

A Multiple interventions Approach to Increasing Technology Adoption(MITA): Evidence from Mexico

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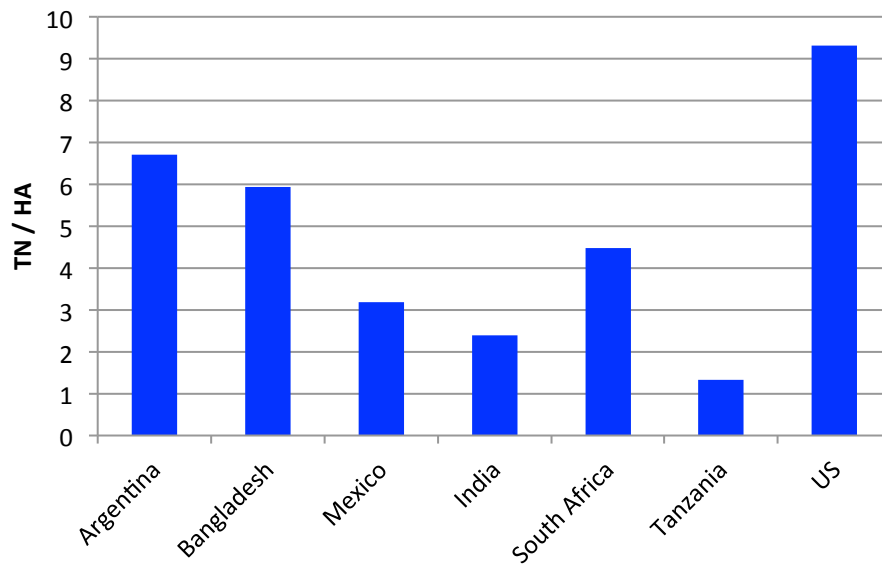
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Low Productivity

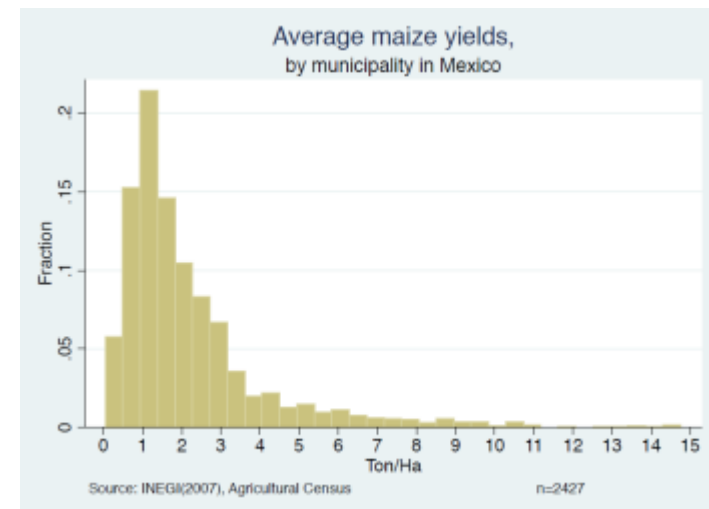
**Average Maize Productivity
2008-2012**



* Includes irrigated and non irrigated plots

Source: FAO STATISTICS <http://faostat3.fao.org/faostat-gateway/go/to/home/E>

Although yields have been improving in Mexico since the 80's, they are as low as those in much poorer countries, particularly among small land holders.



Scope of Work

- There is some debate about whether observed variation in yields reflects:
 - Essential heterogeneity (e.g. Suri (2006) Barrett, Marenya and Barrett (2009))
 - Constraints (e.g. Information, access to credit, etc)
- MITA aims to understand both the nature of the essential heterogeneity (measurement) and constraints (interventions).
- Detailed measurement of land quality and inputs
- Interventions:
 - Improved information
 - Land (Soil Analysis and recommendations)
 - Best Practices (Frequent AEW visits)
 - Relaxing credit constraints

Productivity determinants

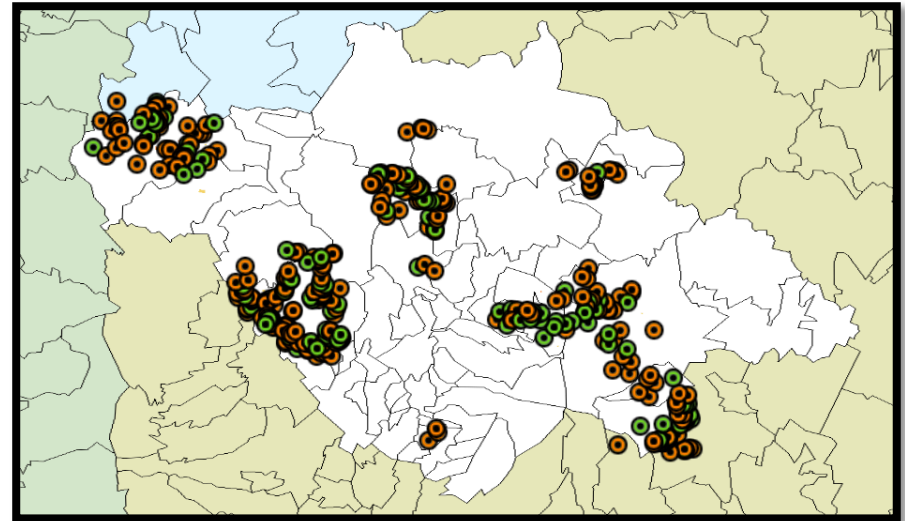
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Farmer's characteristics: age experience, gender, education, monthly income	x					x	x
AEW		x					x
Plot non-observable characteristics: SA results			x		x	x	x
Plot observable characteristics: soil type, slope , past productivity				x	x	x	x
R-squared	0.066	0.098	0.129	0.238	0.314	0.3696	0.375

Theory

- Consider a production function with 2 sources of uncertainty:
 - (unobserved) quality of the land
 - weather shocks (rains and frost)
- An informative signal of any source should decrease overall uncertainty and increase overall investment

Design & Sample

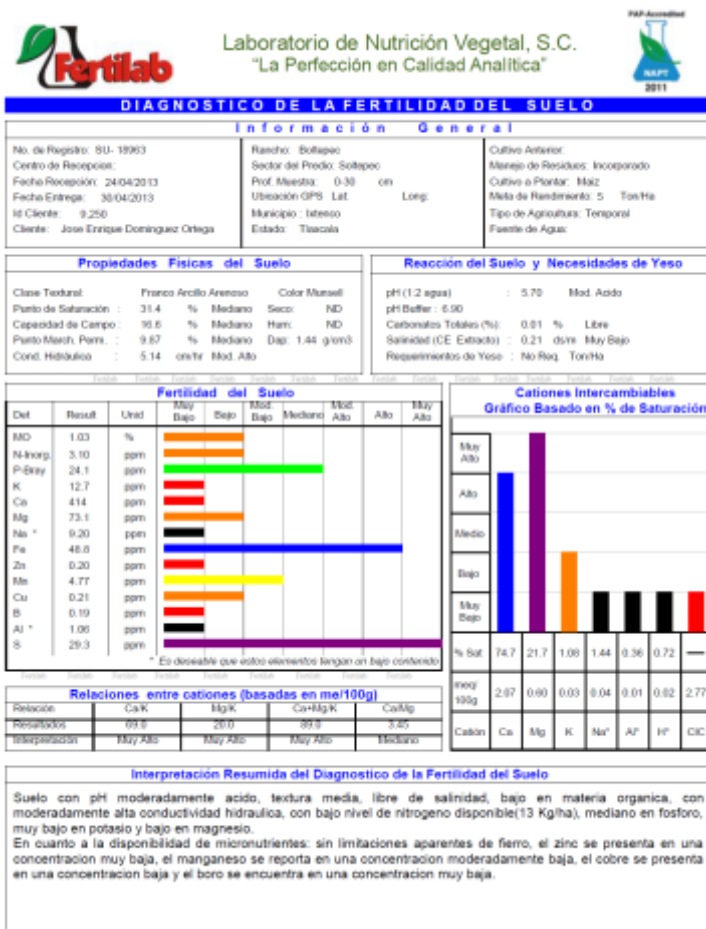
- In 2013 we followed 430 farmers in Tlaxcala.
- 155 farmers were part of the control, while 275 were equally divided into 3 treatments
 - **Free Soil Analysis and recommendations**
 - **Free Soil Analysis and recommendations + AEW + Free Foliar Fertilizers**
 - **Free Soil Analysis and recommendations + AEW + Costly Foliar Fertilizers**



Soil Analysis Intervention

Soil Analysis and Recommendations

- Determinants of soil characteristics: PH, electrical conductivity, , type of soil, saturation point, cationic interchange
- Nutrients: OM, N, P, K, Ca, Mg, Na, Fe, Zn, Mn, Cu, B, S



Dosis de Mejoradores y de Fertilizantes, recomendada por Fertiliab, de acuerdo a los resultados del análisis del suelo

Registro Fertiliab	Maíz Para	Cal t/ha	Yeso t/ha	N	P2O5	K2O	Mg	Fe	Zn	Mn	Cu	B
SU-18963	5 t/ha	0.0	0.0	96	20	60	3.9	0.0	4.0	1.0	1.5	0.7

Epoca de fertilización	Sulfato amonio	Urea	MAP 11-52-00	Cloruro Potasio	Sulfato Magnesio	Sulfato Hierro	Sulfato Zinc	Sulfato Manganeso	Sulfato Cobre	Sulfato Granubor	Cantidad Fertilizante
Siembrá	0	60	38	100	39	0	11	3	5	5	262
1ª Fert. (30 días)		140		0	0						140
2ª Fert. 50 días		0		0							0
Total	0	200	38	100	39	0	11	3	5	5	402

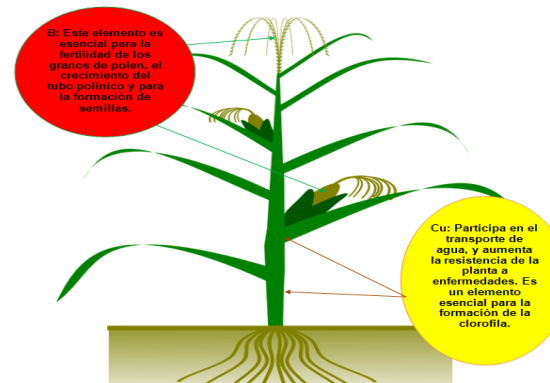
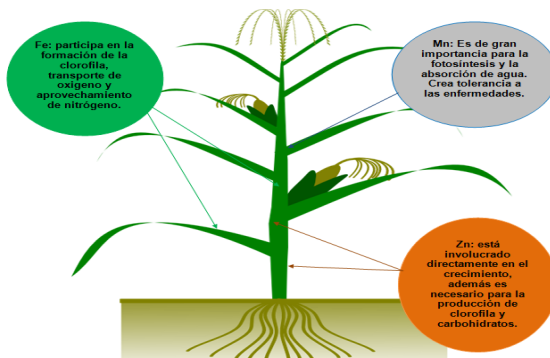
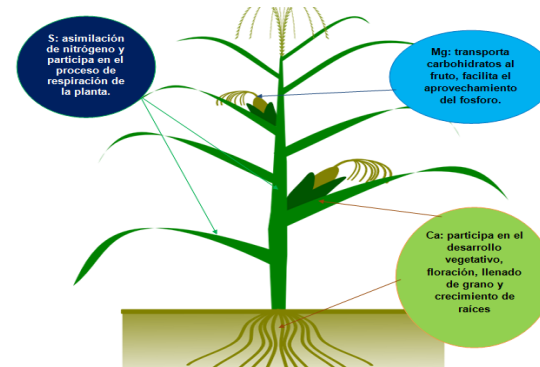
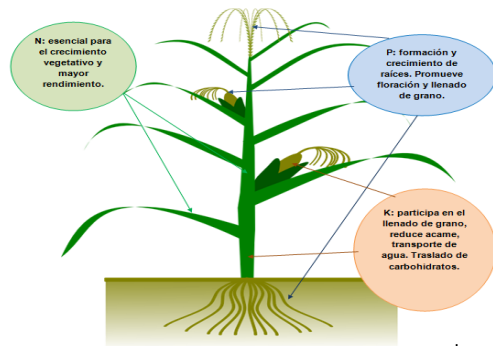
Recomendaciones sobre el uso de dosis, fuentes, épocas de aplicación.

1. La incorporación de cal agrícola permite incrementar el pH de los suelos ácidos, para maximizar el aprovechamiento de nutrientes y reducir daños por aluminio. Este mejorador solo se aplica cuando el pH del suelo es menor de 6.5 y la dosis se basa en la determinación del pH buffer. Se debe de usar siempre cal dolomitada, para suministrar Calcio y Magnesio al suelo.
2. El Yeso agrícola, solo se aplica cuando existen altos niveles de sodio, y el propósito es mejorar las propiedades físicas del suelo. Cuando es requerido se debe aplicar antes del rastreo para que quede bien incorporado en el terreno y surta su mejor efecto. Si la dosis recomendada de yeso, rebasa las 5 ton/ha, es necesario dividir la aplicación de yeso en dos eventos, uno para un cultivo y otro para el siguiente ciclo.
3. Cuando se va a incorporar rastreo después de la cosecha, se recomienda aplicar sulfato de amonio, de preferencia asperjado al residuo, para que al ser incorporado al suelo se facilite su descomposición. Se recomienda aplicar 25 kg de sulfato de amonio por cada tonelada de rastreo incorporada. Una dosis de 120 kg de Sulfato de Amonio/ha, es un promedio razonable.
4. En cereales de invierno la fertilización nitrogenada se debe dividir en dos eventos, el 50% a la siembra y el resto en la segunda fertilización antes del riego de auxilio. Mientras que en maíz y sorgo se debe aplicar el 30% del nitrógeno a la siembra y el resto de preferencia en dos eventos más, siempre que sea posible.
5. Las fuentes usuales de nitrógeno son la urea y el sulfato de amonio granulados. En pHs alcalinos se recomienda más el uso de sulfato de amonio, siempre y cuando no se apliquen más de 500 kg de fertilizante al momento de la siembra. En caso necesario se puede combinar el uso de sulfato de amonio con urea, dado que esta última tiene mayor % de nitrógeno, y requiere de una cantidad menor.
6. El fósforo se debe de aplicar al momento de sembrar o antes de esta. La fuente de fósforo que aquí se recomienda es MAP granulado (11-52-0), pero pueden también usarse otras fuentes como 1) Fosfato Bifosfórico o DAP (18-46-0), o 2) Superfosfato de calcio triple (0-46-0). Además, existen otras fuentes en el mercado que pueden también dar buenos resultados. Es importante que en caso de cambiar la fuente, se tome en cuenta la cantidad requerida de cada nutriente que se menciona en el cuadro de arriba, para que no se altere la dosis recomendada de los nutrientes que se detectaron en el análisis como deficientes en el suelo.
7. La fuente de potasio indicada para los cultivos extensivos es Cloruro de Potasio granulado, por su menor costo. En el caso de hortalizas se recomienda usar nitrato o sulfato de potasio. Se recomienda aplicar la mitad del potasio en la siembra y la otra mitad en la segunda fertilización.
8. Cuando el nivel de Magnesio en el suelo es bajo, se recomienda la aplicación de Magnesio y cuyas fuentes disponibles en el mercado son: Sulfato doble de potasio y magnesio [E-Mg] y Sulfato de magnesio granulado.
9. El uso de micronutrientes es muy importante, los dos micronutrientes que recurrentemente reportan niveles bajos en el suelo son el Zinc y el Boro. Cuyas fuentes pueden ser: Sulfato de Zinc granulado, Granubor o bien mezclas de micronutrientes ricas en Boro y Zinc. También puede requerirse aplicaciones de manganeso y cobre, cuya fuente puede ser el sulfato o bien mezclas de micronutrientes que se comercializan en el mercado.
10. Es importante complementar la aplicación de micronutrientes al suelo con aplicaciones foliares de aquellos nutrientes que se deficiencia como deficientes en el análisis. Esto es particularmente importante en suelos muy alcalinos, donde el uso de la fertilización foliar suele ser más eficiente. Cuando se usan fertilizantes foliares se recomienda usar en la mezcla iones hídricos y físicos, junto con otros macronutrientes.

Soil Analysis Intervention

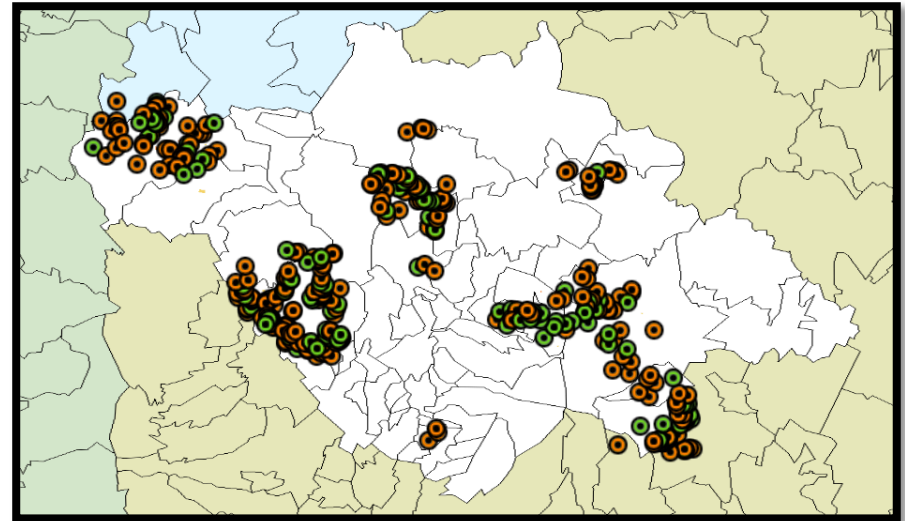
Farmers Trainings (45 minutes to 1 hour and a half)

- How to understand the soil analysis
- Importance of each nutrient during each stage of crop development
- Importance of following the recommendations to follow increase productivity



Sample & Design

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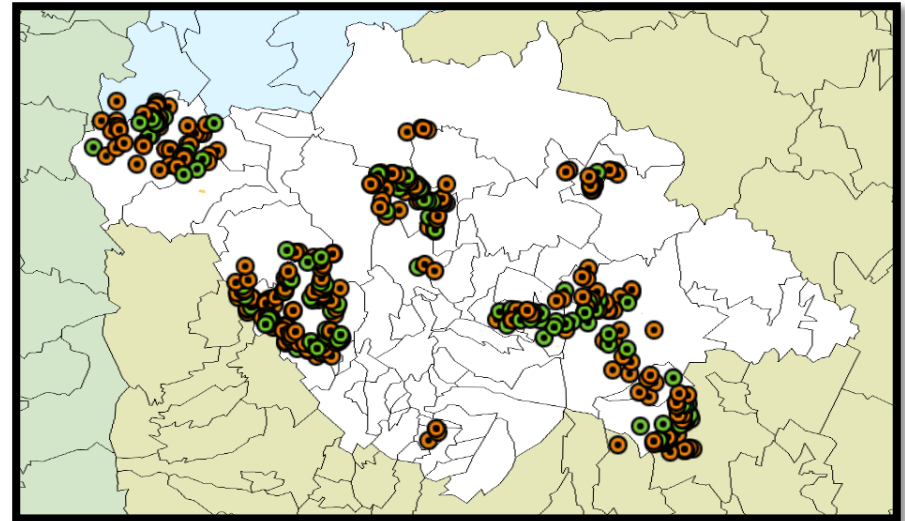
Agricultural Extension Workers Intervention

- 7 Agricultural Engineers specialized in Crop Sciences from Chapingo and Tlaxcala University
- Trained in CIMMYT's Conservation Agricultural Protocols to perform 6 visits during the spring/summer cycle
- Equipped with digital tablets programmed with CIMMYT AEWs Maize Surveys for Mexico's soil. The tablets are also equipped with GPS locators and cameras to monitor the crop development and that the visits were in fact realized.

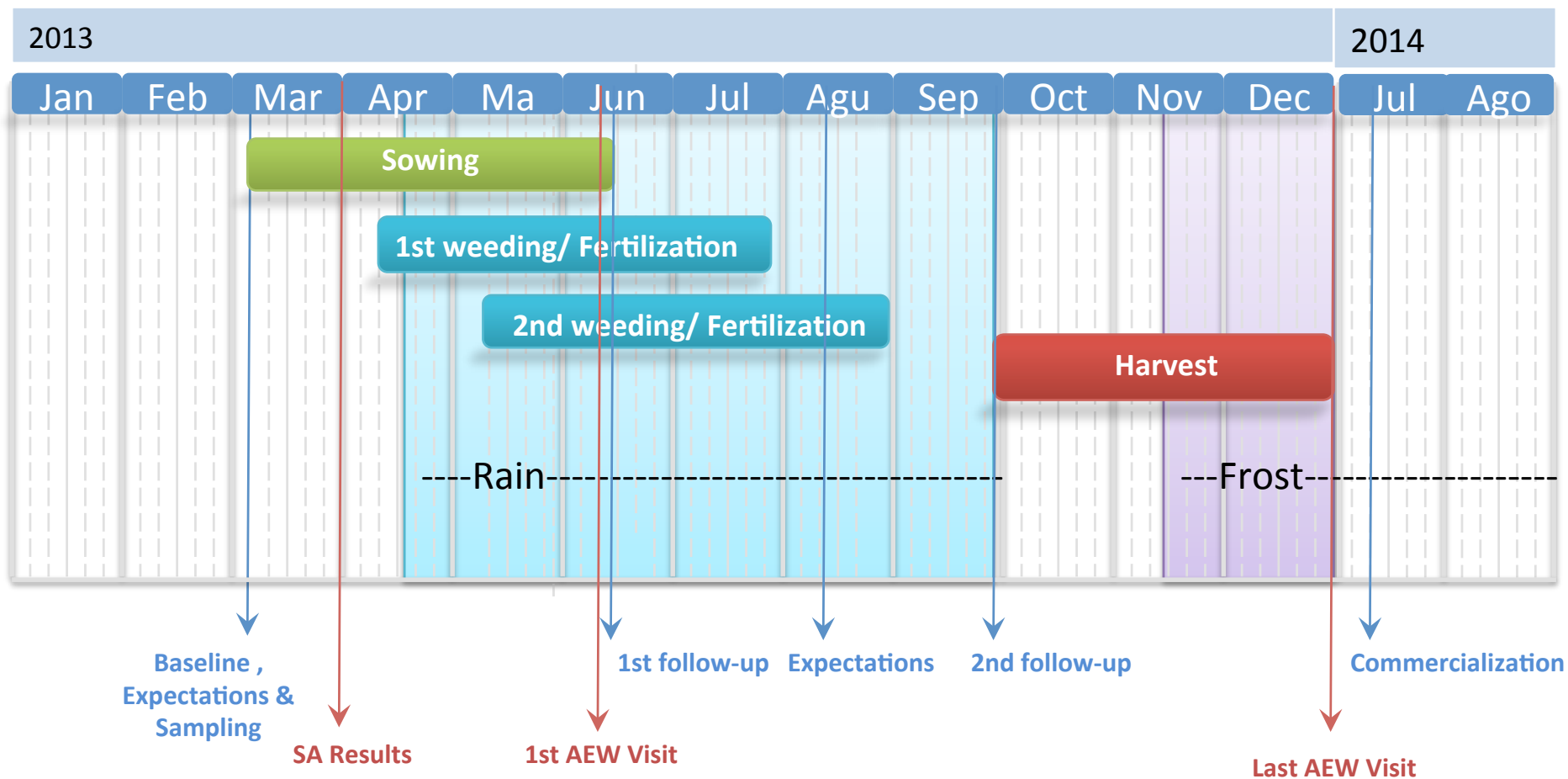


Sample & Design

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- The sample was stratified based on:
 - Climactic zones
 - Farmer landholdings size
 - Whether farmer had attended promotion meeting



Calendar



Attrition

- By last survey only 282 farmers, 32% of the original sample, remain in the program.
- The principal source of attrition (64% of drop-outs) were farmers who didn't sow maize in the sampled plot due to late arrival of rains in Tlaxcala.
- Besides the high percentage of drop-outs, no differential attrition is observed across treatments.

VARIABLES	Drop-out
SA	▼ -0.0516 ▼ (0.0606)
SA+AEW	▼ 0.00515 ▼ (0.0509)
Control Mean	0.3441
Observations	▼ 429
R-squared	▼ 0.099
P-value (SA=SA+AEW)	0.602
P-value (SA=0 SA+AEW=0)	▼ 0.338

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Balance

- To check if the randomization was balanced across treatments, we use key variables in explaining differences across plots productivity:
 - Farmers characteristics
 - Agricultural practices and
 - Soil quality
- Strata fixed effects are included and SEs are clustered by farmer (when plot level data is used).

Balance

- Farmer characteristics

VARIABLES	(1) Gender	(2) Complete Secondary education or higher	(3) Age	(4) Years of experience as a farmer	(5) Monthly income (\$)
SA	-0.0217 (0.0661)	0.0838 (0.0847)	5.137** (2.355)	1.451 (3.455)	8.435 (1,204)
SA+AEW	-0.0165 (0.0609)	0.00542 (0.0743)	3.820* (2.107)	4.361 (2.724)	-934.5 (1,260)
Control Mean	0.171	0.257	58.01	37.8	4,416
Observations	203	203	202	203	166
R-squared	0.100	0.074	0.143	0.058	0.198
P-value (SA=0 SA+AEW=0)	0.941	0.562	0.0588	0.265	0.633
P-value (SA=SA+AEW)	0.934	0.350	0.587	0.379	0.378

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Balance

- Agricultural practices

VARIABLES	(1) Native maize productivity	(2) Hybrid maize productivity	(3) Total maize productivity	(4) Used fertilizer during sowing 2012	(5) Used fertilizer during crop developmen t 2012	(6) Used foliar fertilizer during crop developmen t 2012
SA	-0.205 (0.256)	-0.154 (0.626)	-0.254 (0.299)	-0.0799 (0.0739)	0.00663 (0.0162)	-0.0233 (0.0660)
SA+AEW	0.147 (0.269)	-0.00243 (0.535)	0.221 (0.296)	-0.0416 (0.0655)	-0.0357 (0.0272)	0.00793 (0.0595)
Control Mean	1.818	2.845	2.094	0.2307	0.989	0.1758
Observations	180	53	223	266	266	266
R-squared	0.096	0.307	0.112	0.130	0.046	0.178
P-value (SA=0 SA+AEW=0)	0.438	0.964	0.235	0.549	0.114	0.878
P-value (SA=SA+AEW)	0.205	0.808	0.0892	0.606	0.0441	0.614

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Balance

- Soil quality

VARIABLES	(1) Plot size (ha)	(2) Have ever done SA	(3) Positive Slope	(4) Black Soil	(5) Frost in last 5 years
SA	0.392 (0.513)	0.0485 (0.100)	-0.00442 (0.0350)	-0.0532 (0.0776)	-0.0548 (0.0684)
SA+AEW	0.810* (0.445)	-0.0967 (0.0813)	0.0141 (0.0288)	0.0663 (0.0764)	-0.0830 (0.0595)
Control Mean	3.144	0.351	0.956	0.274	0.8901
Observations	266	266	266	266	266
R-squared	0.422	0.104	0.039	0.048	0.088
P-value (SA=0 SA+AEW=0)	0.194	0.226	0.814	0.315	0.369
P-value (SA=SA+AEW)	0.415	0.115	0.574	0.130	0.683

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Intermediate Outcomes

- Investment in fertilizers (not foliar)

VARIABLES	(1)	(2)	(3)	(5)
	Number of fertilizations	Investment in fertilizers during sowing (\$/ha)	Investment in fertilizers during crop development (\$/ha)	Total investment in fertilizers (\$/ha)
SA	0.165*	149.1	475.7	624.8*
	(0.0903)	(125.5)	(308.7)	(322.5)
SA+AEW	0.199**	14.23	248.7	262.9
	(0.0849)	(97.71)	(214.6)	(222.8)
Control Mean	1.559	374.7	2,035	2,409
Observations	347	361	361	361
R-squared	0.104	0.183	0.091	0.091
P-value (SA=0 SA+AEW=0)	0.0354	0.484	0.231	0.127
P-value (SA=SA+AEW)	0.735	0.317	0.482	0.279

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Intermediate Outcomes

- Investment in fertilizers relative to recommended dosage

VARIABLES	(1) N recommended - N used (kg/ha)	(2) P recommended - P used (kg/ha)	(3) K recommended - K used (kg/ha)
SA	-1.387 (14.70)	-22.13** (9.971)	-7.891* (4.124)
SA + AEW	7.424 (11.33)	-4.379 (5.045)	-3.743 (3.874)
Control Mean	-19.06	-2.317	23.55
Observations	337	336	336
R-squared	0.057	0.122	0.162
P-value (SA=0 SA+AEW=0)	0.744	0.0787	0.146
P-value (SA=SA+AEW)	0.540	0.0856	0.391

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Intermediate Outcomes

- Investment in fertilizers relative to recommended dosage

VARIABLES	(1) N recommended - N used (kg/ha)	(2) P recommended - P used (kg/ha)	(3) K recommended - K used (kg/ha)
SA	13.03 (9.816)	13.71* (8.228)	-1.036 (2.705)
SA+AEW	1.200 (7.180)	-0.892 (3.185)	3.379 (2.887)
Control Mean	61.24	29.98	28.36
Observations	337	336	336
R-squared	0.059	0.060	0.196
P-value (SA=0 SA+AEW=0)	0.376	0.235	0.383
P-value (SA=SA+AEW)	0.206	0.0929	0.188

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Expectations and Investment

VARIABLES	(1) log (min-max)	(2) Investment in fertilizers (\$/ha)
period = 2	-0.464*** (0.102)	1,660*** (153.8)
Treatment 3 groups = 1, SA	0.0557 (0.121)	131.9 (138.5)
Treatment 3 groups = 2, SA + AEW	-0.0162 (0.100)	9.698 (108.2)
2.period#SA	-0.0470 (0.163)	307.8 (378.1)
2.period#SA+AEW	0.0164 (0.136)	195.9 (250.1)
Control Mean	-0.9087	1,204
Observations	642	722
R-squared	0.121	0.305
P-value(2.period#SA=0 2.period#SA+AEW=0)	0.946	0.606
P-value(2.period#SA=2.period#SA+AEW)	0.686	0.779

Robust standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

Yield Estimation

The yields measurement was done using the procedure developed by CIMMYT, outlined in "Maize Doctor", the process for estimating yields consists of the following steps:

1. Selection 5-10 (depending on plots' size) sampling points
2. Measurement of plant density
3. Measurement of number of cobs per square meter
4. Measurement of number of grains per cob
5. Estimating yield based on 2-4
6. Moisture adjustment to the yield obtained in 5



Final Outcomes

VARIABLES	(1) Estimated yield (ton/ha)	(2) Self reported yield (ton/ha)
SA	0.304 (0.285)	-0.0969 (0.223)
SA + AEW	0.494* (0.264)	0.695*** (0.229)
Control mean	3.923	2.08
Observations	351	361
R-squared	0.095	0.095
P-value (SA=0 SA+AEW=0)	0.172	0.001
P-value (SA=SA+AEW)	0.508	0.00134

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Conclusions

- Some confirmation of the theory...
 - Soil analysis provides new information and investment increases
- To Do:
 - Compute profits, rather than yields
 - Variation in soil analysis over time...