UNIVERSITÄT HOHENHEIM

Institut National de la Recherche Agronomique du Niger

The seedball project

Sometimes, things can be so simple

Collaborative Research on Sorghum and Millet

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

KANSAS STATE UNIVERSITY

USAID FROM THE AMERICAN PEOPLE

The seedball project

Becoming

Evolution

Maturity

Aging

End

The seedball project

A kind of summary

Agronomy	Management	Farmers'voices	Institutional	Economy

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Becoming

The reason: poor performance of staple crop pearl millet in subsistence environments

Technologies must be simple, affordable, based on local resources, and should not confront local traditions

Micro-dosing as template

Participation, co-development with local farmer organisations, holistic approach as key principles

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Evolution

Pre-studies as pre-requisites

Bachelor thesis on potential social and cultural adoption obstacles

Master thesis on-station on potential formulas and yield effect

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Maturity

<u>SMIL project phase I</u>

The final formula for pearl millet seedballs

Parallel testing on-station and on-farm

Increasing freedom of management options

Large-N trials

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Aging

SMIL project phase II

Seedballs for sorghum

Influencing factors in detail known

Outscaling

Marketing and teaching materials

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End

SMIL project phase II

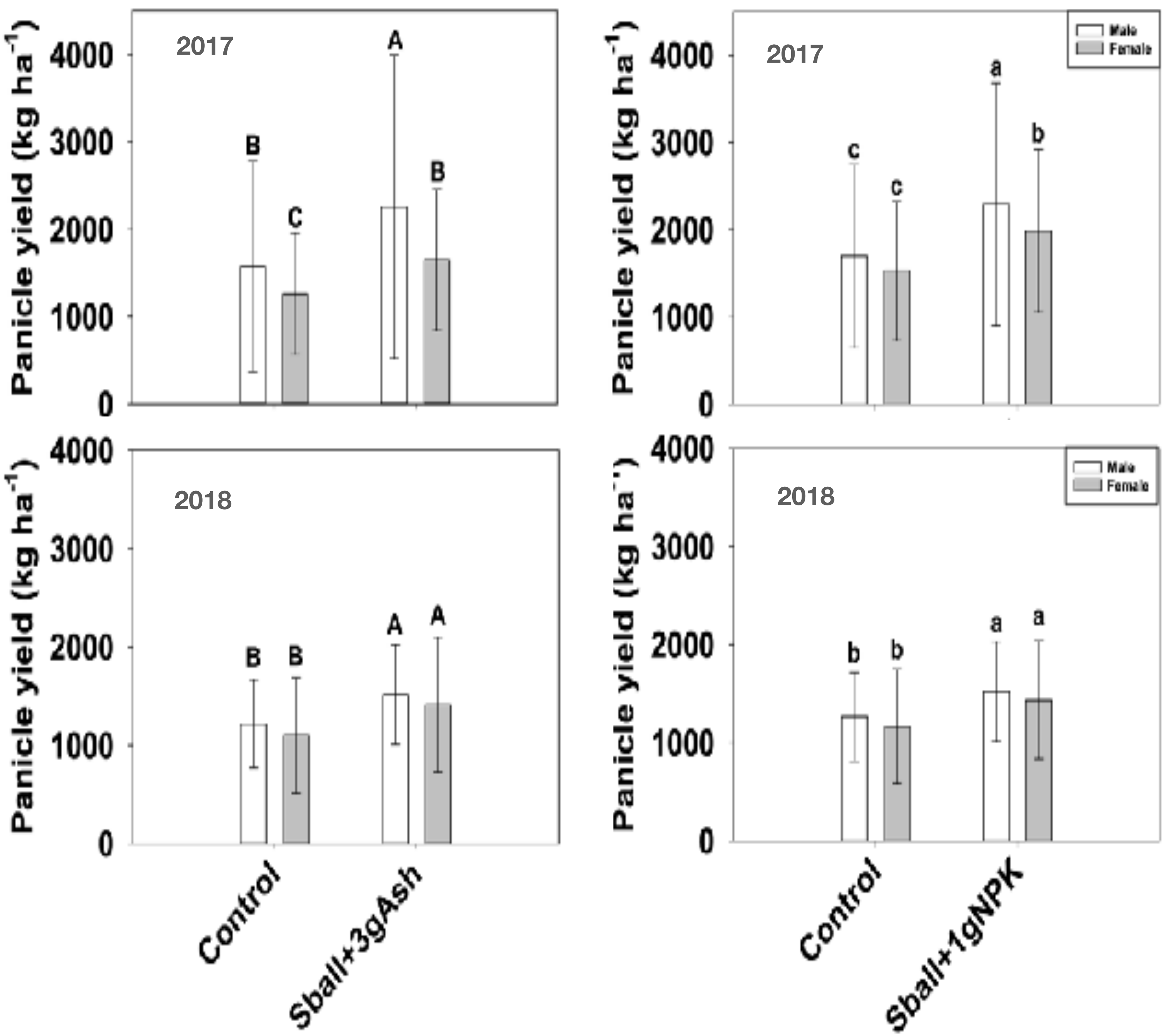
Social and institutional environment

Economic effects

Mechanisation

Story telling

Gender effect



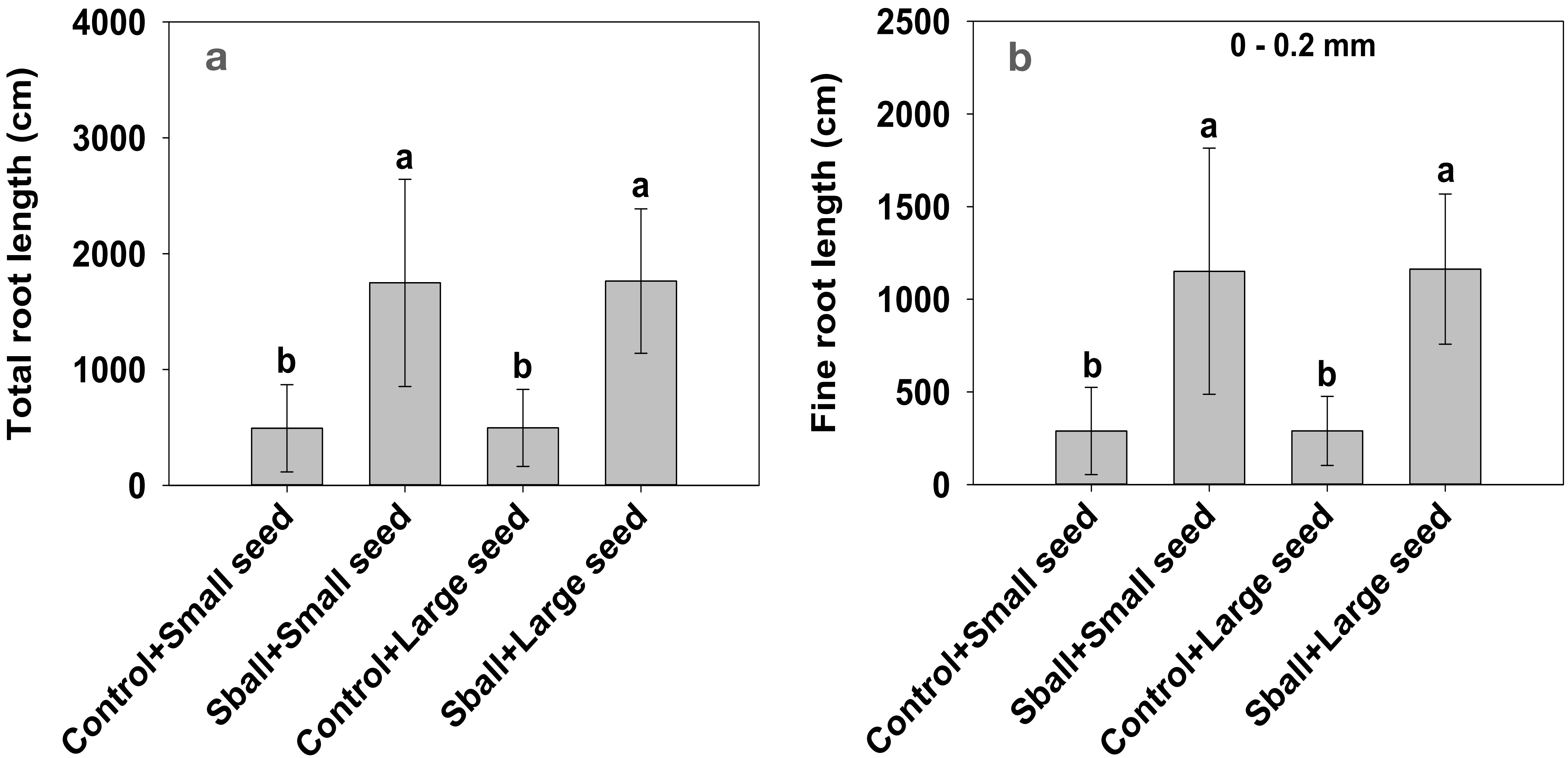
- ➢ Male farmers produce the highest yields due to more fertile and easier accessible land + work support by women
- ➢ Relative effect depends on the season
- ➢ Female farmers using seedballs outperform male farmers applying conventional sowing

Seasonal effects (panicle yield kg ha^{-1})

Year	Control	Wood ash	% Increase	Control	NPK	% Increase
2016	1846 (31)	2335 (31)	26	1935 (27)	2521 (27)	30
2017	1430 (539)	1760 (539)	23	1440 (457)	2052 (457)	43
2018	1142 (723)	1433 (723)	25	1170 (458)	1460 (458)	25
2019	1211 (365)	1410 (365)	16	1170 (230)	1309 (230)	12
2020	767 (267)	956 (267)	25	769 (122)	933 (122)	21
Mean	**1279**	**1579**	**23**	**1297**	**1655**	**28**

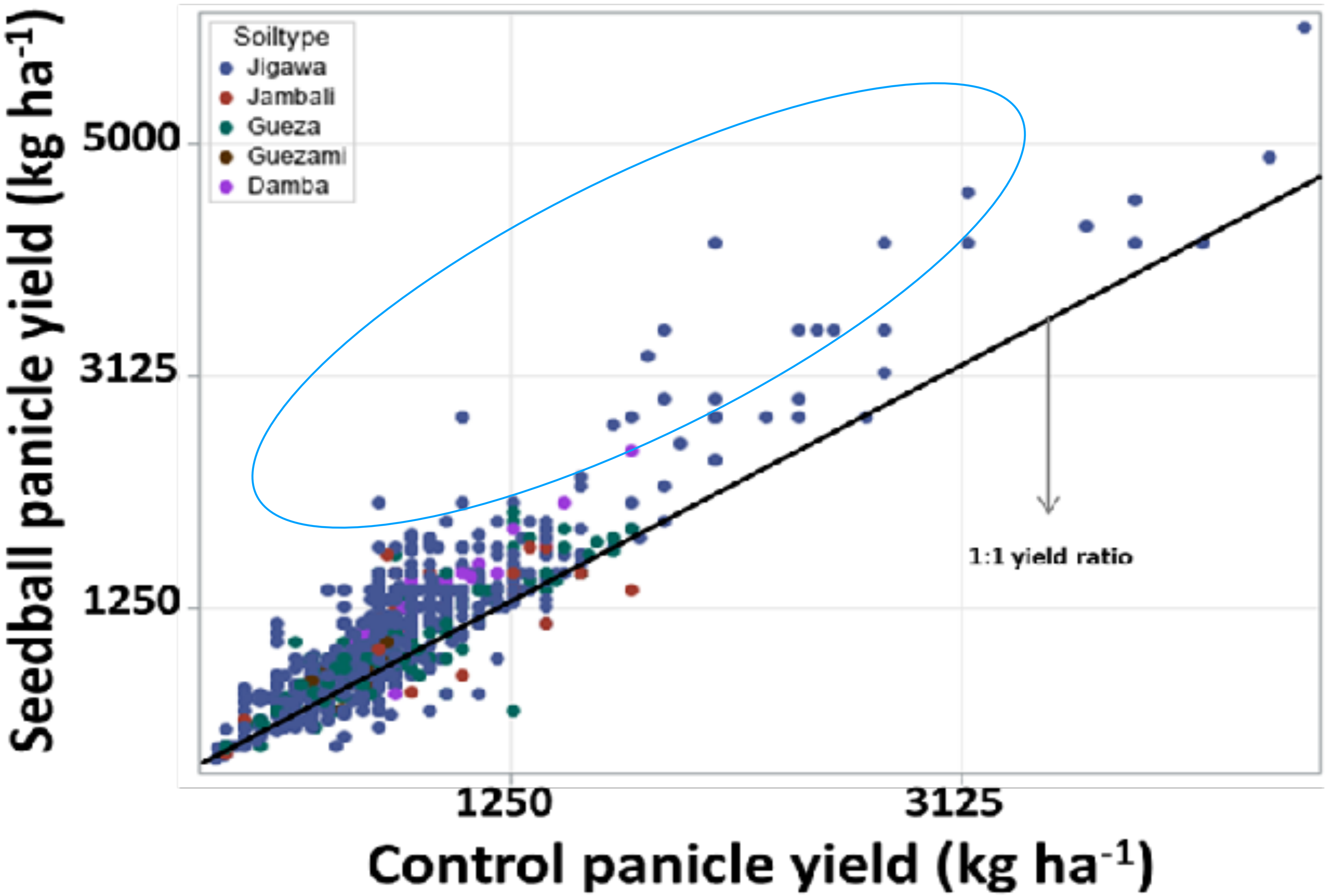
- **Annual effects on seedball type performance**
- **Wood ash more steady / NPK less effect with free management**

Seed size effect



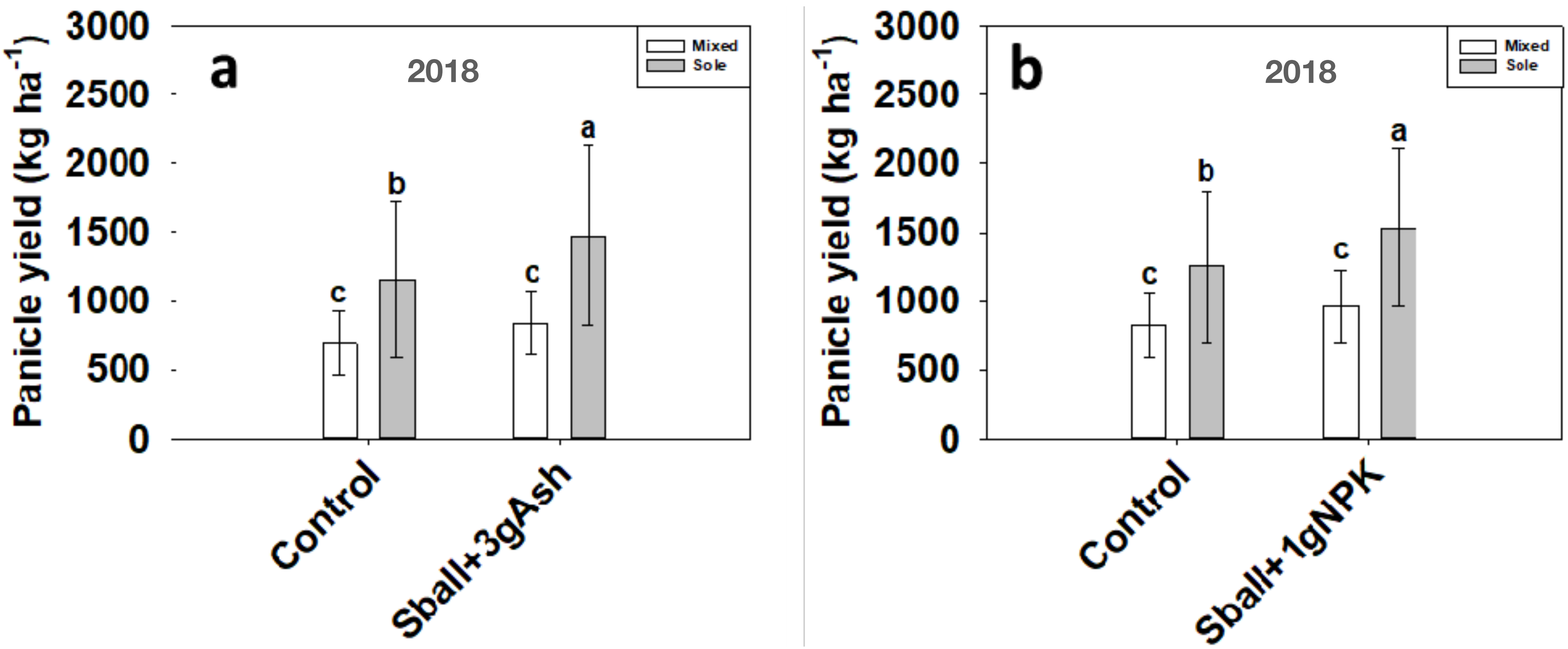
- ➢ Independent of seedsize, seedball technology enhances pearl millet seedling general performance in chemically infertile soils.
- ➢ Nutritionally enhanced pearl millet seedlings have relatively high vigour and the potential to better tolerate stress conditions (drought, nutrient deficiency) and subsequently increase panicle yield.

Local soil type effect



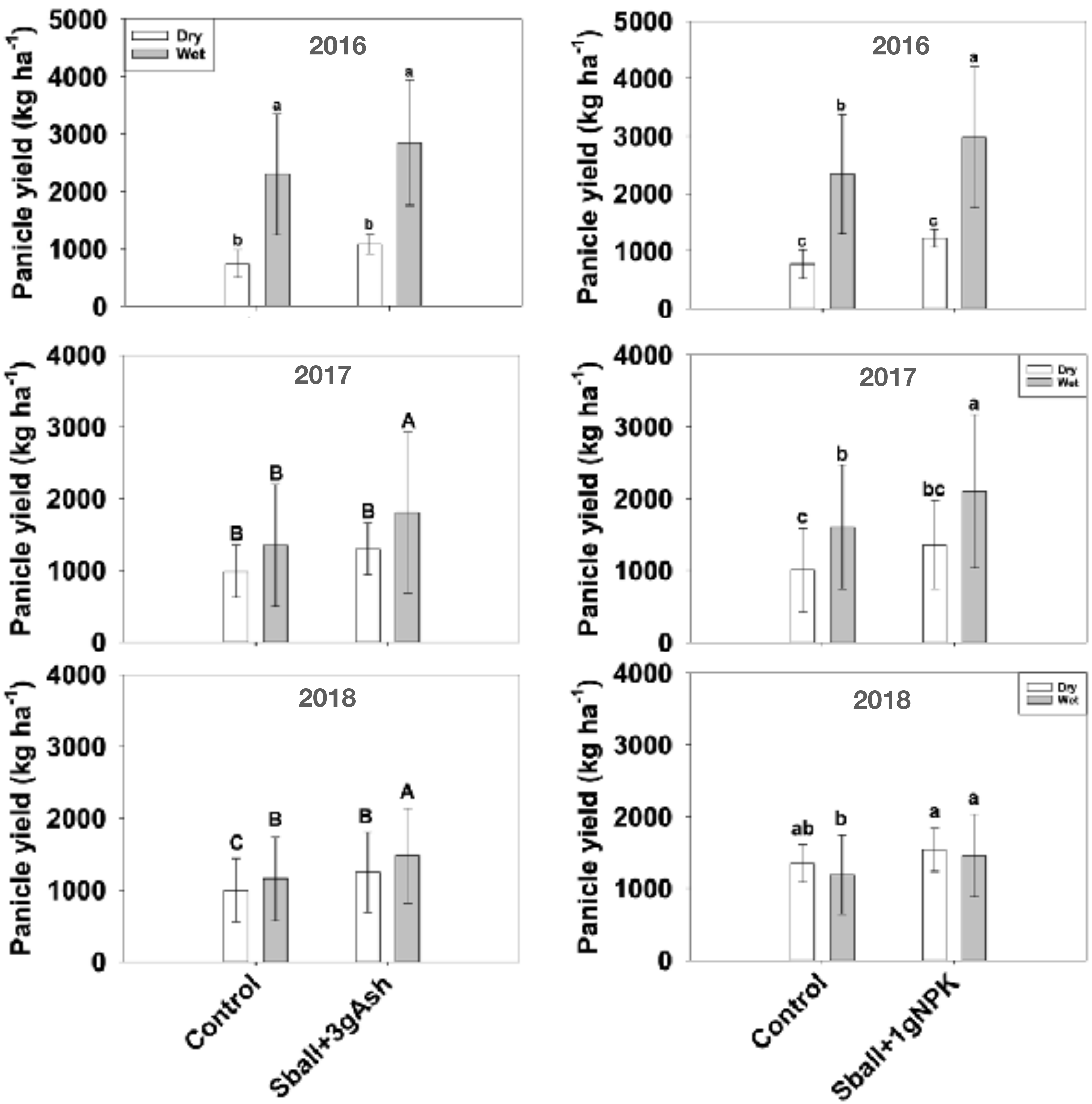
- ➢ **Large differences in expectable yield**
- ➢ **Jigawa with better response and highest yield expectation**

Management effect



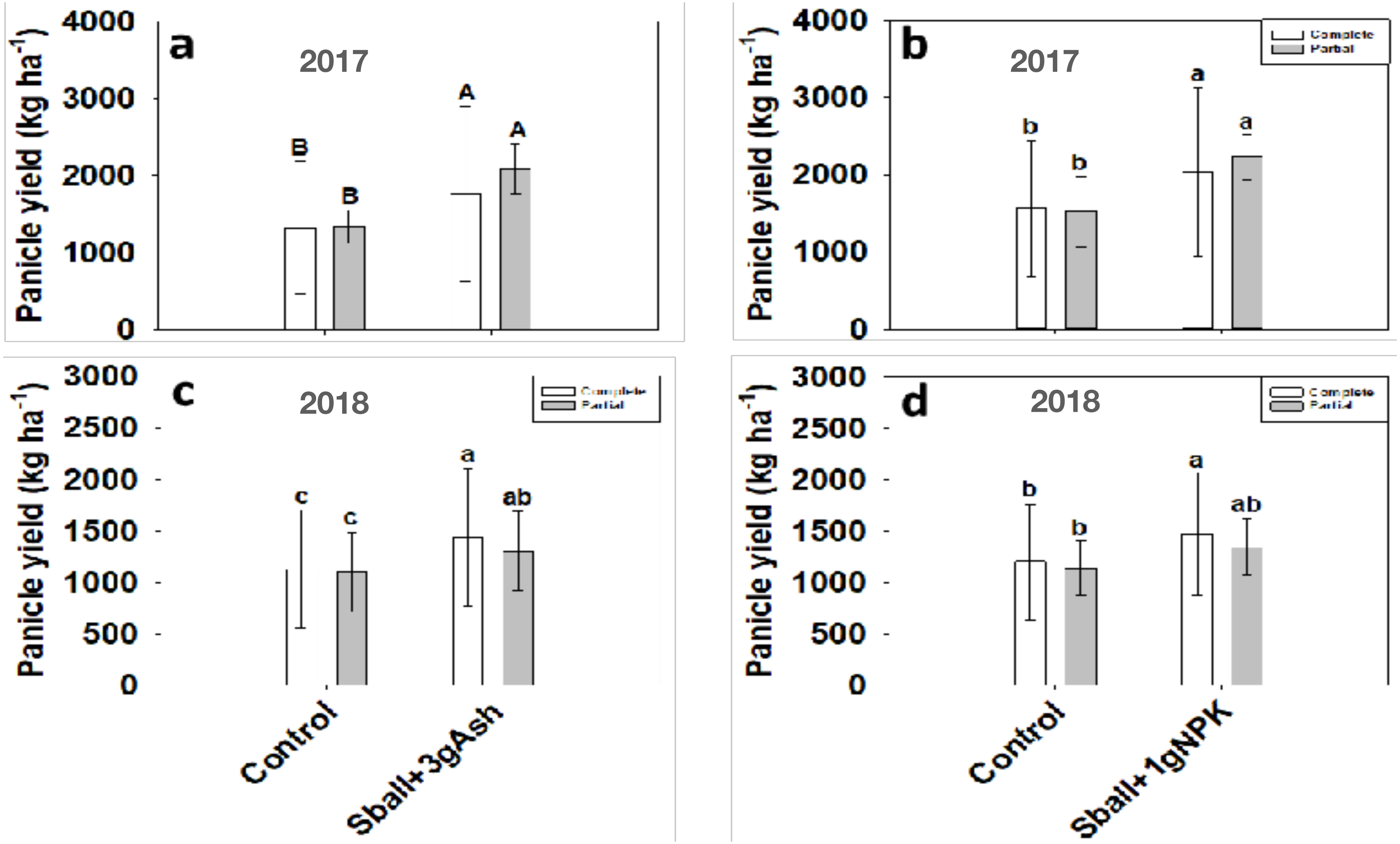
- ➢ **Sole cropping outperforms mixed cropping in general**
- ➢ **In mixed cropping effects exist, but without statistical significance**

Wet versus dry sowing annual effects (panicle yield kg ha^{-1})



- ➢ In 2016-17 significantly higher panicle yield with wet sowing. However, this ceases over time
- ➢ Non-significant effect of sow-time on seedball performance in 2019 and 2020
- ➢ Yields with seedball application under dry sowing were always higher. Thus given the other advantages, it still is an option for women farmer.

Weed management effect

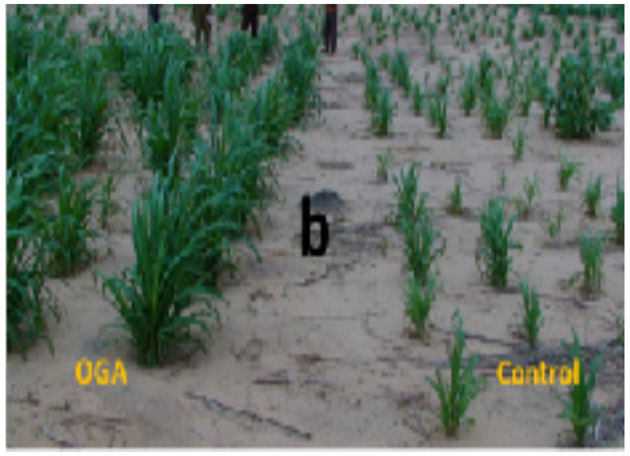


➢ **Partial weeding has varying seasonal effects depending on storm (i.e. erosion) events, but spares time in critical phases (i.e sowing)**

➢ **Given the always lower SD it is risk reducing**

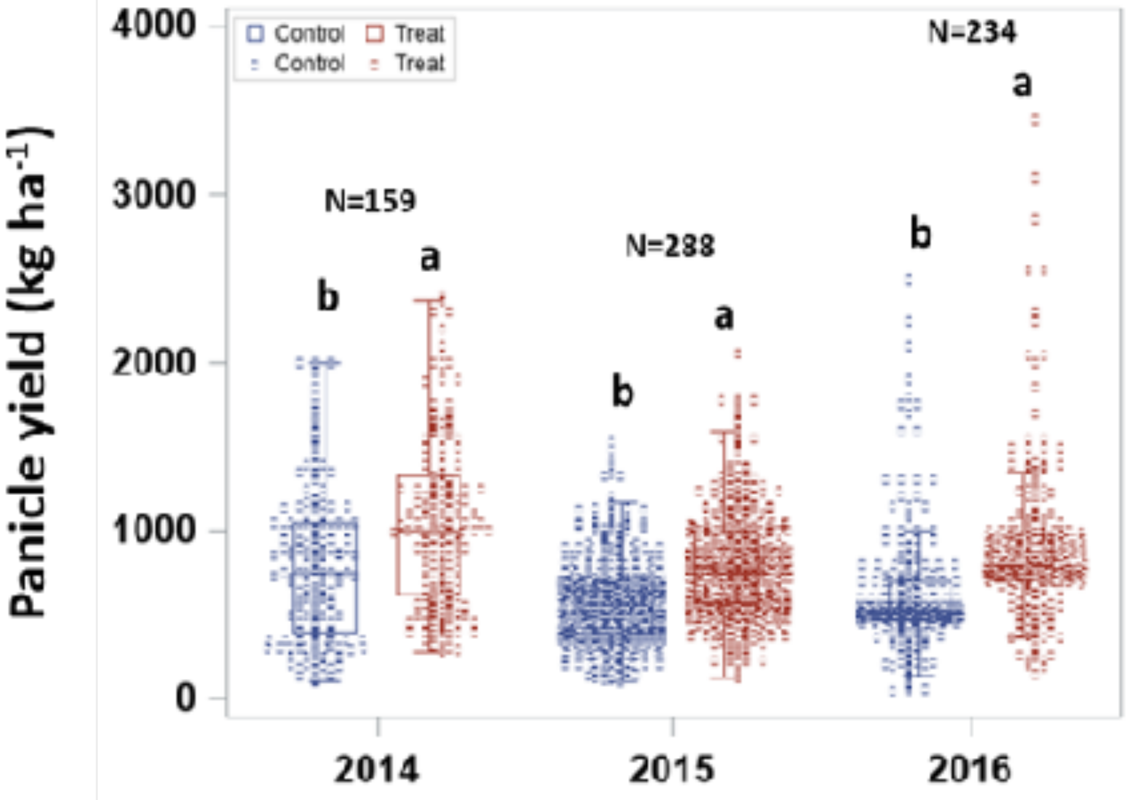
OGA (fermented human urine) effect on pearl millet yield in on-farm trials

Woman applying "OGA"



On-farm trial: OGA Vs conventional sowing

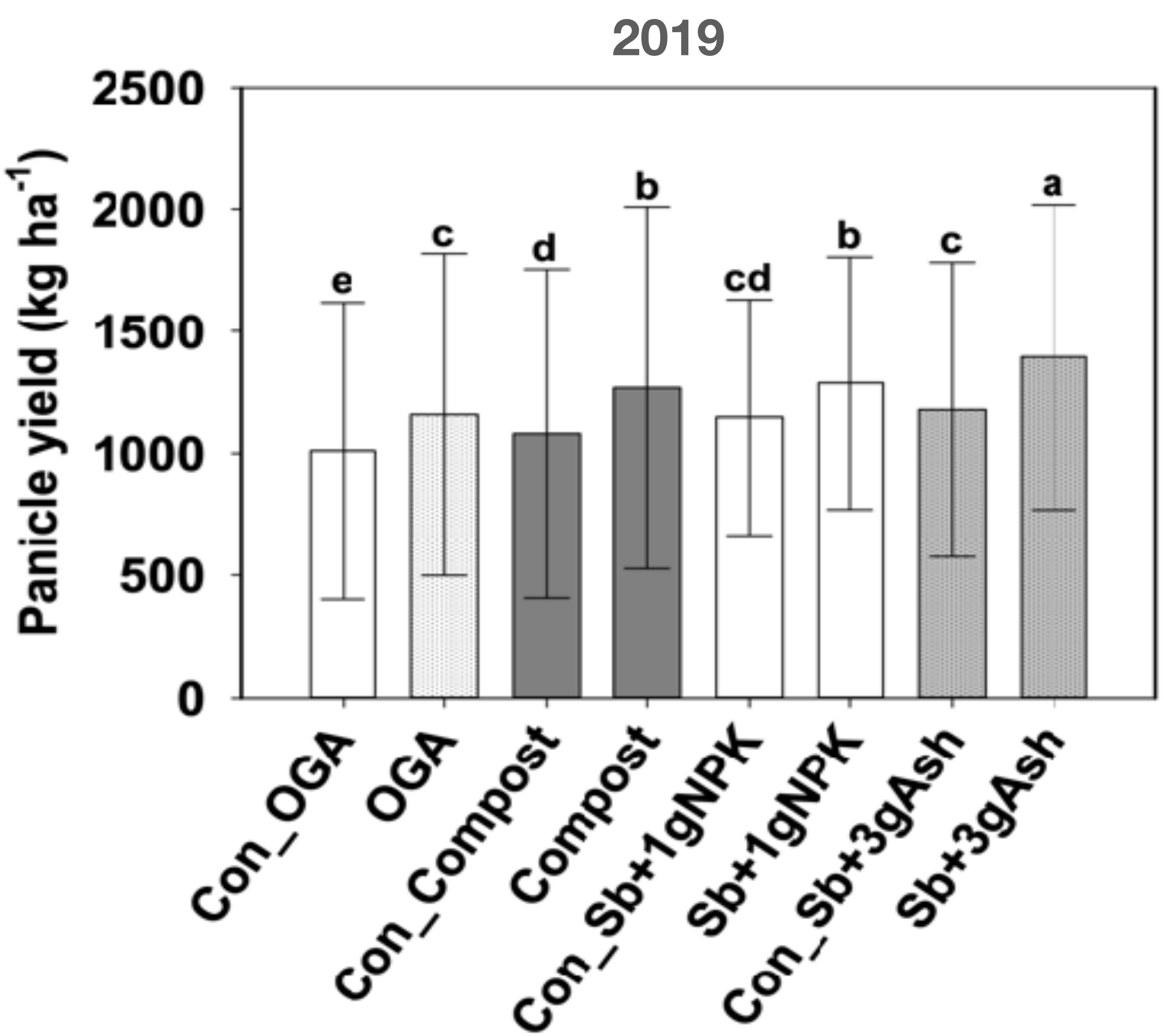
- **Storage time:** 2 – 3 months before field application
- **Application:** 14 and 35 DAS
- **Dosage:** 0.2 liter per pocket/0.4 liter when diluted with water at 1:1



Pearl millet panicle yield by treatment over all test sites in Niger Republic and the period 2014 – 2016.

OGA increases pearl millet panicle yield by about 30% and is thus a potential post-emergence N supplement to the seedball technology that delivers P.

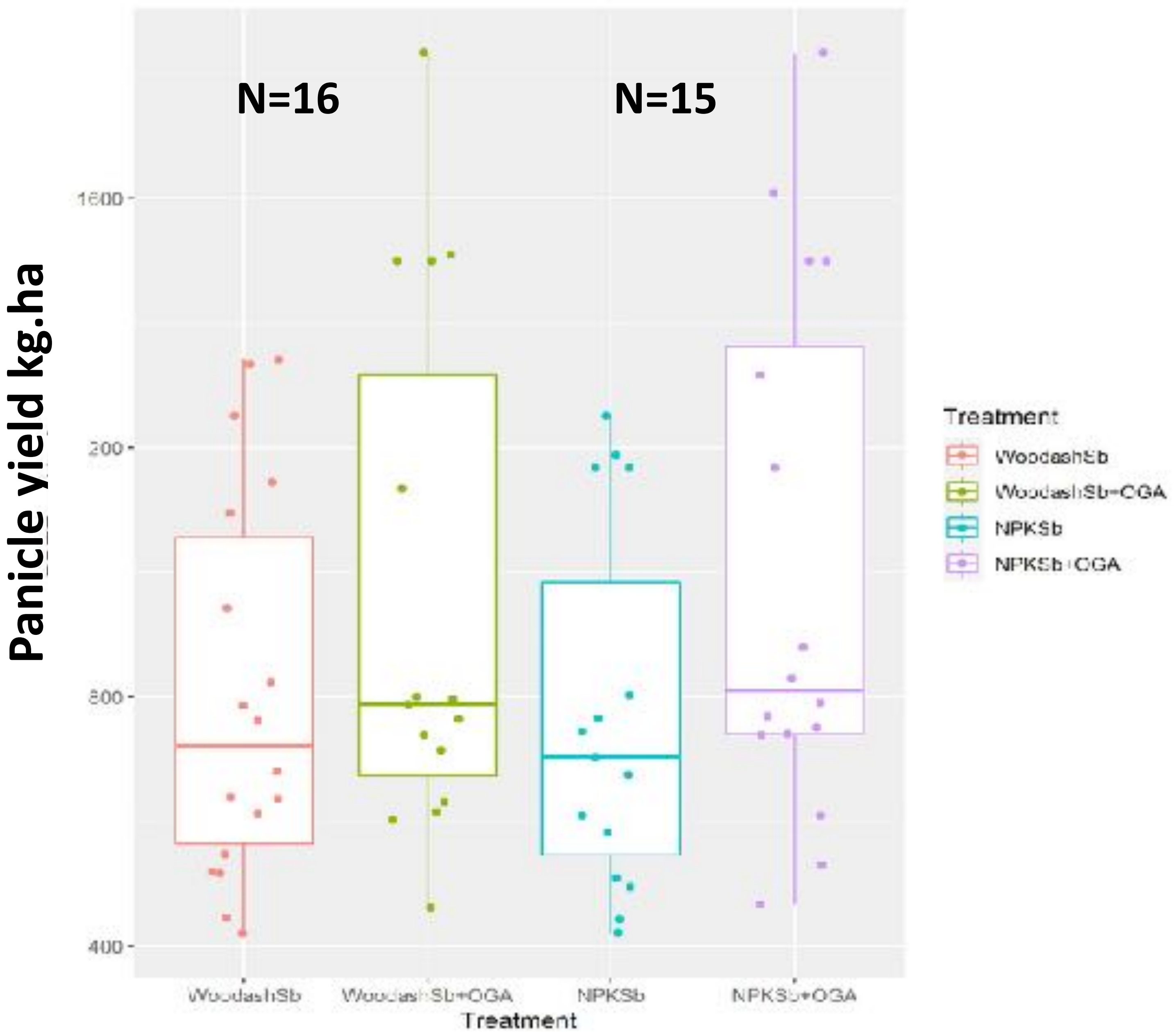
Seedballs versus other complex fertilizers



- Seedballs produce the highest overall yield, with less work and transport costs

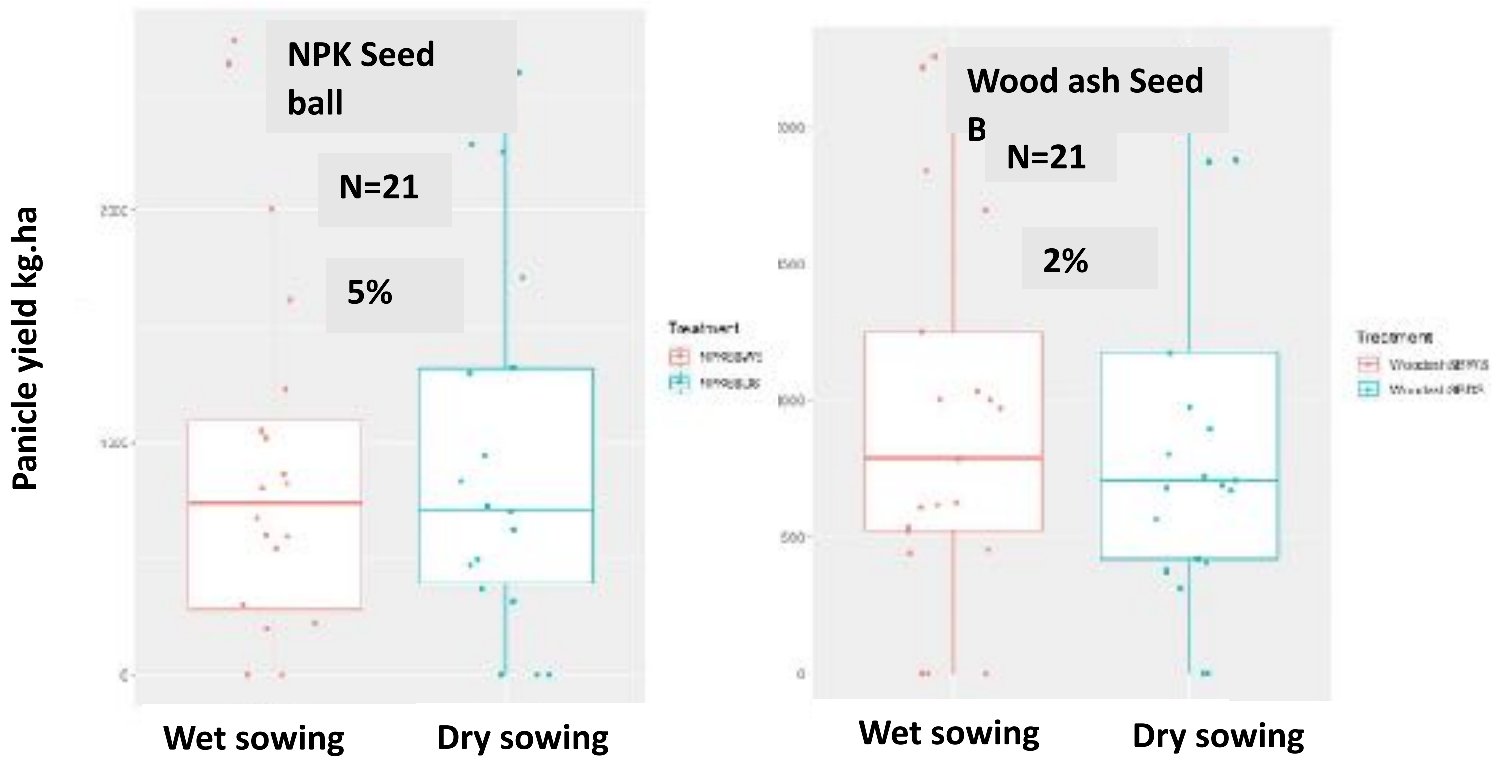
OGA as post emergence fertilizer in seedball trials 2021

Post emergence fertilizer (OGA) additionally increases pearl millet panicle yield in chemically infertile soils (e.g. women's fields)



Transferring the seedball to sorghum: Is it possible?

On-farm sorghum results



Three centimeter-sized seedballs made from a mixture of 80g sand, 50g loam, and either 4,5g wood ash or 1,5g NPK 15:15:15, and about 3g Sorghum seed


No statistically significant difference

Transferring the seedball to sorghum: Is it possible?

On-Farm results

Panicle yield effect (kg ha^{-1}, 2020-2021: Wood ash vs. NPK seedballs)

Year	Control	Wood Ash	% Increase	Control	NPK	% Increase
2020	783	1031	32	830	1144	38
2021	453	518	13	394	485	23
Mean	**618**	**775**	**22**	**612**	**815**	**30**

Annual effects!

Seedballs produce a similar potential sorghum yield increase as for pearl millet and are thus recommended

Which way towards mechanization?

Seedball hand production

Frame technology

Electric mechanisation

Solution still not found!

Simplicity of the technology

- ➢ It does not require any skill
- ➢ Seedballs are easily produced
- ➢ Respect of gender equality

Affordability

- ➢ Low investment (use of local materials without cost)
- ➢ Reduced seed wastage (put a small amount of seed just 2,5 grammes of millet seed for 100 balls = 100 hills)
- ➢ Avoidance of farmers eating their seeds before the season
- ➢ Why not transferring to other small-seed crops???



Socio-economic aspects

- Working hour reduction especially for women who have a busy schedule
- Respecting family reality as women will be able to sow dry and work after the rain to in the field of their husbands
- Reduced labor costs since the seedballs are produced during the off-season
- No social or religious barriers
- Applicable independent of social status
- Waiting for seedball machine to become reality

Yield and income generation

- ➢ Applying seedballs can increase yield up to 30%
- ➢ No negative effect on cropping system
- ➢ Participatory evaluation for decision making (wood ash, NPK, dry, and wet sowing, soil type)
- ➢ Discussion or debate on commercialising seedballs

Indexe de preference (%)=
[Nbre cartes vertes + ½ cartes jaunes) X 100 / nbre de participants]

Photo: Treatment vs. control evaluation

Recommendations

- ➢ Transfer to other crops like sorghum
- ➢ Using other additives (e.g. fungicides)
- ➢ Seedball machine for higher output, larger are application
- ➢ Spreading the technology
- ➢ Expand the synergy to other projects and program partners
- ➢ Enhance post harvest fertilization (OGA, RNA, ompost, …….)
- ➢ Where no loam as binding agent available: substitution by other materials like compost….

Socio-economic survey on the effect of on-farm training in Maradi region

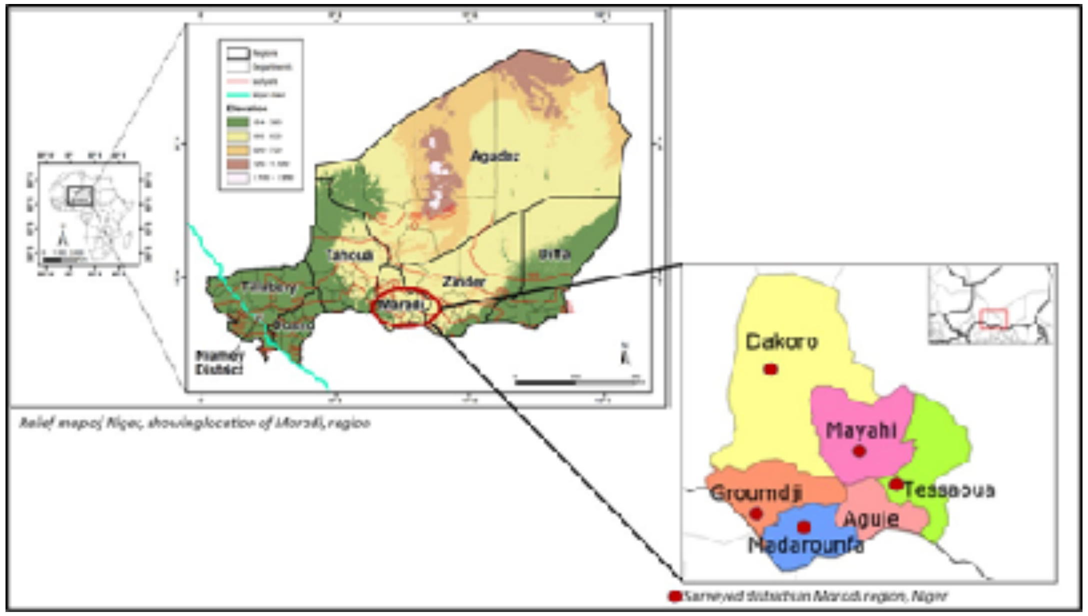
Objective:

To systematically evaluate farmers' adoption decision processes and perception of on-farm testing e.g.:

- ✓ yield returns
- ✓ labour cost,
- ✓ financial cost,
- ✓ labour burden for men vs. women

A standardized questionnaire was designed, and a survey carried out reaching to:

481 farmers in 18 villages, across 8 communities, in 5 districts



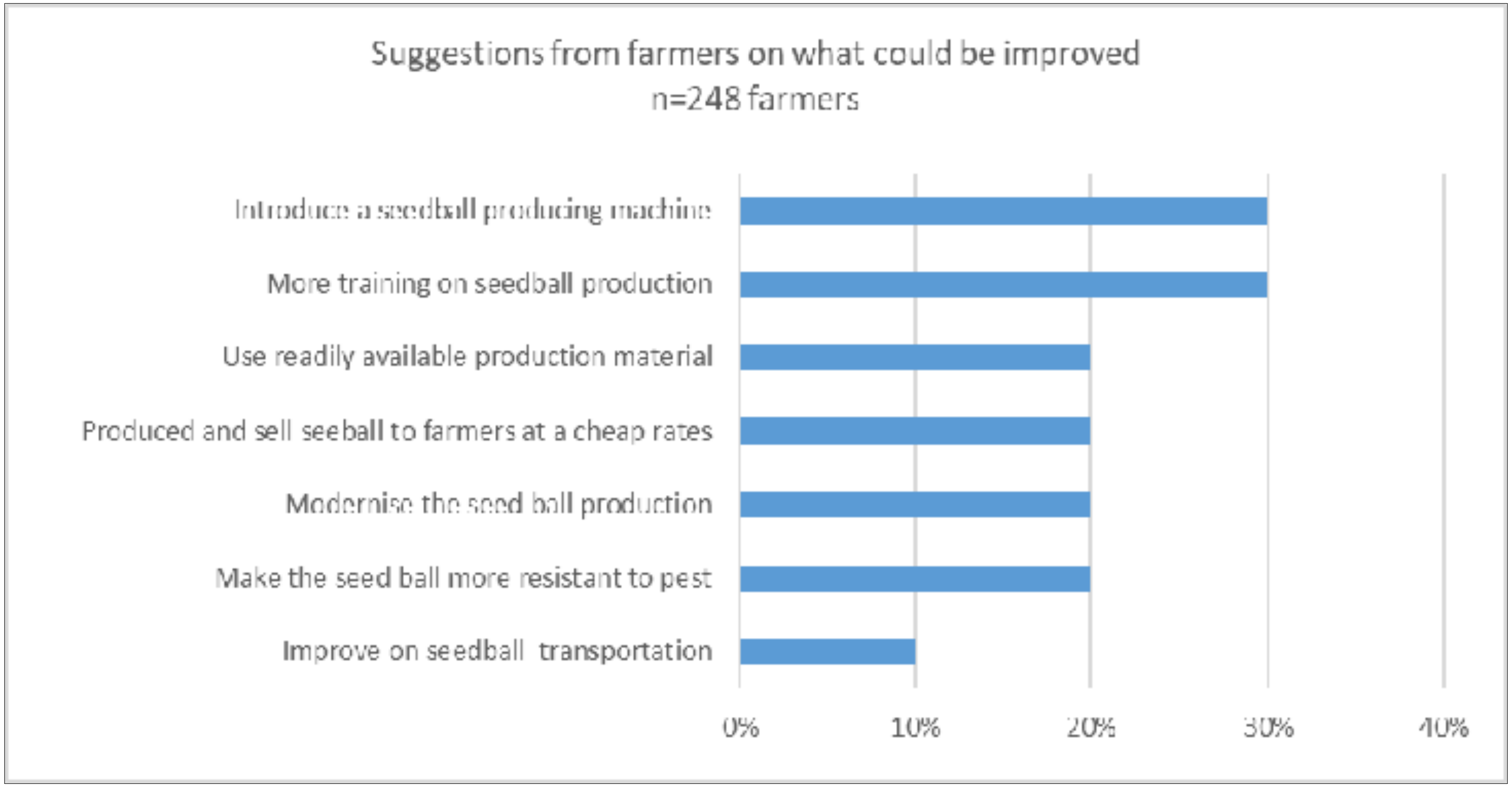
Survey’s key findings 1

Surveyed districts across Maradi	% of farmers according to the number of training sessions received							
	1	2	3	4	5	6	7	10
Dakoro	100%	0%	0%	0%	0%	0%	0%	0%
Groumdji	33%	45%	14%	8%	0%	0%	0%	0%
Madarounfa	39%	17%	19%	11%	14%	0%	0%	0%
Mayahi	14%	11%	27%	24%	13%	8%	2%	1%
Tessaoua	22%	31%	33%	9%	4%	0%	0%	0%
Grand Total	32%	24%	21%	12%	8%	2	1%	0%

Surveyed districts across Maradi	% of farmers according to the number of training sessions necessary to master the technology									
	1	2	3	4	5	6	7	8	9	10
Dakoro	0%	20%	80%	0%	0%	0%	0%	0%	0%	0%
Groumdji	2%	24%	39%	19%	13%	2%	3%	0%	0%	0%
Madarounfa	11%	31%	30%	24%	3%	0%	0%	0%	0%	0%
Mayahi	1%	19%	27%	15%	3%	14%	2%	12%	5%	3%
Tessaoua	8%	34%	15%	30%	13%	0%	0%	0%	0%	0%
Grand Total	5%	25%	32%	19%	6%	5%	1%	4%	2%	1%

- ✓ On-farm trainings created space for general awareness and a broader understanding of the purpose and the functioning of the seedball technology.
- ✓ This is reflected in the positive perception of farmers towards the technology, e.g., on yield returns, labour, financial cost, amongst others.
- ✓ Most farmers seem to favour 2-3 training sessions for proper understanding of the technology
- ✓ ➔we conclude that levels of technology comprehension differ across districts,
- ✓ **hence the need for more targeted future trainings.**

Survey's key findings 2



- From the overall sample (481 farmers):
  - ✓ 248 of farmers (approx. 60%) moved on using the technology in own farms (**early adopters**),
  - ✓ 206 farmers (approx. 40%) maintained the same trial plots, (**skeptical adopters**).
  - ✓ **Skeptical adopters might likely make an adoption decision once clear gains start emerging from the early adopter farmers.**

- Farmer suggestions:
  - ✓ possibility for producing and selling seedballs
  - ✓ engaging the local mass media (e.g., use of TV) in seedball promotion

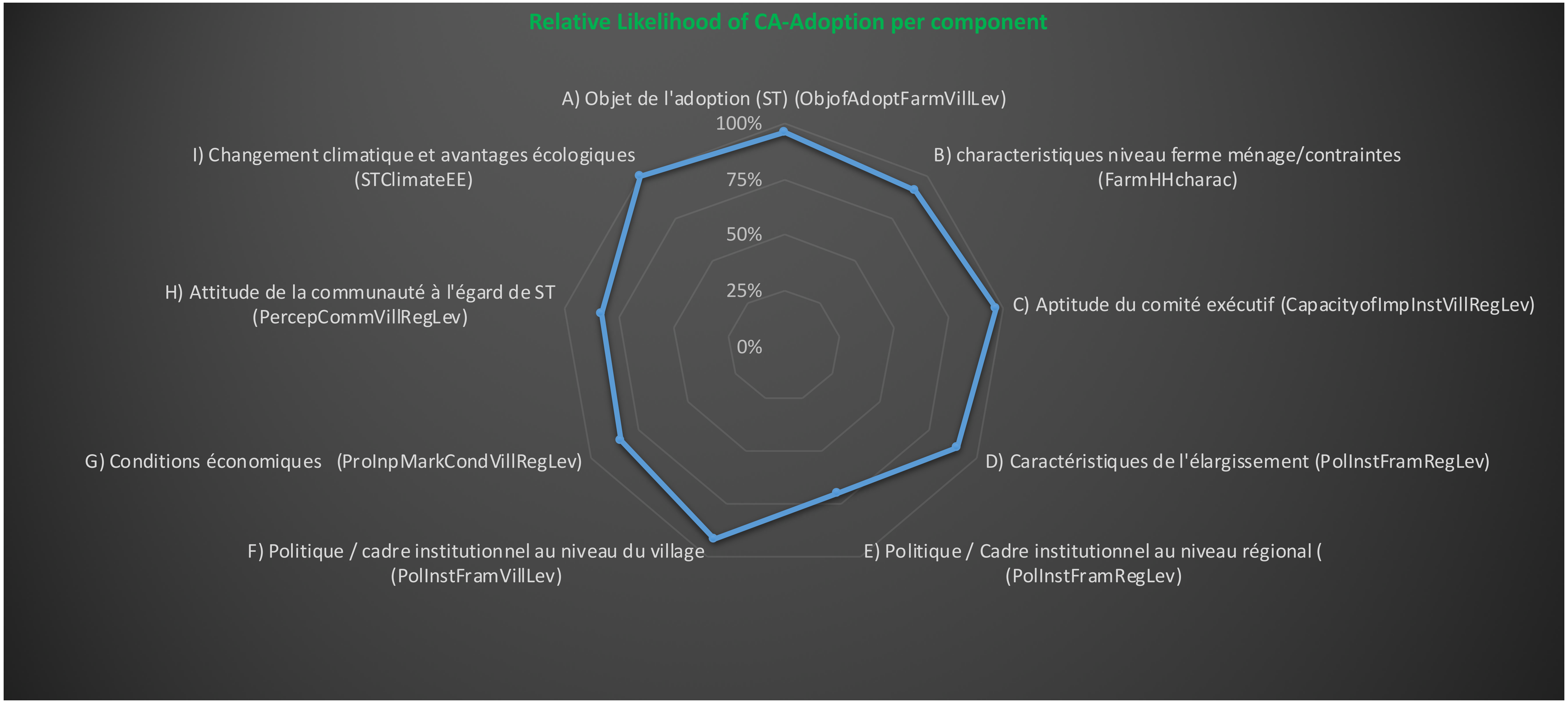
Study on fostering and hindering factors for adoption

Methodology:

- ✓ Adaptation of the QAToCA tool for qualitative assessment of the seedball technology (QATO-ST) based on,
  - a 1day multi-Actor workshop,
  - hosting over 50 participants,
  - drawn from the whole Maradi region

QUATO-ST main findings 1

- Overall adoption potential = **89%**
- Maradi south

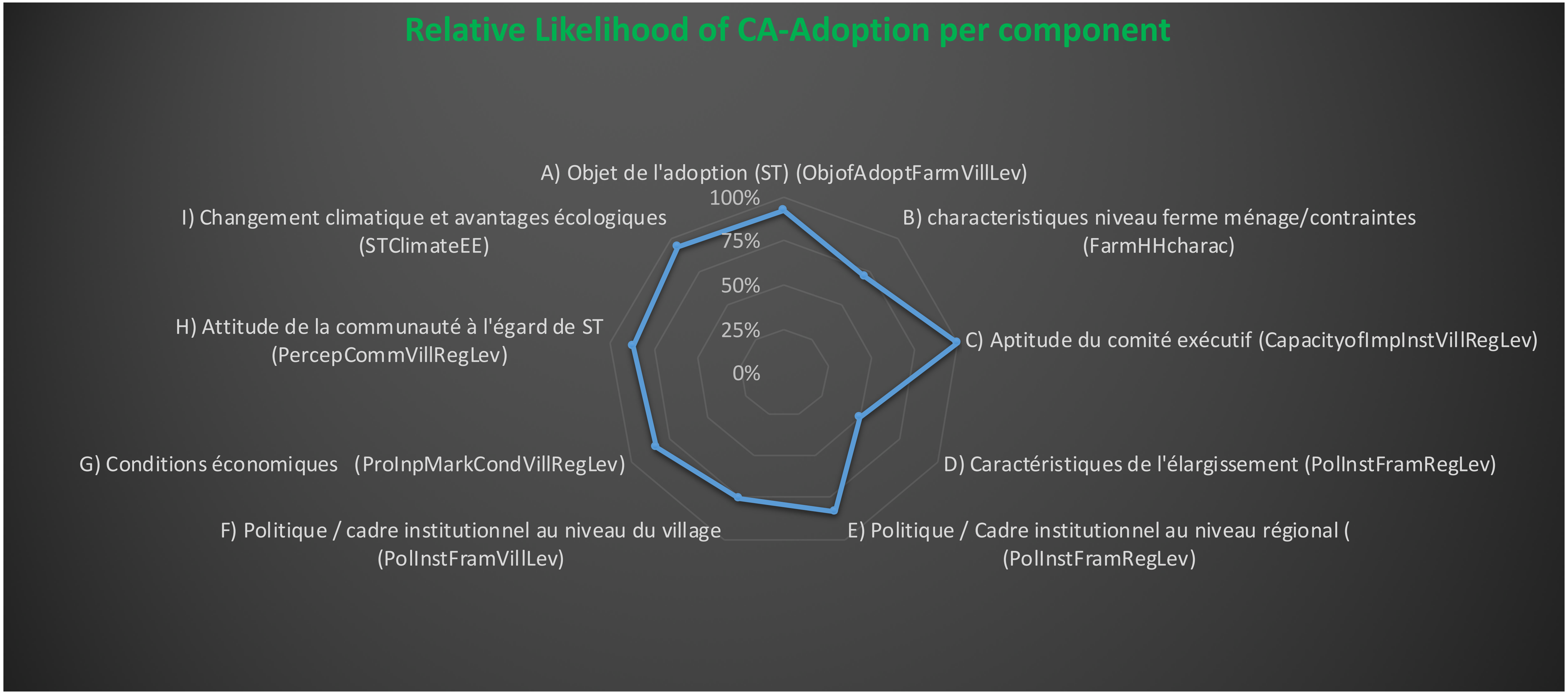


- **Specific hindering factors to adoption**

Farmers strongly disagree (< 1), disagree (2) with following statements for the region, hence they play a hindering role for adoption potential		
B5	Household members have access to technical inputs for ST production (e.g. machinery)	2
E1	There is no social, political, or ethnic tension in the ST project region	0
H1	Project activities do not interfere with economic activities of non-adopters	2

QUATO-ST main findings 2

- Overall adoption potential = **82%**
- Maradi north



- **Specific hindering factors to adoption**

Farmers strongly disagree (1), disagree (2) with following statements for the region, hence they play a hindering role for adoption potential		
ID	Statement	
B1	Average farmers own sufficient financial resources to cover costs of ST	2
B2	Majority of farmers have knowledge of ST or traditional/indigenous knowledge like ST	2
B5	Household members have access to technical inputs for ST production (e.g., machinery)	2
D2	There is a clear and realistic time frame for dissemination including an exit strategy	2
F3	The local rules/customs do not hinder the introduction of ST practice	1

Economic evaluation of seedball impact

Objectives

- Use econometric modelling to assess seedball impact on millet yield
  - Based on agronomic and farm level data
  - Matching household level information using a cohort approach
- Use cost-benefit analysis to quantify the profit accrued from yield premium

Methodology

- 03 approaches to assess a robust and rigorous impact
  - Simple regression model (1) of yield on seedball controlling for sowing, weeding, inputs and village characteristics.
  - Used pseudo-panel approach to match LSMS HH information to sampled SMIL HH based on longitude and latitude.
  - Simple regression model (2) = model (1) + HH characteristics
  - Model (3) = Model (2) assuming farmer selection bias
- Use cost-benefit analysis: based on inputs elasticities and seedball impact magnitude.

Results

Seedball types	Marginal Impacts		
	OLS 1	OLS 2	ETE
NPK	19.06%	19.37%	18.25%
ASH	21.44%	21.86%	19.94%

Findings and Comments

- NPK and ASH seedball positively and significantly increase millet yield
- Economic and agronomic assessments led to approx. the same impact of seedball
- Need to scale up the experiment to non-Fuma Gaskia farmers
- Seedball stands as promising answer to climate change in drylands regions

Perspectives on Financial Analysis

1. We plan to simulate the potential yield gain from a regional and national adoption of seedball
2. We also plan to estimate the household level financial return following seedball adoption

Does the seedball technology work?	Yes It increases the yield and reduces risk on investment
Where is it best suited?	- On sandy, chemically infertile soils - Particularly yield differentiating fS, OM and low Al_{ex} - In a subsistence environment (yield <1t ha-1) - Usually on women fields away from the settlement - For dry sowing - In combination with post-emergence fertilisation (OGA)
Important	- Do not use NH4+-containing fertilizer in the formula - Strictly stick to the maximum fertilizer input - Do sowing at the right depth (3cm) - Conduct several trainings

Lessons learned from the project

- Technology development needs a long haul approach
- Potential obstacles to adoption and adaptation should be researched beforehand
- It is worth building on farmer experience
- On-station and on-farm evaluation should run in parallel
- Large N-trials give better insights into suitability of the technology
- Freedom of management in farmers fields should increase over time
- Socio-economic evaluation should be intrinsic part of the project

- As researcher I do not want to be responsible for the dissemination of the technology
- Long-term funding is a key to success!

We are grateful

to the whole SMIL team for magnificent support and engagement

to the whole SMIL research group for continuous inspiration

to USAID, Anton & Petra Ehrmann Stiftung, McKnight foundation

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to all collaborators and farmers for their great ability to adapt, to help

and to deal with external shocks, including me.

Let the world become a better one, without war, with active peace, without hunger and mutual support and understanding!

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