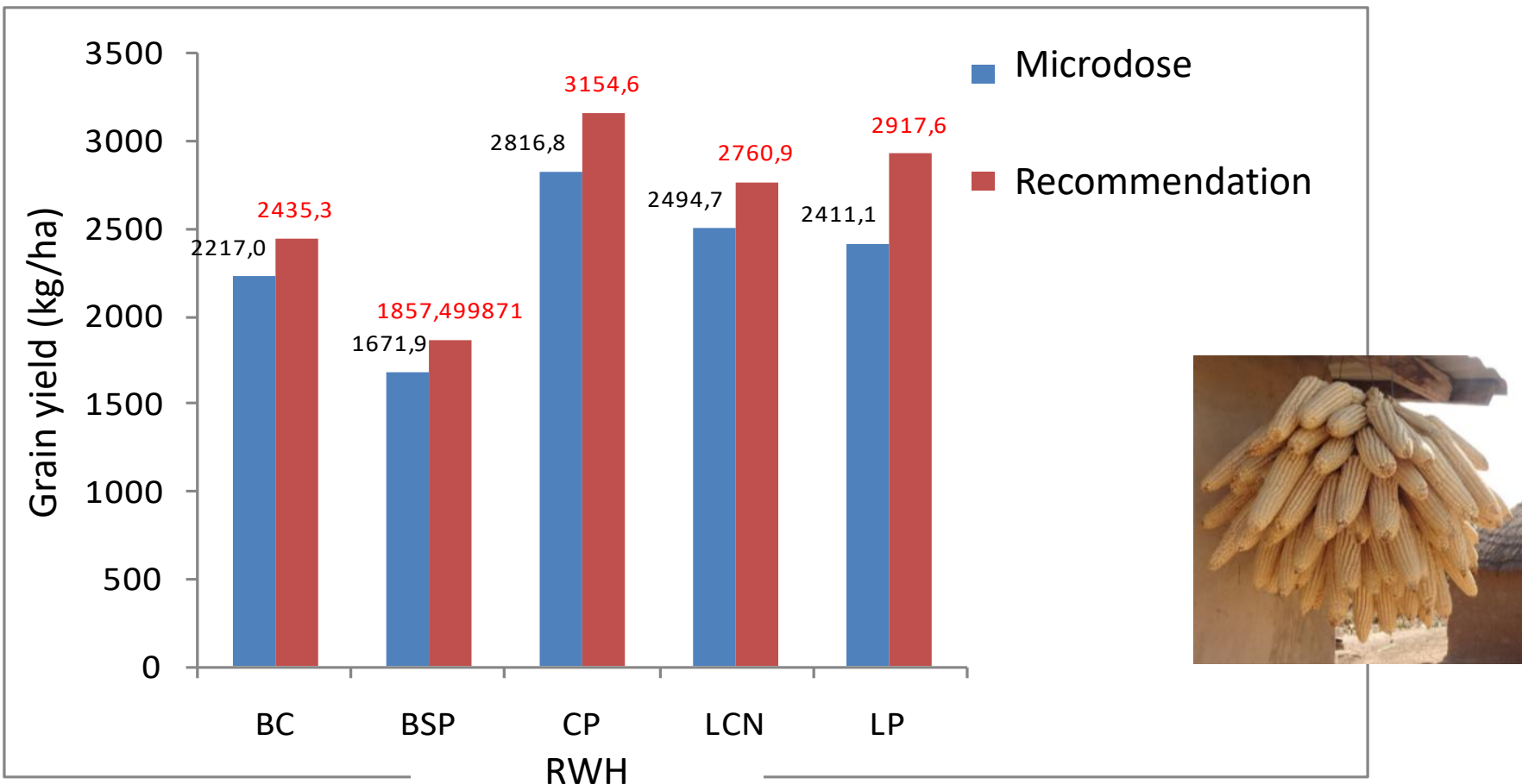
- Yield, 2012



Farmer field demonstrations-Benin

Findings

- Maize Yield

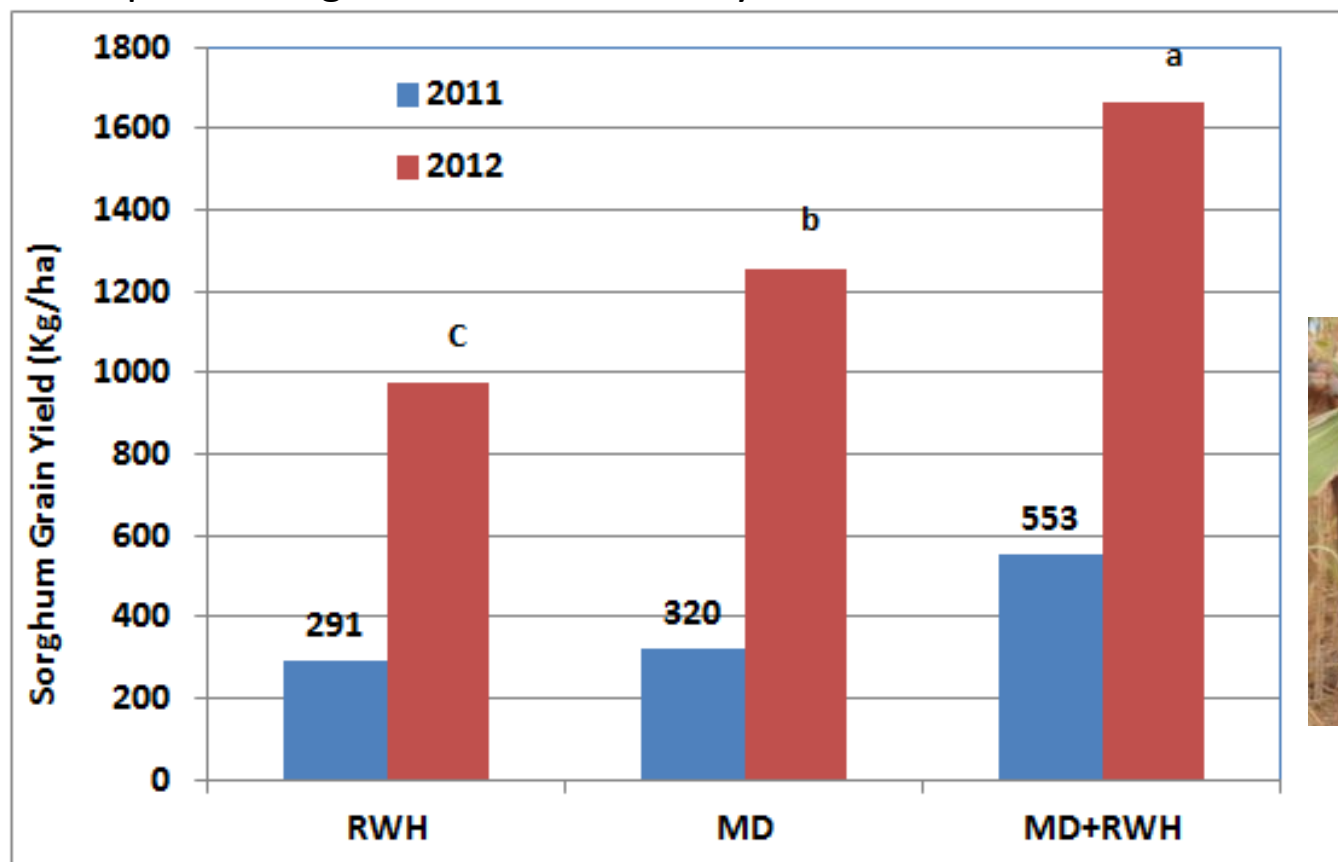


Farmer field demonstrations-Burkina Faso

Findings

- Sorghum in Zondoma

Sorghum grain yield under influence of Rain Water Harvesting and Micro dosing techniques during two contrasted rainy seasons

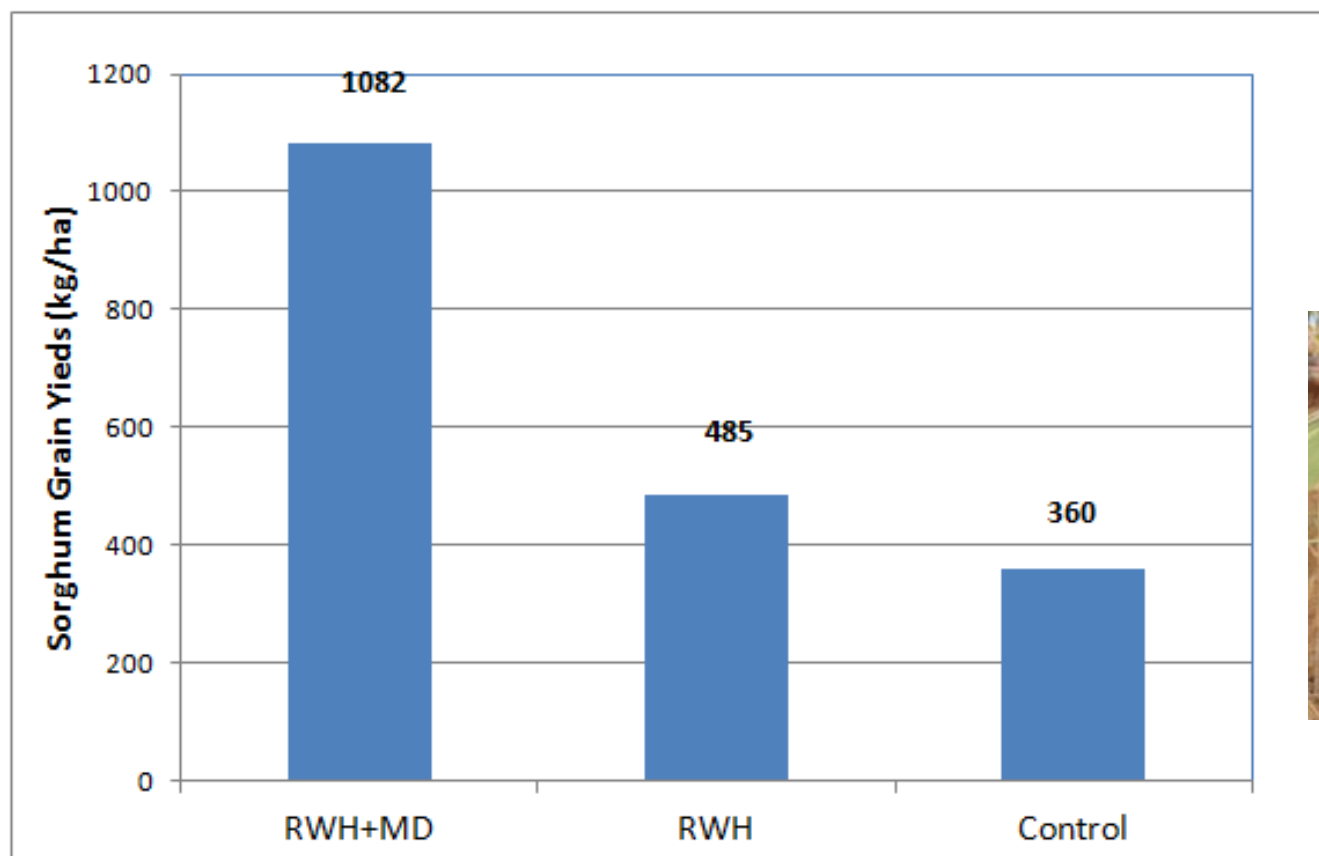


Farmer field demonstrations-Burkina Faso

Findings

- Zondoma, 2011-2012 MD x RWH

Microdosing combined with Rain Water Harvesting results in a significant sorghum grain yield (200 %), while RWH induced a yield increase by only 30 %.

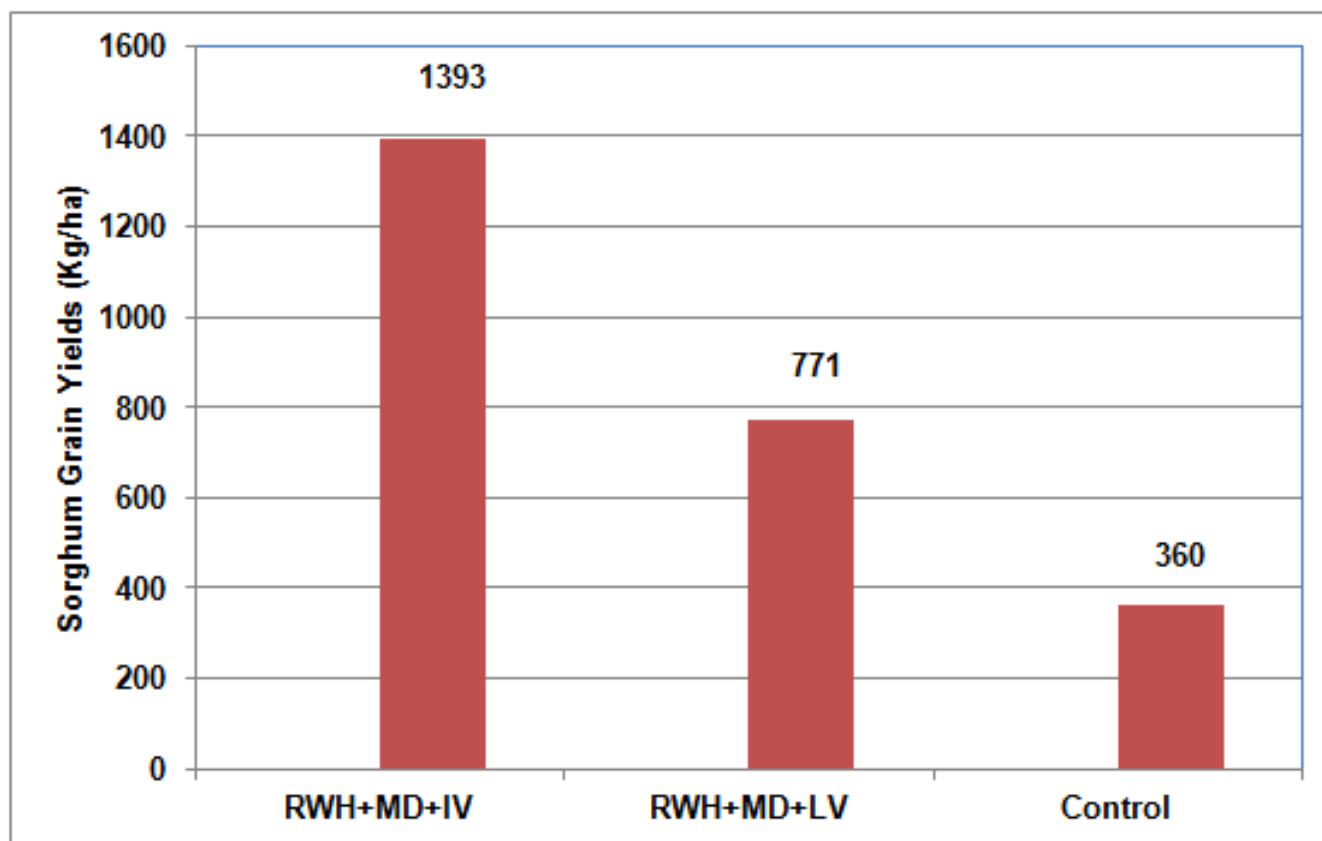


Farmer field demonstrations-Burkina Faso

Findings

- Kouritenga 2011-2012 (MD x RWH x Variety)

Microdosing is one of the best performing ISFM technology in combination with RWH, improved germplasm, local practice



Environmental sustainability

Findings

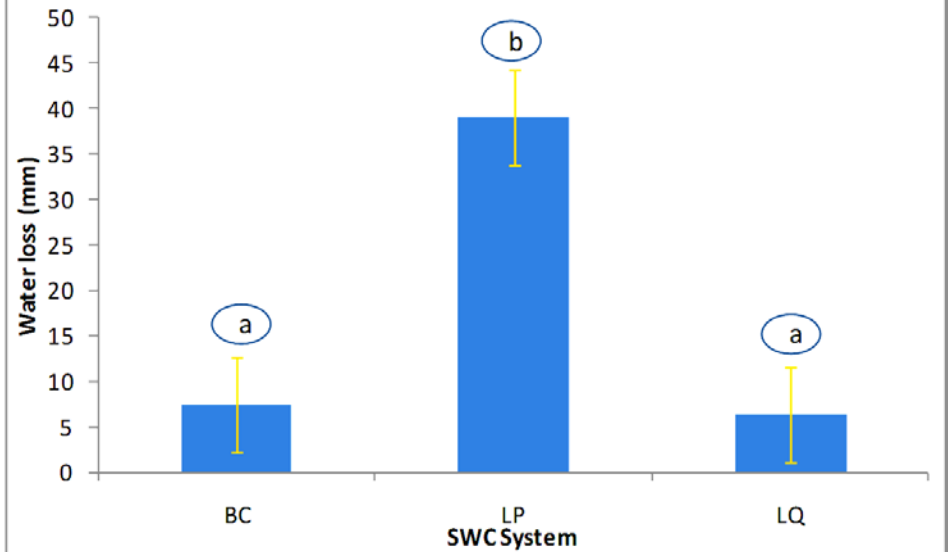
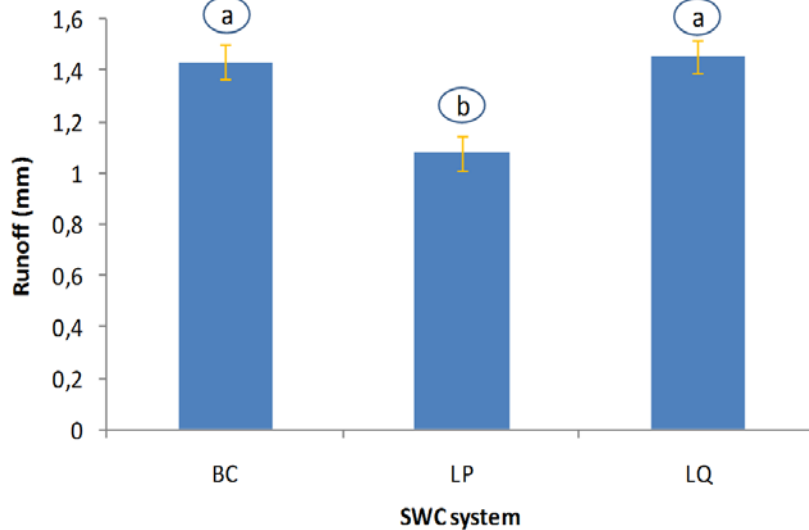
- Erosion control Vs Leaching

the more a given SWC technique is effective in harvesting water the more prone to drainage (with possible nutrient leaching) it is. Further analysis are underway to compare nutrient leaching (N, P, K)



Effect of SWC on drainage (2 Oct 2013)

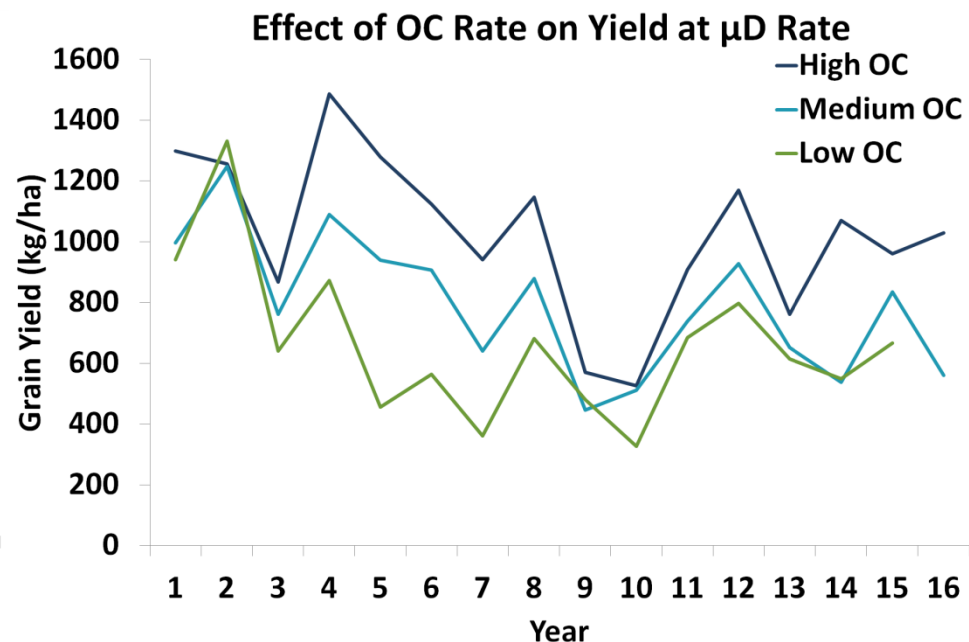
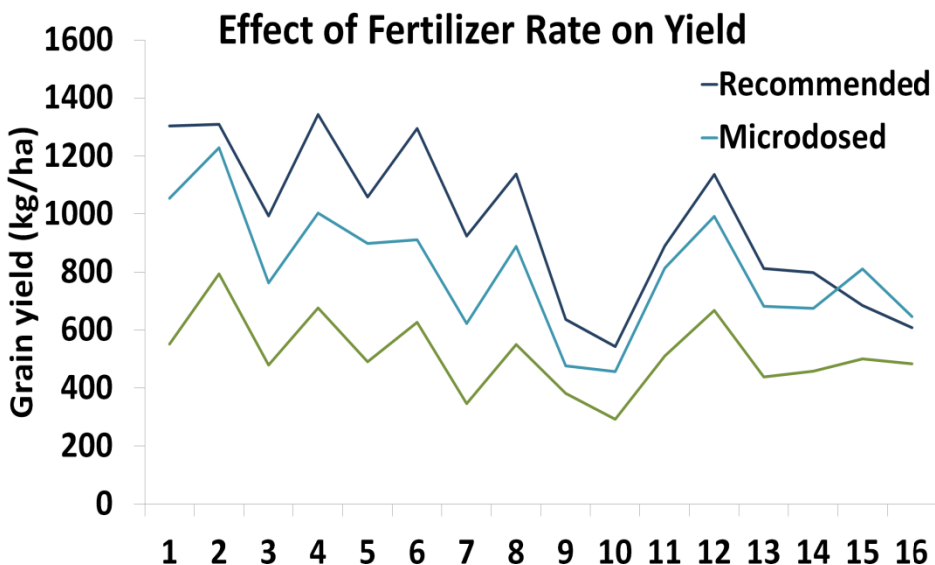
Effect of SWC on runoff



Long term sustainability

Findings

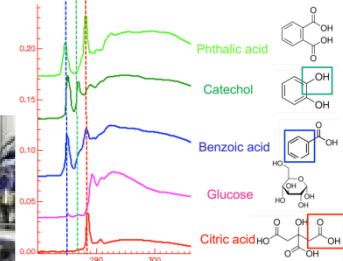
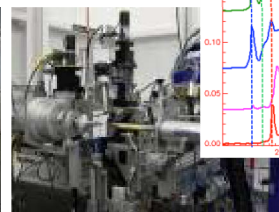
- Long term yield trend (Sadore, Niger 1998-2013)
 - Microdosing does not lead to a greater yield decline than the recommended rate with or without organic matter
 - Yield trends may be more influenced by climate and precipitation than treatment.



Long term sustainability Findings

• Changes in soil quality (Sadore, Niger 1998-2013)

- No evidence that microdosing is more deleterious to soil quality than recommended practices
- Even the highest rate of OC input is not increasing soil organic matter content



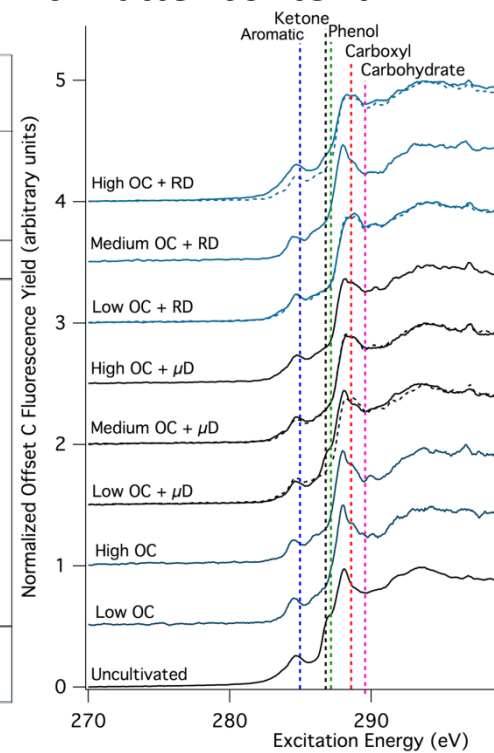
Synchrotron analysis UofS, Canada

Table 1. Effect of long-term microdosing (μ D) on soil properties in continuous millet and millet-cowpea intercrop

Treatment	pH*	EC	Organic Carbon	Total P	Available P**	Total N
kg/ha		mS/cm	%	mg/kg	mg/kg	mg/kg
Unfertilized	5.33	47.99	0.24	144.1	5.88	96
μ D	5.08	53.22	0.26	161.8	10.86	104.5
Recommended	4.95	52.76	0.27	172.9	22.9	127
	<.001		<.05	<.001	<.001	<.001
Low OC + μ D	4.82	67.74	0.27	131.14	8.78	126.58
Medium OC + μ D	5.21	60.93	0.24	183.40	9.88	89.78
High OC + μ D	5.22	43.94	0.29	198.46	12.15	96.27
	<.001		<.05	<.05	<i>n.s.</i>	<i>n.s.</i>

*In water

**Mehlich-3 extraction



Concluding remarks

- On-farm experiment and demonstrations
 - The microdose treatments showed a better NUE and WUE than the recommended dose and the control.
 - Microdosing does not lead to a greater yield decline than the recommended rate with or without organic matter
 - No evidence that microdosing is more deleterious to soil quality than recommended practices
- Microdosing advantages and reasons for upscaling
 - low fertilizer application rate,
 - high probability of yield response
 - a favorable fertilizer/grain price ratio.

Thanks



On farm experiment-Benin

Experimental setup

- Experiment design: split plot design with two factors
 - Factor2: mineral fertilizer application (4 levels):
 - Recommended dose/ 5.52g NPK /hill at 25DAS (230kg NPK /ha) and 1.2g urea /hill 45DAS (50kg urea /ha)
 - Microdose option 1: 4g/hill of NPK at sowing ((166 kg NPK /kg) and we still have to put 1.2g/hill of urea 45DAS(50kg urea /ha)
 - Microdose option 2: 2g/hill of NPK at sowing (83.33 kg NPK /ha) and we still have to put 1.2g urea /hill at 45DAS (50kg urea /ha)
 - Control: no fertiliser (0g/hill of NPK and 0g/hill of urea

Farmer field demonstrations-Benin

Strategy

- Maize under various Rain Water Harvesting
 - Recommendation:
 - 150 Kg of NPK/ ha and 50 Kg of urea/ha.
 - Microdose:
 - 83 Kg of NPK/ ha and 41 Kg of urea/ha.

		Microdose		Recommendation	
Date	Fertiliser	Quantity/hill	Practical qty/hill	Quantity/hill	Practical qty/hill
1-15 DAS	NPK	2,0 g	3 fingers pinch		
15 DAS				3,6 g	2 x 3finger pinch
45 DAS	Urea	1,0 g	3 fingers pinch	1,2 g	4 fingers or 2 x 3 fingers

Farmer field demonstrations-Benin

Findings

- Benefit/Cost analysis, 2011-2013

Fertilization	Microdose		Recommended	
	N B (CFA)	B/C	MB (CFA)	B/C
RHW technique				
Flat Ploughing	276280	1.70	311037	1.58
Tied Ridges	265863	1.49	289289	1.31
Stone Rows	338954	2.17	367995	1.94
Contour line ploughing	291979	1.84	320094	1.64
Perpendicular ploughing	213221	1.11	239728	1.01
Moyenne	277259	1.66	305629	1.50