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Crowdsourcing citizen-science for diversification and adaptation in agriculture: evidence from three continents

Kauê de Sousa

What is the problem we want to solve?

Challinor et al. (2016) *Nat. Clim. Change* **6**:954-958
Tollenaar et al. (2017) *Nat. Clim. Change* **7**:275-278
Deutsch et al. (2018) *Science* **361**(6405):916-919

What is the problem we want to solve?

What is the problem we want to solve?

- We need **diverse**, **location-specific** and **scalable solutions** for a climate adapted agriculture

- But current methods cannot address these solutions…

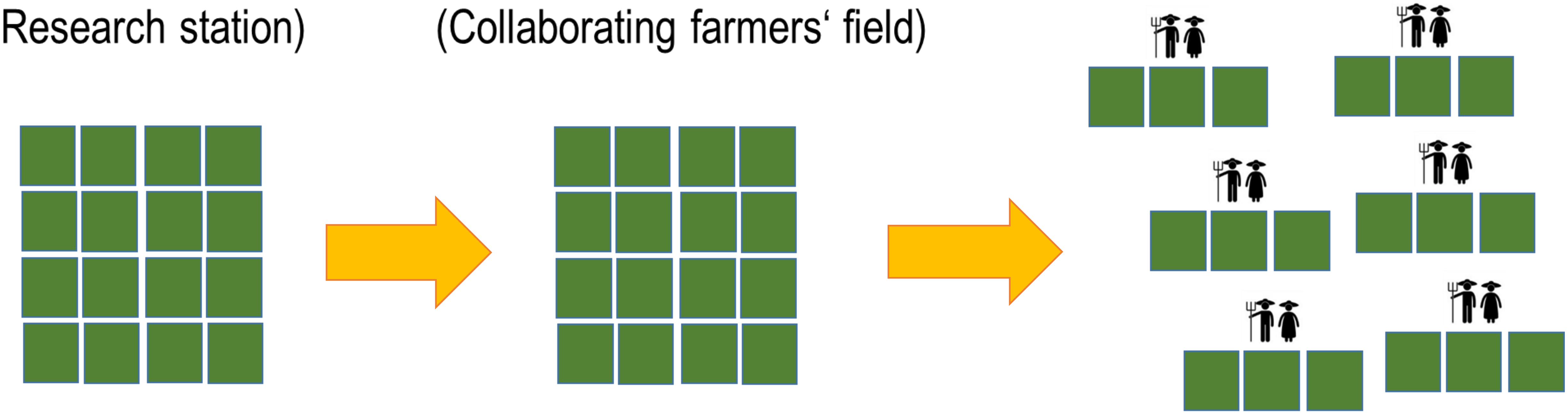
Lipper et al. (2014) *Nat. Clim. Change* **4**:1068–1072

A new agricultural research paradigm

Centralized trial
(Research station)

Centralized trial
(Collaborating farmers‘ field)

Decentralized trial



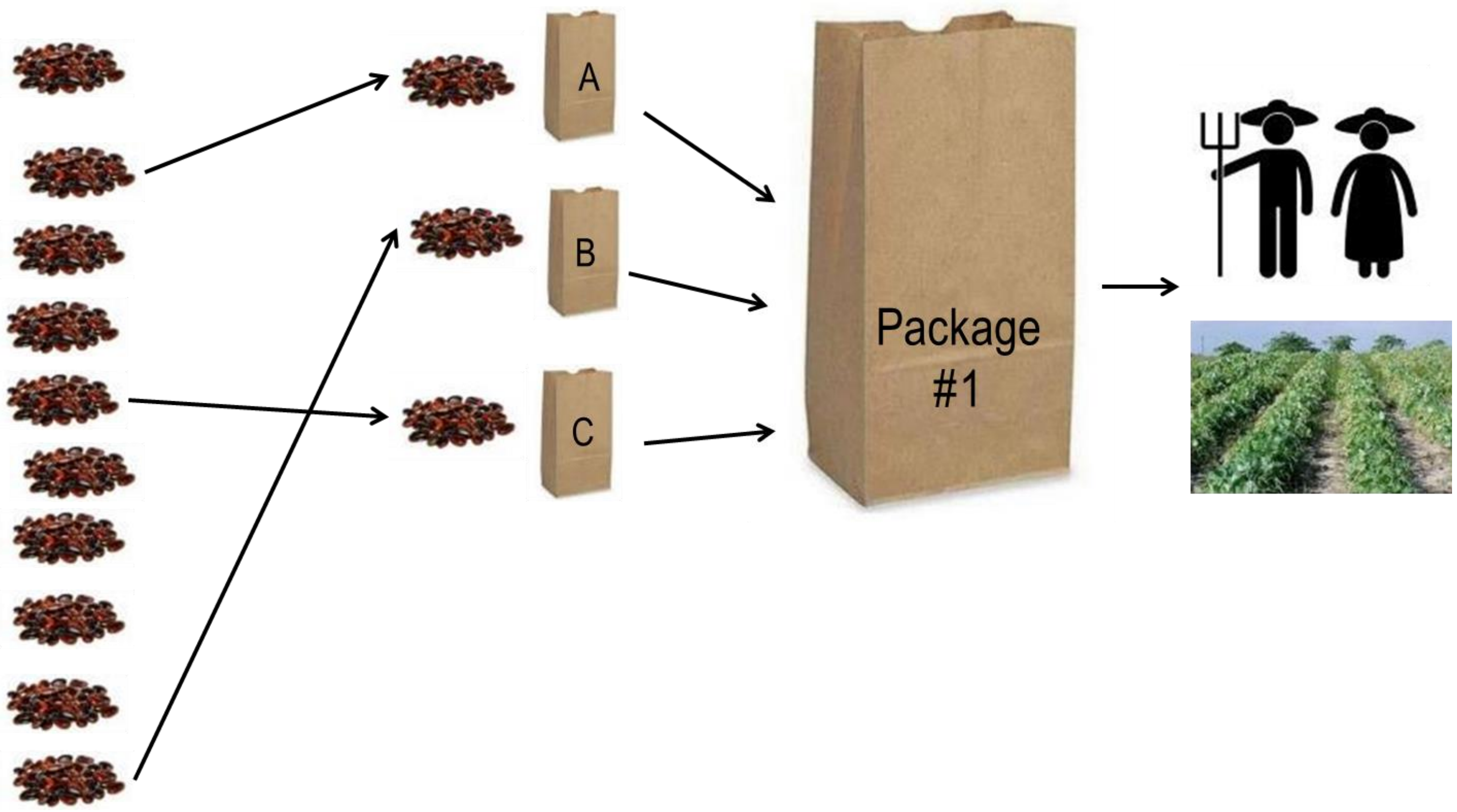
Managed by
researchers

Managed by
researchers and
one farmer

Managed by
many farmers

Crowdsourcing for climate adaptation

- A blind set of 3 varieties
- A randomization scheme
- Real farm conditions
- Farmers **rank** the varieties



van Etten et al. (2019) *Expl. Agric.*
Beza et al. (2017) *PloS ONE* **12**(5):e0175700

Combining many partial rankings for the full picture

	+		-
	A > C > D		
	C > D > G		
	A > D > G		

A>C>D>G

Turner et al. (2019) CRAN. *PlackettLuce*

Crowdsourcing for climate adaptation


PNAS PNAS

Check for updates

Crop variety management for climate adaptation supported by citizen science

Jacob van Etten[a,1,2], Kauê de Sousa[a,b,1], Amílcar Aguilar[c], Mirna Barrios[c], Allan Coto[a], Matteo Dell'Acqua[d], Carlo Fadda[e], Yosef Gebrehawaryat[e], Jeske van de Gevel[f], Arnab Gupta[g,3], Afewerki Y. Kiros[h], Brandon Madriz[a], Prem Mathur[g], Dejene K. Mengistu[e,h], Leida Mercado[i], Jemal Nurhisen Mohammed[h], Ambica Paliwal[g], Mario Enrico Pè[d], Carlos F. Quirós[a], Juan Carlos Rosas[j], Neeraj Sharma[g,4], S. S. Singh[k], Iswhar S. Solanki[l], and Jonathan Steinke[a,m]

[a]Bioversity International, 30501 Turrialba, Costa Rica; [b]Department of Agricultural Sciences, Inland Norway University of Applied Sciences, 2318 Hamar, Norway; [c]Tropical Agricultural Research and Higher Education Center, 61000 Matagalpa, Nicaragua; [d]Scuola Superiore Sant'Anna, Institute of Life Sciences, 56124 Pisa, Italy; [e]Bioversity International, 1000 Addis Ababa, Ethiopia; [f]Bioversity International, 00100 Nairobi, Kenya; [g]Bioversity International, Delhi 110012, India; [h]Department of Dryland Crop and Horticultural Sciences, Mekelle University, 7000 Mekelle, Ethiopia; [i]Tropical Agricultural Research and Higher Education Center, 30501 Turrialba, Costa Rica; [j]Zamorano Panamerican Agricultural School, 11101 Tegucigalpa, Honduras; [k]Indian Council for Agricultural Research–Indian Institute of Wheat and Barley Research, Karnal (Haryana) 132001, India; [l]Indian Agricultural Research Institute, Samastipur (Bihar) 848125, India; and [m]Department of Agricultural Economics, Humboldt University of Berlin, 10099 Berlin, Germany

Edited by B. L. Turner, Arizona State University, Tempe, AZ, and approved January 9, 2019 (received for review August 9, 2018)

Crop adaptation to climate change requires accelerated crop variety introduction accompanied by recommendations to help farmers match the best variety with their field contexts. Existing approaches to generate these recommendations lack scalabil-

to local climate adaptation. This local focus is a strength as well as a limitation. Scaling is constrained by the resource-intensive nature of current participatory experimental methods and the incompatibility of datasets across different efforts (9). The result-

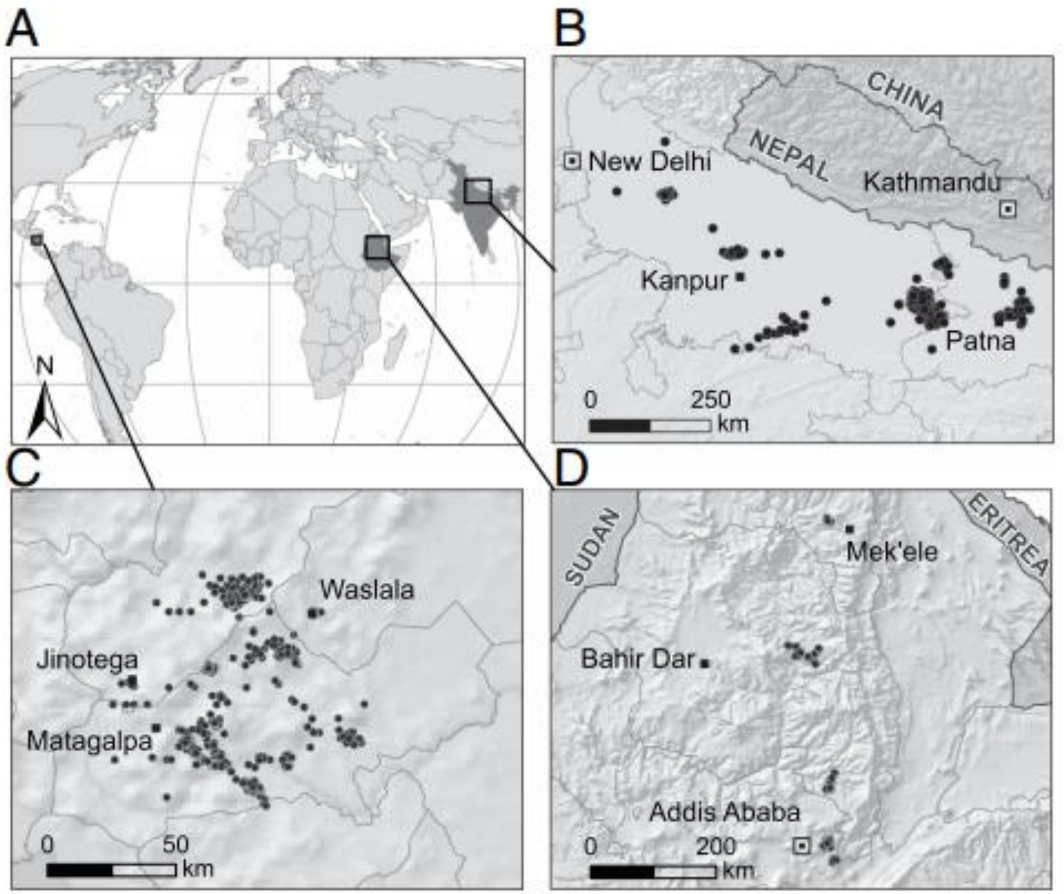


Fig. 1. Research sites: (*A*) overview, (*B*) India, (*C*) Nicaragua, and (*D*) Ethiopia. Farms included in the trials are indicated as dots.

12,409 trial plots

van Etten, de Sousa, et al. (2019) PNAS **116**(10):4194-4199

What we found...

This approach can improve variety recommendations in four aspects:

1. Reduction of climate bias

2. Incorporation of seasonal climate forecasts

3. Risk analysis

4. Geographic extrapolation

Reduction of climate bias

Table 1. Goodness of fit (pseudo-R^2) of PLTs determined with 10-fold cross-validation

PLT model	Nicaragua	Ethiopia	India
No covariates	0.1484	0.3947	0.0381
Design	0.1869	0.4709	0.0721
Climate	**0.1978**	**0.4870**	**0.0882**
Climate + geolocation	0.1977	0.4720	0.0872

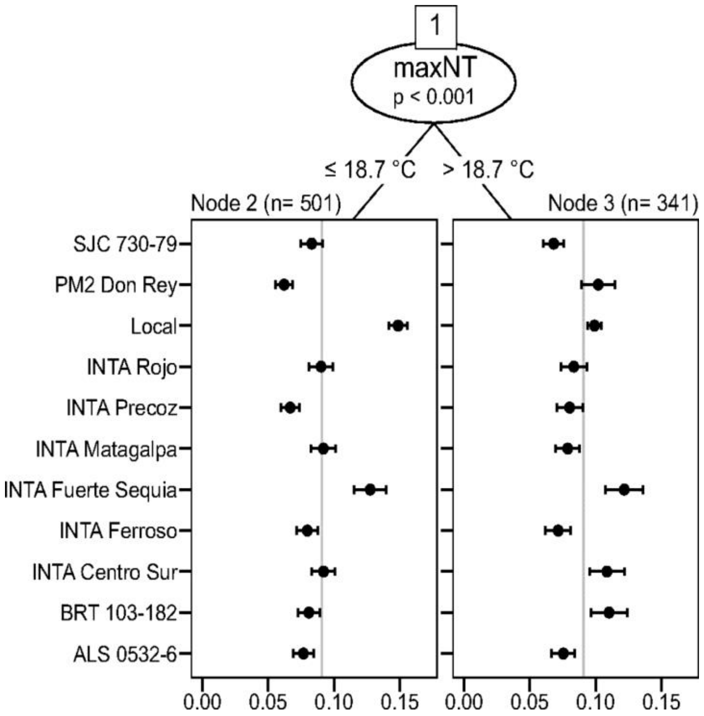
The model with only climate covariates has the best fit in all cases (indicated in bold).

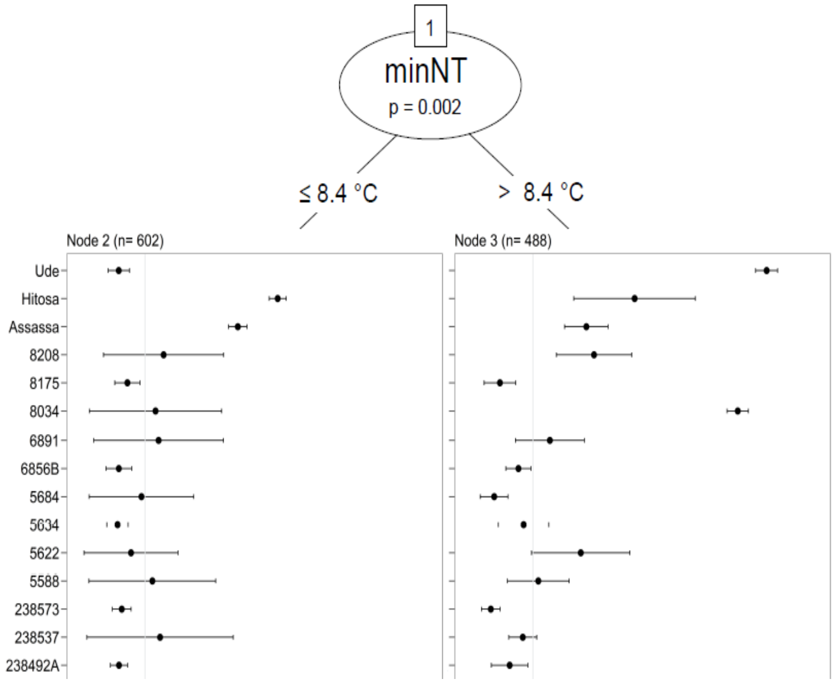
Table 2. Goodness of fit (pseudo-R^2) of generalizable PLT models

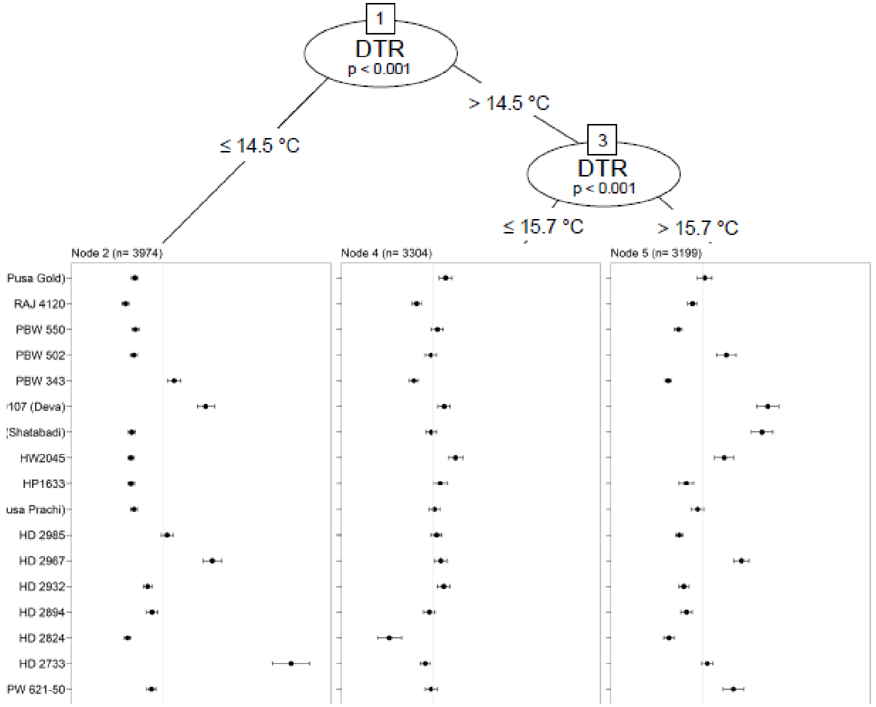
Model	Nicaragua	Ethiopia	India
No covariates	0.1533	0.4280	0.0611
Average season	0.1536	0.4290	0.0694
Perfect forecast	0.1749	0.4442	0.1065

Model average season corrects for climatic sampling bias by averaging predictions over a base period of seasonal climate data. Model perfect forecast uses observed climatic covariates in the predicted seasons. Values represent cross-validated pseudo-R^2 values averaged across blocks and weighted with the square root of the sample size of each block.

Incorporation of seasonal climate forecasts





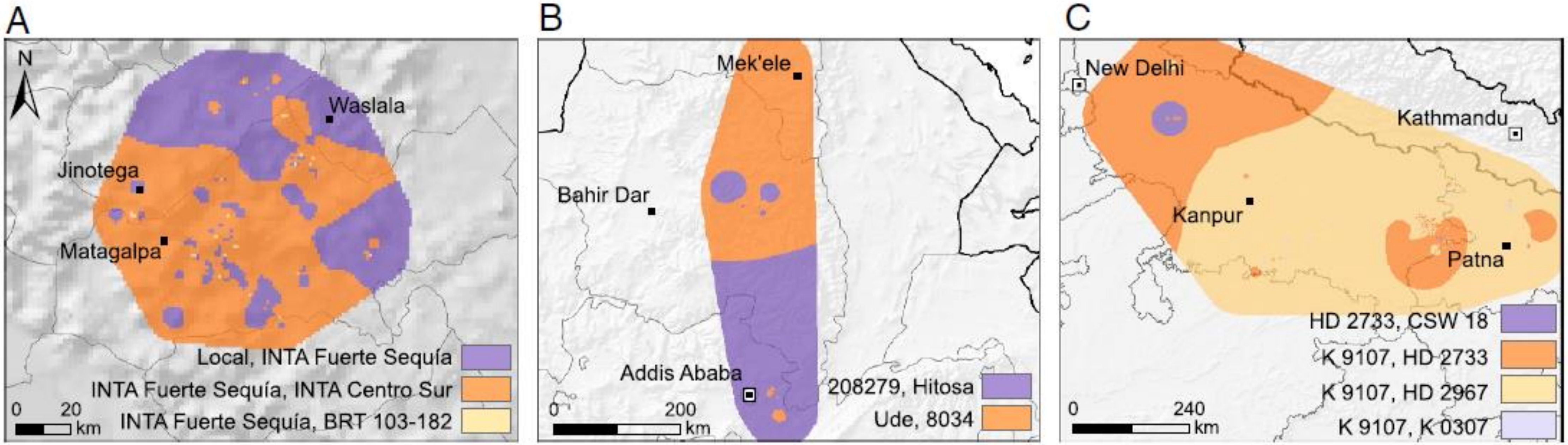


Risk analysis

Table 3. Expected probability of winning (average of all farms over the base period) and worst regret measures of a subset of the varieties

Case study and variety	Probability of winning	Worst regret
Common bean (Nicaragua)		
Local variety	**0.130**	0.023
INTA Fuerte Sequía	0.125	**0.021**
INTA Centro Sur	0.098	0.057
BRT 103-182	0.092	0.068
INTA Rojo	0.088	0.082
INTA Matagalpa	0.087	0.057
Durum wheat (Ethiopia)		
208279	**0.059**	0.062
Hitosa	0.049	**0.035**
208304	0.041	0.048
8034	0.030	0.053
Ude	0.025	0.063
222360	0.023	0.061
Bread wheat (India)		
K 9107 (Deva)	**0.077**	0.051
HD 2967	0.068	0.047
HD 2733	0.066	**0.036**
K 0307 (Shatabadi)	0.063	0.095
CSW 18	0.042	0.073
HI 1563 (Pusa Prachi)	0.041	0.093

Geographic extrapolation



Recap…

- Citizen science data revealed generalizable relations between seasonal climate variables and crop variety performance
- Climatic analyses of these data were shown to improve variety recommendations
- The approach can track climate trends as they manifest themselves on farms
- The findings can serve to create variety portfolios that diminish climate risk

Thank you!

kaue.desousa@inn.no

k.desousa@cgiar.org