



From genebanks to farms: how citizen science is transforming crop variety evaluation through the tricot approach

Kauê de Sousa



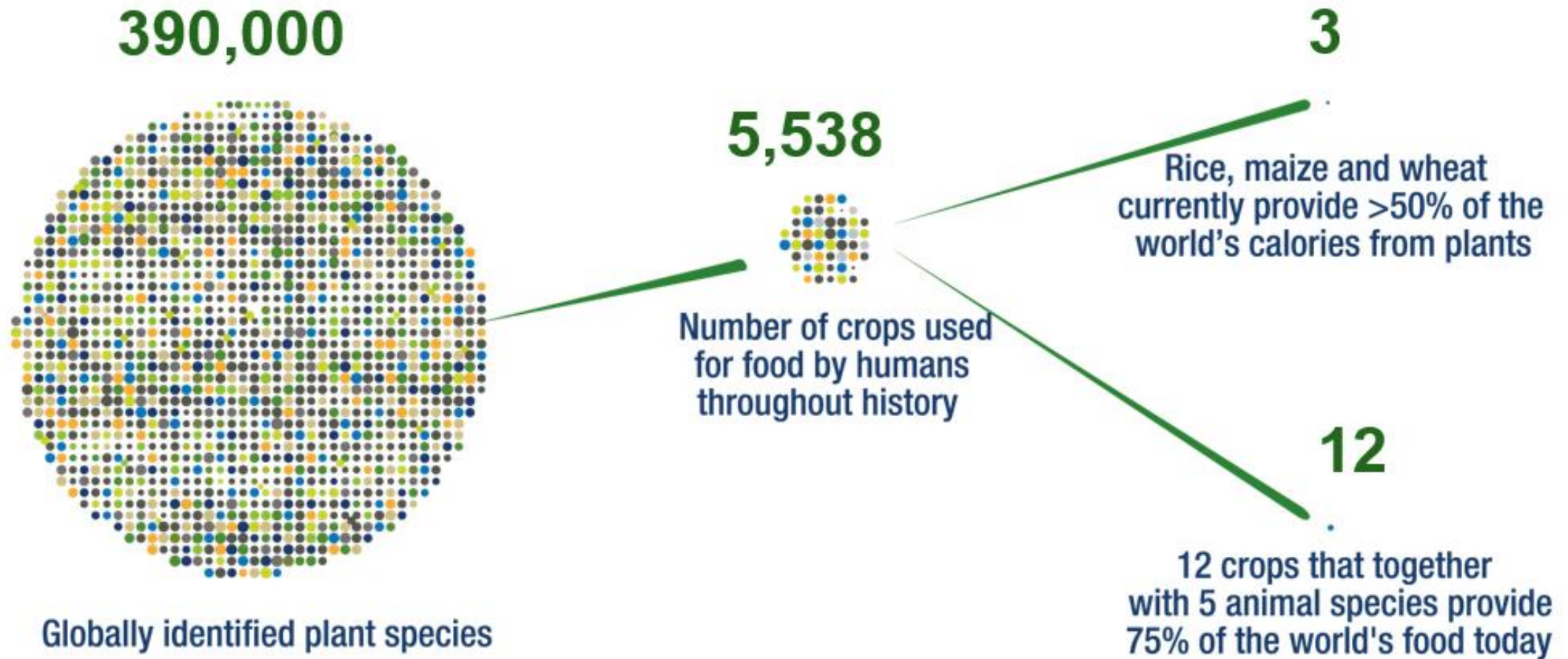
In this presentation

- Challenges that drive our research
- The tricot approach
- Five case studies and lessons

Some slides borrowed from Jonathan Steinke and Jacob van Etten,
the forerunners in this approach

Challenges that we want to address...

Challenge #1: Loss in agrobiodiversity



Challenge #2: Climate Change



Challinor et al. (2016) *Nat. Clim. Change* **6**:954-958

Tollenar et al. (2017) *Nat. Clim. Change* **7**:275-278

Deutsch et al. (2018) *Science* **361**(6405):916-919

Challenge #3: Data capturing

Geographically dispersed trials with limited opportunity to aggregate and **repurpose data**

Little long-term focus on the opportunity that **well structured** data can provide



“data-driven”: means that progress in an activity is compelled by data, rather than by intuition or by personal experience.

Increased agrobiodiversity is part of the solution

Photo: Bioversity International/C.Zanzanaini



Photo: Bioversity International



- Different varieties have different climatic adaptation
- Weather extremes will not affect all varieties equally
- Growing multiple varieties together = climate resilience

Vermeulen et al. (2012) Environ Sci Policy 15(1):136-144

Waha et al. (2018) Global Change Biol

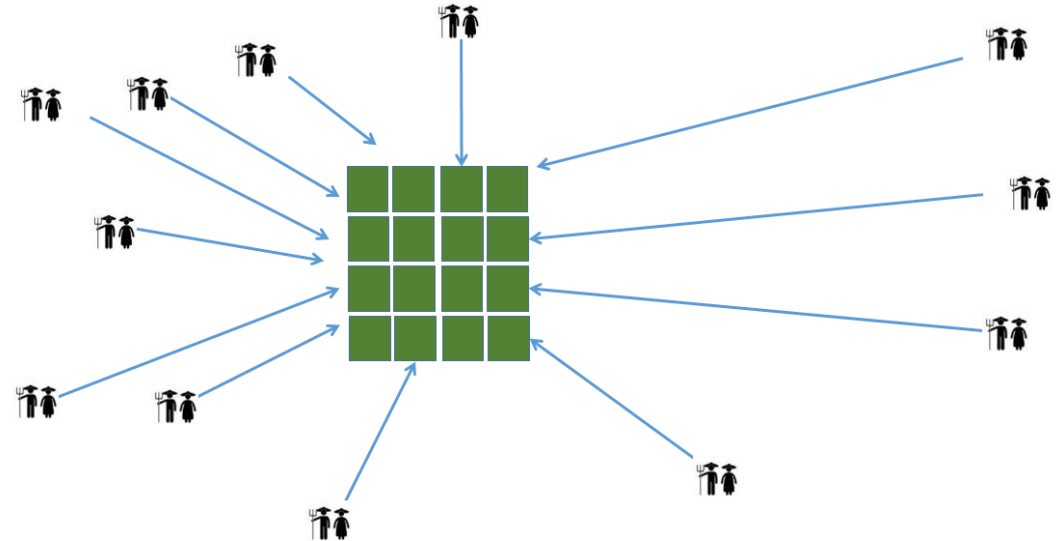
Willet et al. (2019) The Lancet 393(10170):447-492

How can we support farmers to find varieties that match the conditions at their farm?



“
*There is no such
thing as bad
climate
—
only
inappropriate
varieties*
”

Can there be a “best” variety for all?



Inconsistent observations

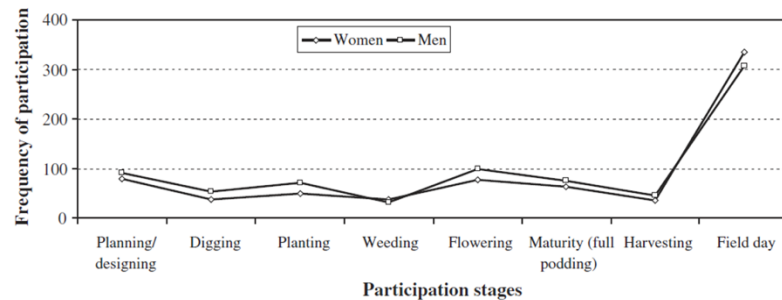


Fig. 4. Participation by gender in key crop stages in three participatory trial sites of western Kenya.

Misiko (2013)

Rhoades and Booth (1982) Agricultural Administration [https://doi.org/10.1016/0309-586X\(82\)90056-5](https://doi.org/10.1016/0309-586X(82)90056-5)

Misiko (2013) Agricultural Systems <https://doi.org/10.1016/j.agsy.2013.04.004>

Why do farmers lack easy access to diversity?

Seed producers

Incentives to produce only few varieties at large scale

Lack of information on variety demand

Farmers

Lack of information about available varieties

“Seeing is believing” / Learning-by-doing approach

Possible solution: Farmer-managed variety trials powered by citizen science

Triadic comparison of technologies (tricot) is a citizen science approach that can help bringing diversity to farms...

The best of existing approaches



Citizen science – high volume of data generated by citizens (not formally trained in the topic)



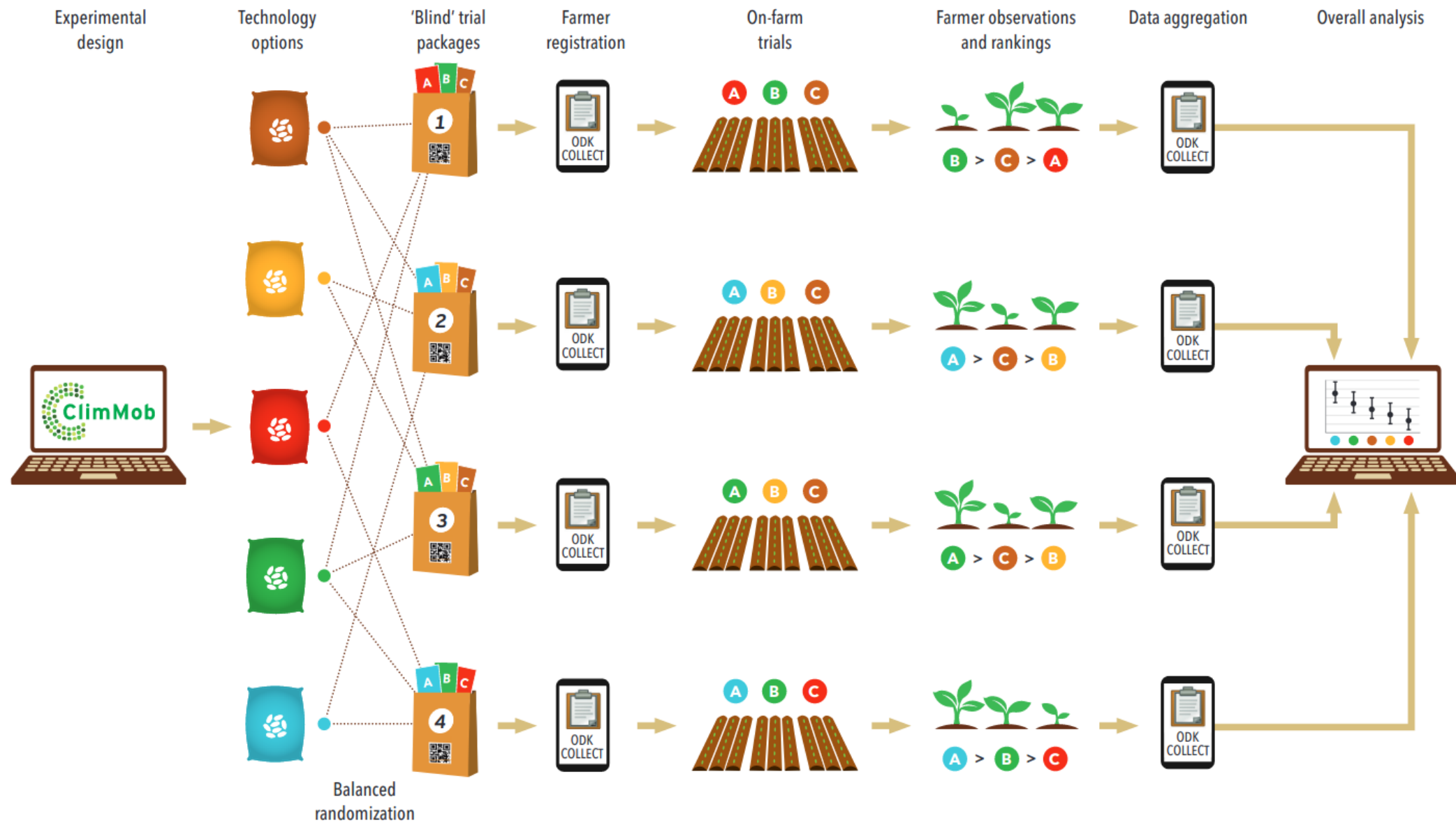
Digital agriculture – trial design, management, data collection and analysis supported by novel digital tools



On-farm testing – capture the performance of tested technologies under real conditions

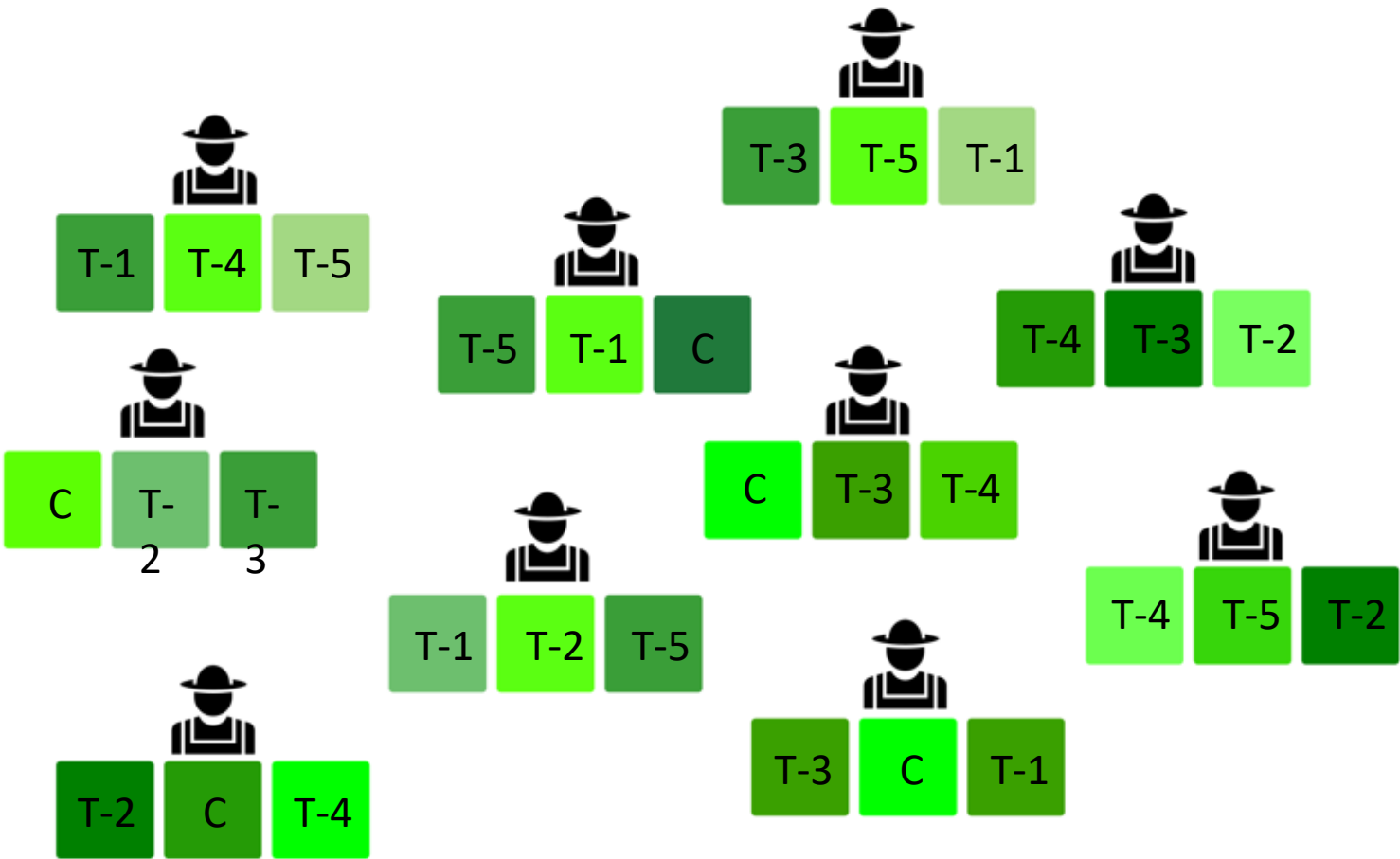


Participatory research – farmers as active participants (user-centred desing)



Incomplete block design

	item_A	item_B	item_C
	<chr>	<chr>	<chr>
1:	Tech-1	Tech-4	Tech-5
2:	Check	Tech-2	Tech-3
3:	Tech-2	Check	Tech-4
4:	Tech-3	Tech-5	Tech-1
5:	Tech-5	Tech-1	Check
6:	Tech-4	Tech-3	Tech-2
7:	Tech-1	Tech-2	Tech-5
8:	Check	Tech-3	Tech-4
9:	Tech-3	Check	Tech-1
10:	Tech-4	Tech-5	Tech-2



Tricot in practice





Trial setting

- Side by side
- On the same day
- Small to allow comparison
- Same management as the main plot (preferably)

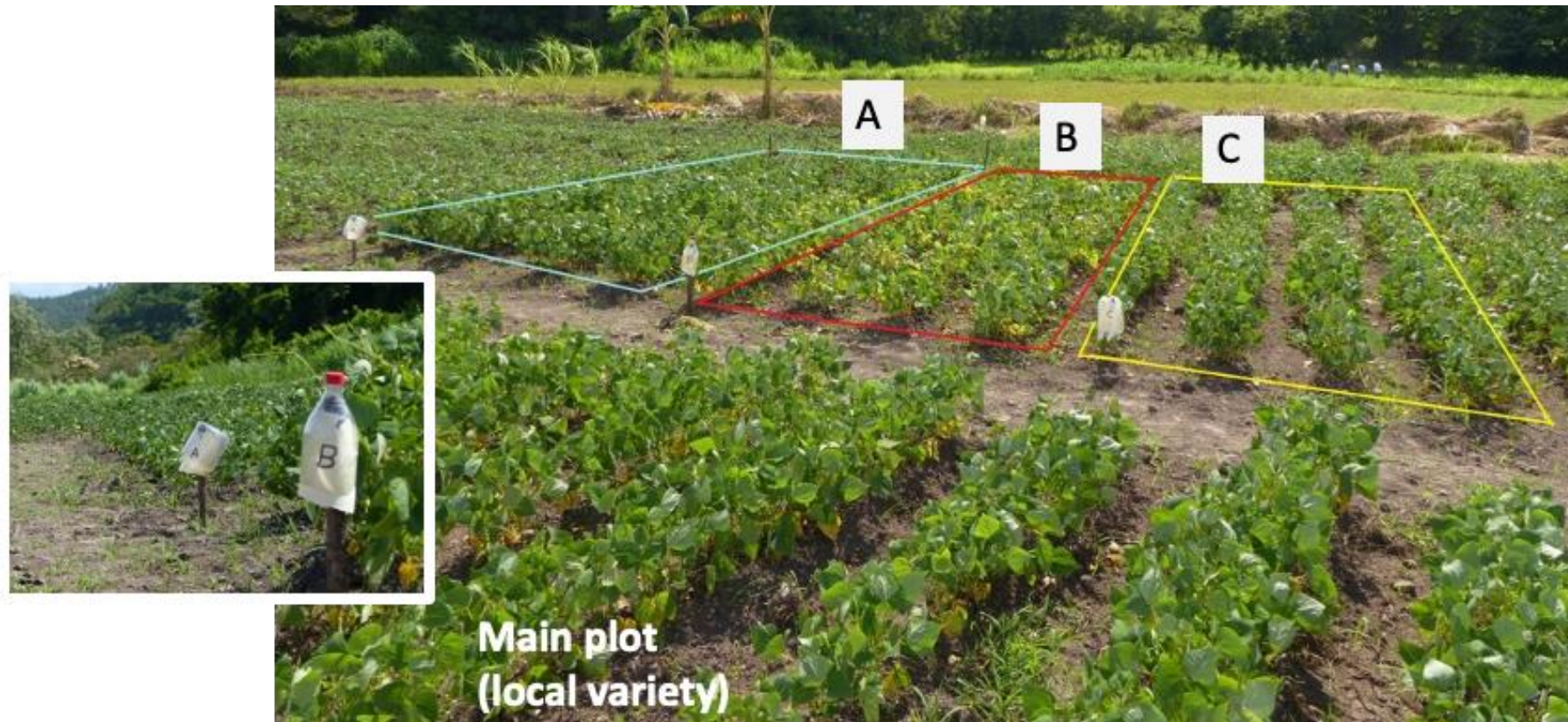




Photo: Neil Palmer/Crop Trust

Farmers make simple observations for different criteria





Photo: Neil Palmer/Crop Trust

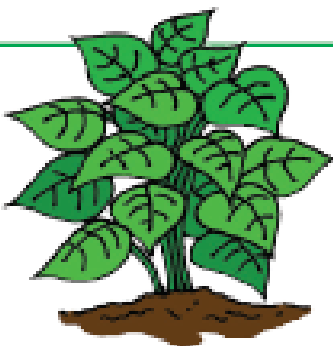
Farmers make simple observations for different criteria

Step #1

After 30 Days

Package number: _____

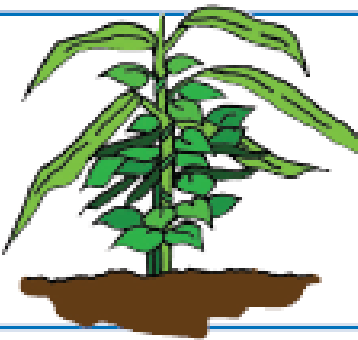
Date: _____



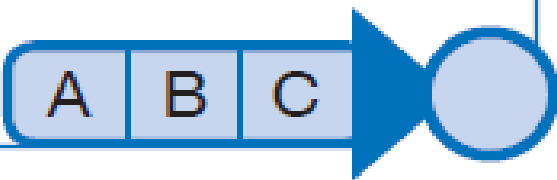
Best leaf development



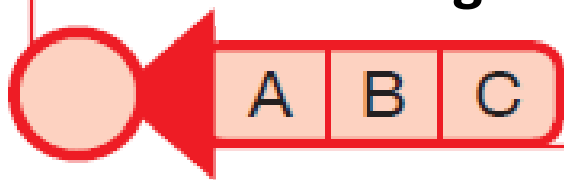
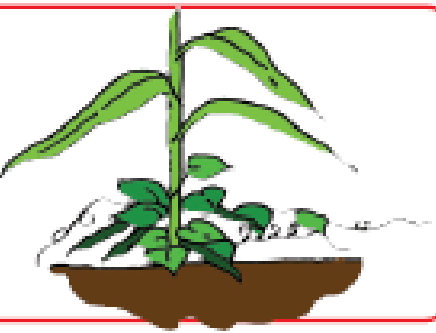
Worst leaf development



Best in winding



Worst in winding



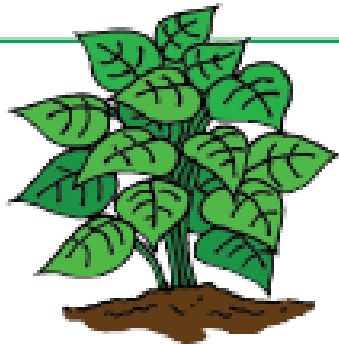
Farmers make simple observations in different criteria

Step #1

After 30 Days

Package number: FR-35

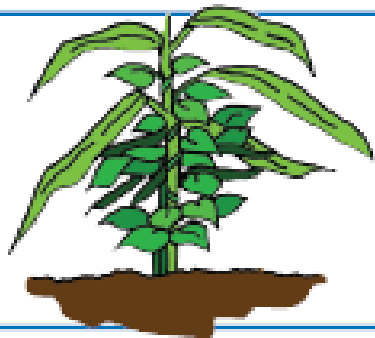
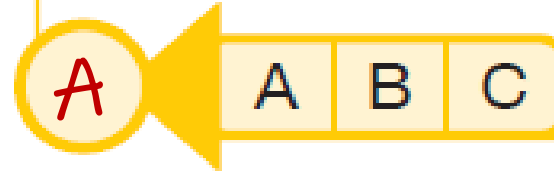
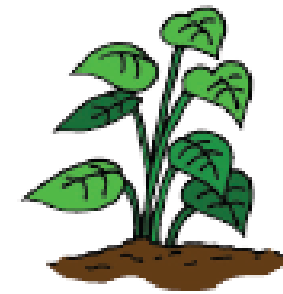
Date: 10 November 2018



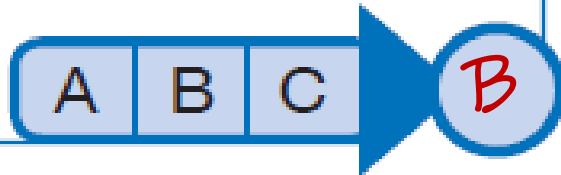
Best leaf
development



Worst leaf
development



Best in
winding



Worst in
winding

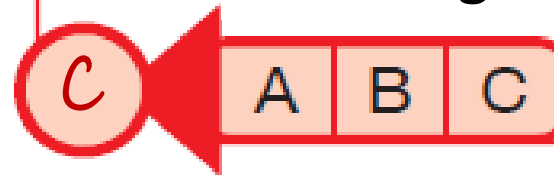
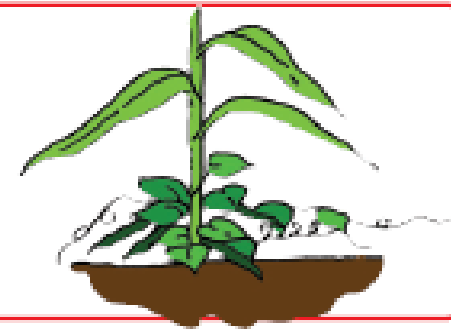
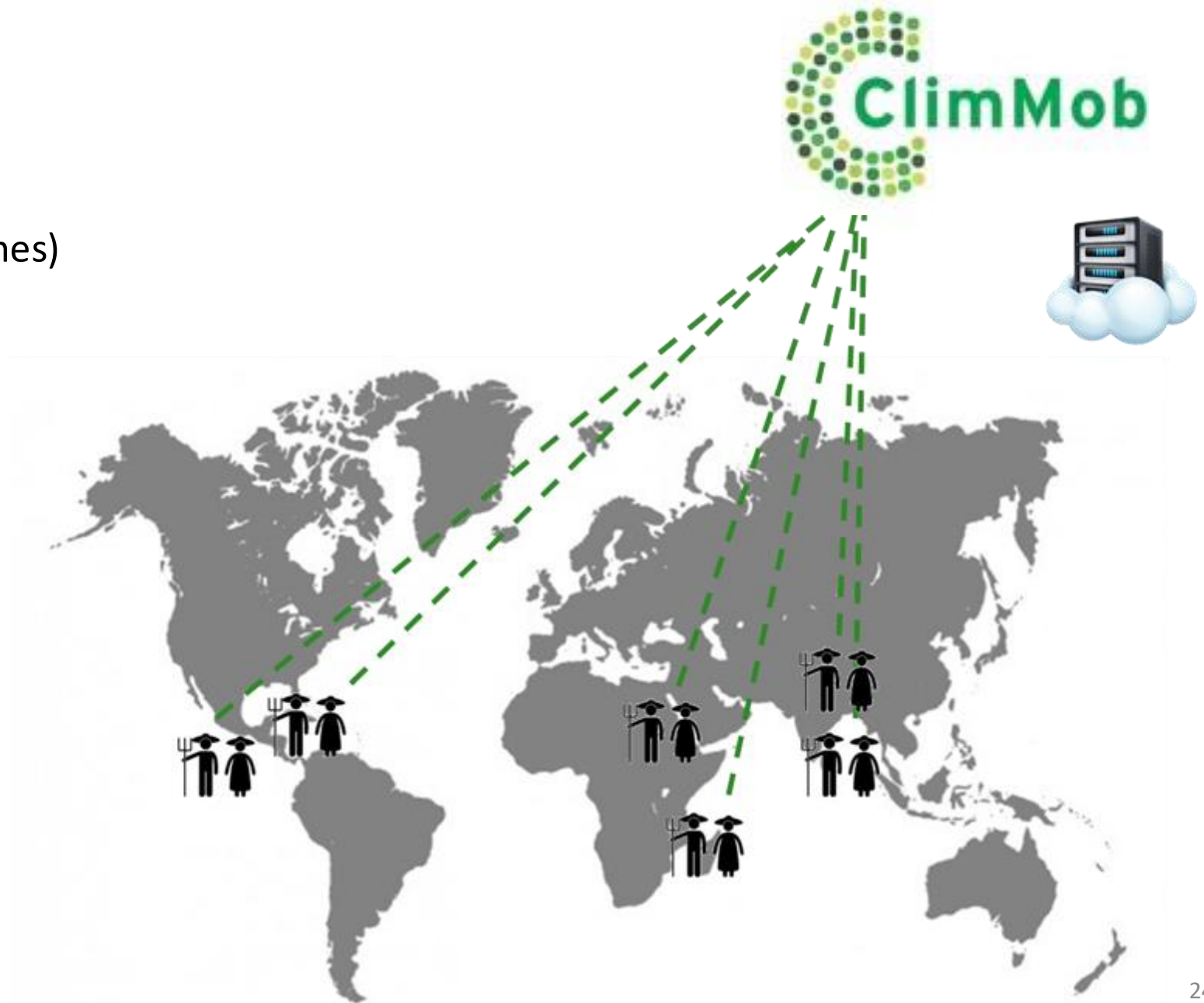




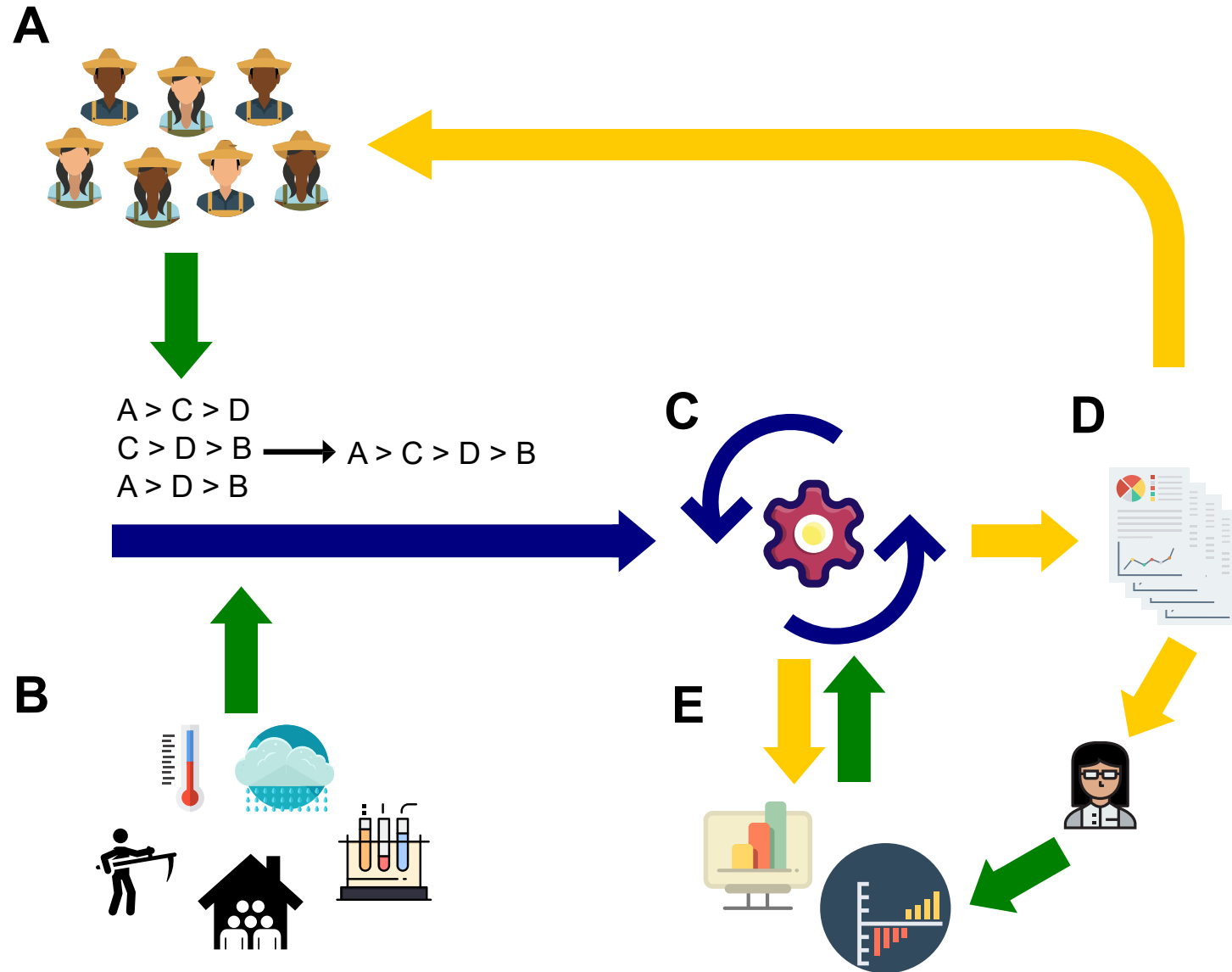
Photo: Neil Palmer/Crop Trust

Data collection

1. ODK App (only Android phones)
2. Data collected on paper and submitted via Enketo



Data workflow



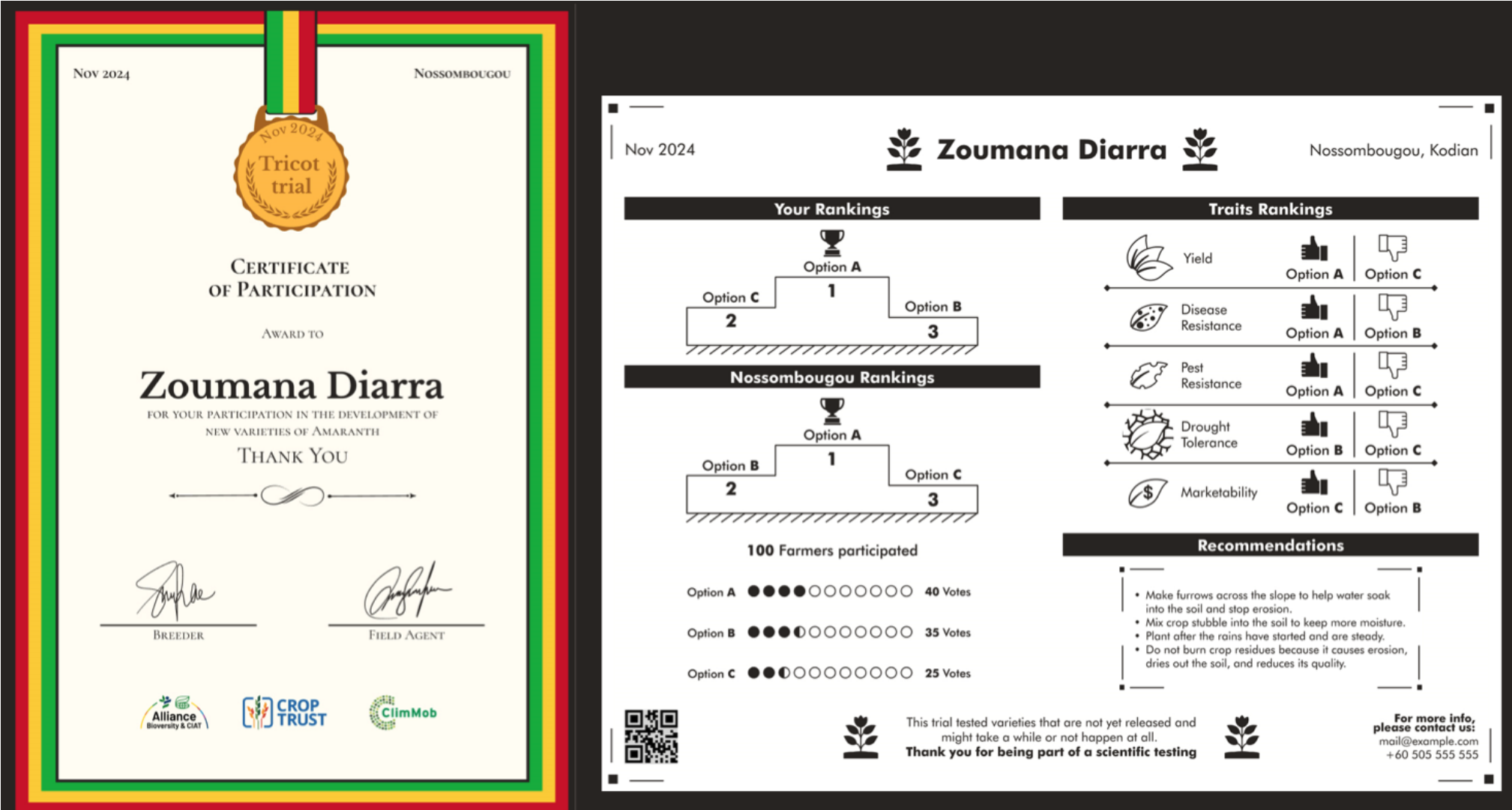
- (A) Multiple participants contribute by performing small, decentralized tasks (e.g., ranking three options).
- (B) Supplementary data are integrated from external sources (e.g. weather, socio-economic, breeding data).
- (C) Aggregated and enriched data are analyzed using the ClimMob platform.
- (D) Automated reports are generated and delivered to trial managers and participants.
- (E) Trial managers can request additional analysis to test new hypotheses, try new analytical approaches and produce scientific papers. Validated innovations from (E) are integrated back into the main analysis pipeline (C), continuously enhancing automation and scalability.

Feedback to farmers

It is an integral and important step on tricot. It needs to be on your budget from the beginning.



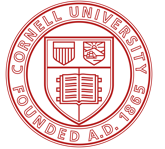
Feedback to farmers



Built on a multi-institutional partnership



Norwegian
University of
Life Sciences



NIBIO
NORWEGIAN INSTITUTE OF
BIOECONOMY RESEARCH



INSTITUT NATIONAL POUR
L'ETUDE ET LA RECHERCHE
AGRONOMIQUES



NRCRI
Delivering the Roots of Prosperity



Ethiopian
SEEDPARTNERSHIP



Ministry of Foreign Affairs of the
Netherlands



USAID
FROM THE AMERICAN PEOPLE



Gates
Foundation



giz Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

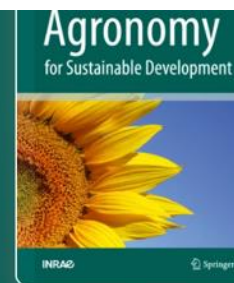
The tricot approach: an agile framework for decentralized on-farm testing supported by citizen science. A retrospective

Review Article | [Open access](#) | Published: 25 January 2024

Volume 44, article number 8, (2024) [Cite this article](#)

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[Gender and socio-economic heterogeneity](#)



Case studies



#1 Variety portfolios

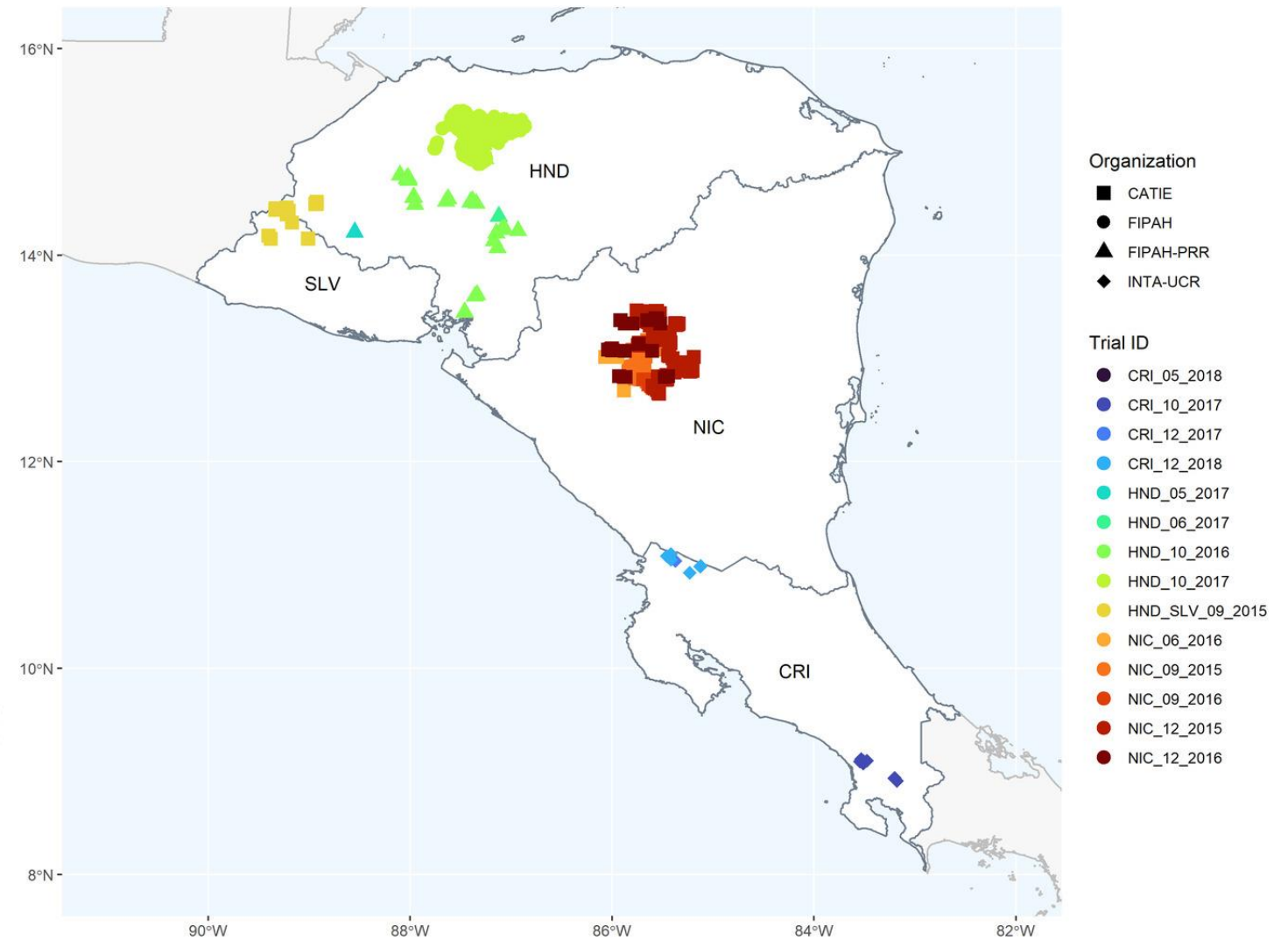
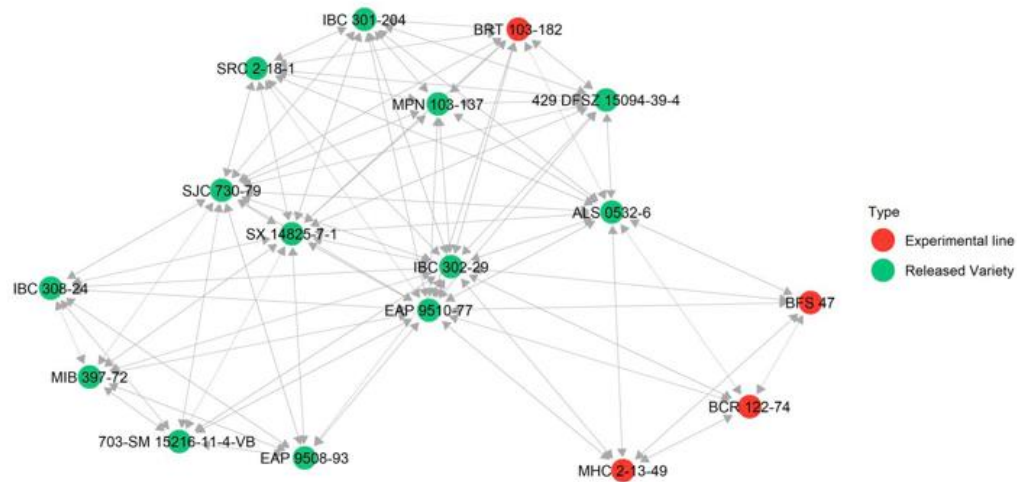
Common beans

Central America (4 countries)

17 genotypes

12 seasons

3,550 farmers (~250 per season)



#1 Variety portfolios

Location-specific insights on genotype performance and environmental interaction.

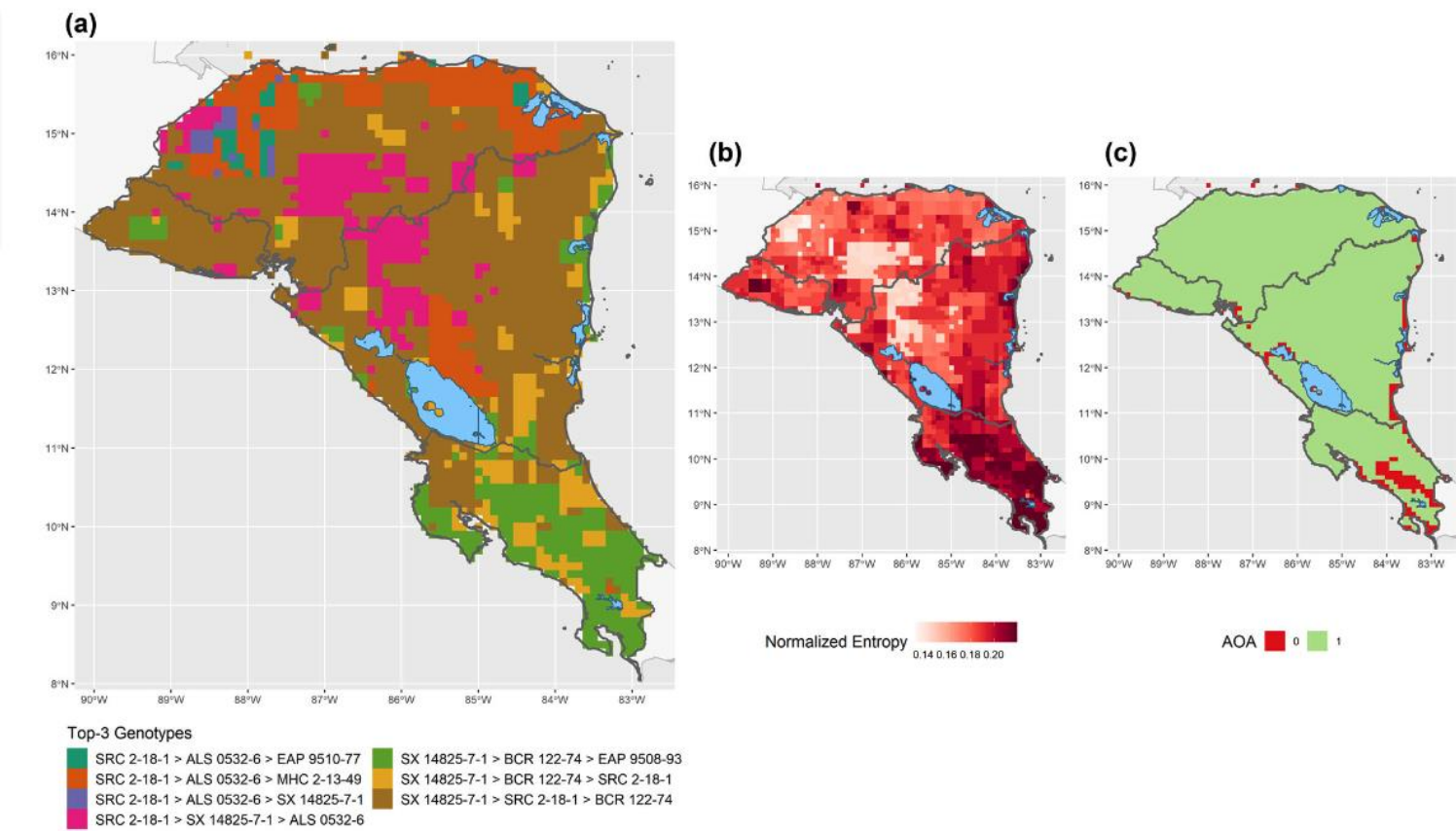
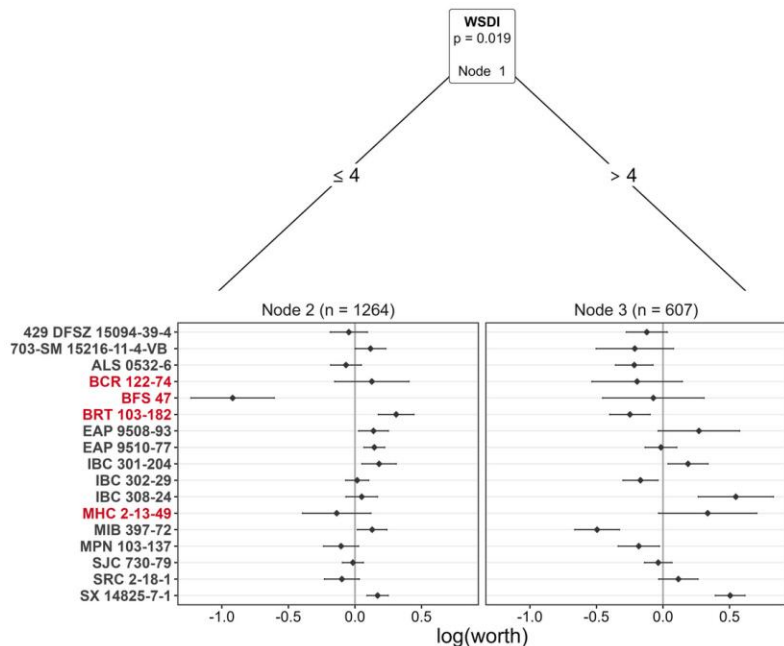


FIGURE 4 (a) Map of genotypes with the higher probability of being in the top three across the study region for the Primera season. (b) Normalized entropy (0–1) of the genotypes with higher probability of being in the top three; the legend scale is constrained to easily visualize the differences. (c) Area of applicability (AOA) for the Primera season; areas in red denote no applicability of the model

#2 Locally adapted genotypes

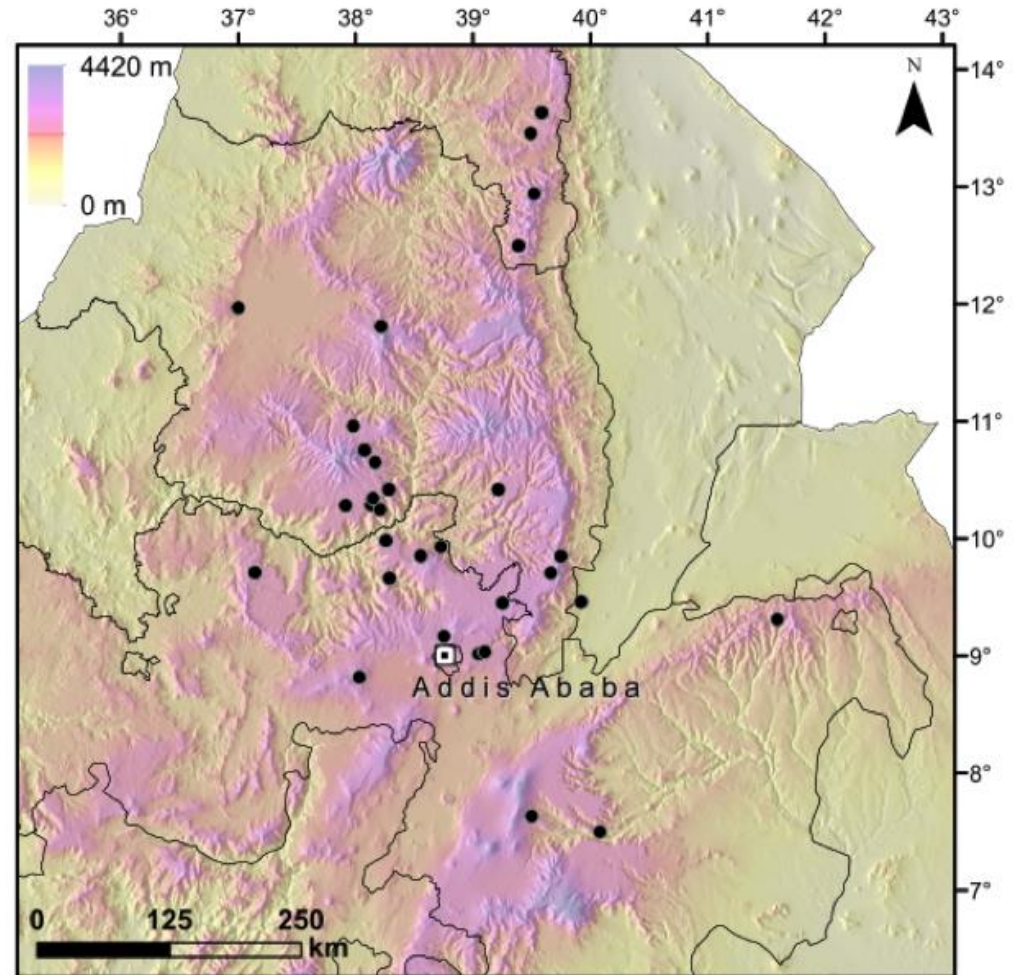
Durum wheat

Ethiopia

41 genotypes

3 seasons

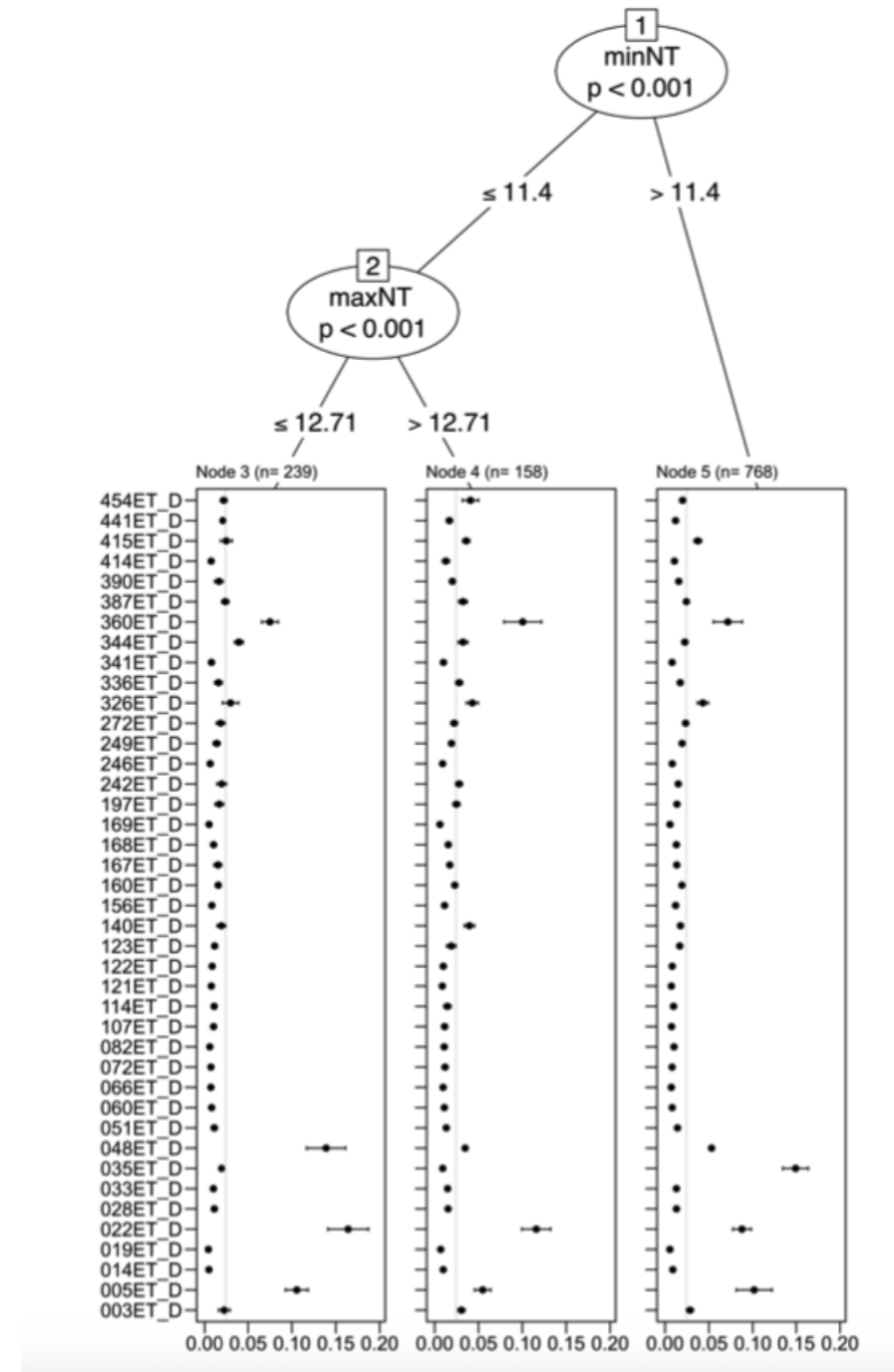
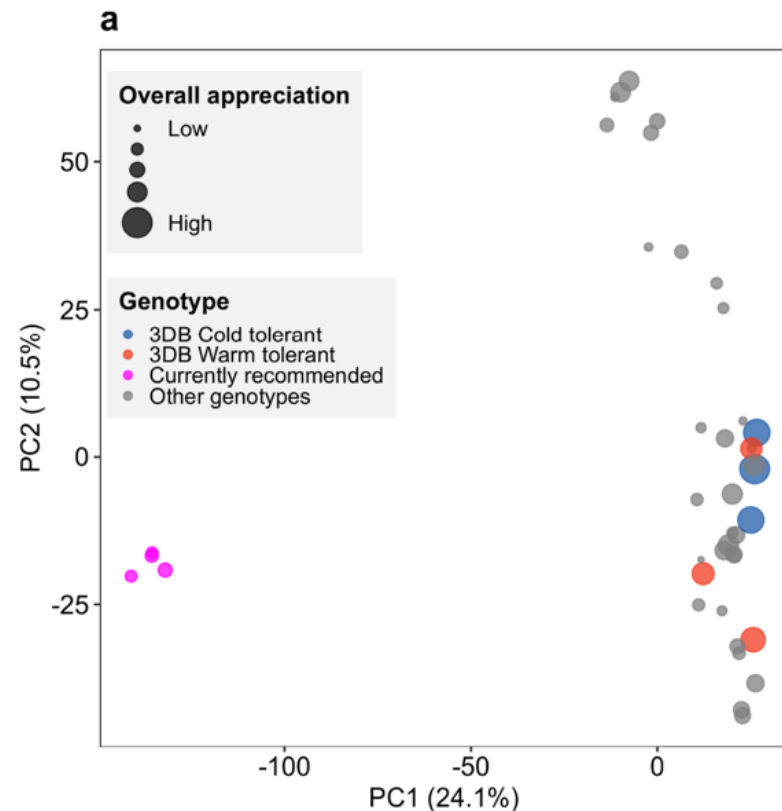
1,100 farmers (~330 per season)



Supplementary Figure 15. Location of origin of the top 41 durum wheat (*Triticum durum* Desf.) genotypes selected for the decentralized trials.

#2 Locally adapted genotypes

Selection of durum wheat genebank accessions with higher local adaptation in Ethiopia.



#3 Consumers' preference

Cassava (gari-eba)
Nigeria
10 genotypes
1,001 participants

Linking farmers socio-economic
data with breeding data

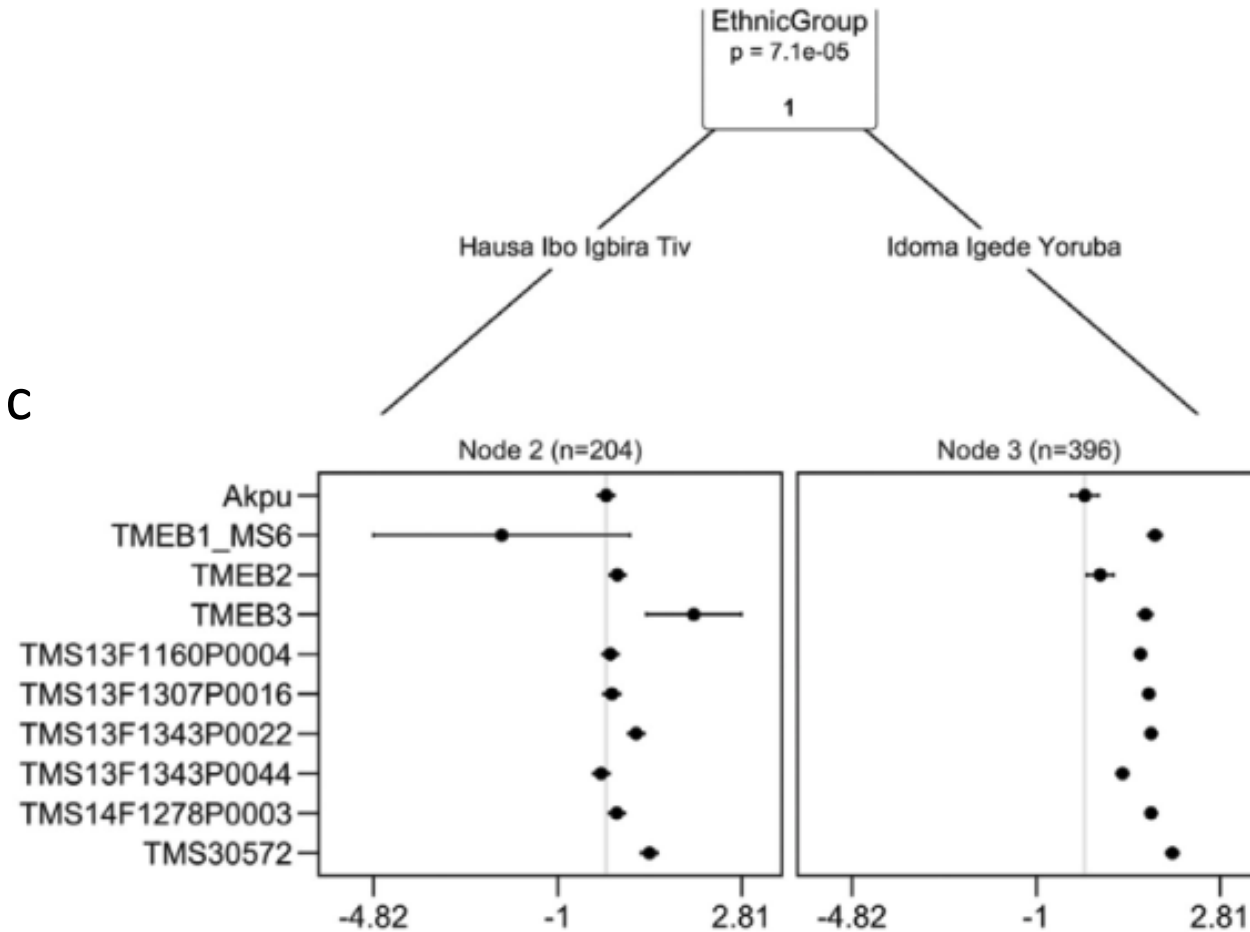


Figure 6. Plackett-Luce tree of consumers' preference for Eba samples derived from ten cassava genotypes (Experiment 3). Splitting covariate selected by the model-based recursive partitioning approach applied to ethnic group. The x axis shows log-worth with genotype Akpu as reference (log-worth set to 0). Intervals are based on quasi-variance estimates.

#3 Consumers' preference

Table 6. Effect of genotypes' biophysical features on the consumers' preference for eba samples and consumers' ethnic groups

Node ^a	Feature	Estimate	Standard error	z value	Pr (> z)	
2	(Intercept)	0.000	NA	NA	NA	
	Solubility	-16.156	5.414	-2.984	2.84E-03	**
	L* gari	0.335	2.016	0.166	8.68E-01	
	a* gari	1.482	0.596	2.487	1.29E-02	*
	b* gari	0.076	0.255	0.298	7.65E-01	
	Cohesiveness	-43.119	130.407	-0.331	7.41E-01	
	Gumminess	0.096	0.793	0.121	9.04E-01	
	Chewiness	0.130	0.467	0.279	7.81E-01	
	Hardness	-0.078	0.281	-0.276	7.83E-01	
	Adhesiveness	-0.019	0.165	-0.117	9.07E-01	
3	(Intercept)	0.000	NA	NA	NA	
	Solubility	-3.611	1.591	-2.269	2.32E-02	*
	L*gari	1.037	0.204	5.079	3.79E-07	***
	a* gari	1.699	0.322	5.271	1.35E-07	***
	b* gari	-0.096	0.015	-6.198	5.72E-10	***
	Cohesiveness	31.817	5.951	5.346	8.98E-08	***
	Gumminess	-0.068	0.044	-1.568	1.17E-01	
	Chewiness	-0.094	0.067	-1.398	1.62E-01	
	Hardness	0.026	0.012	2.289	2.21E-02	*
	Adhesiveness	-0.030	0.021	-1.441	1.50E-01	

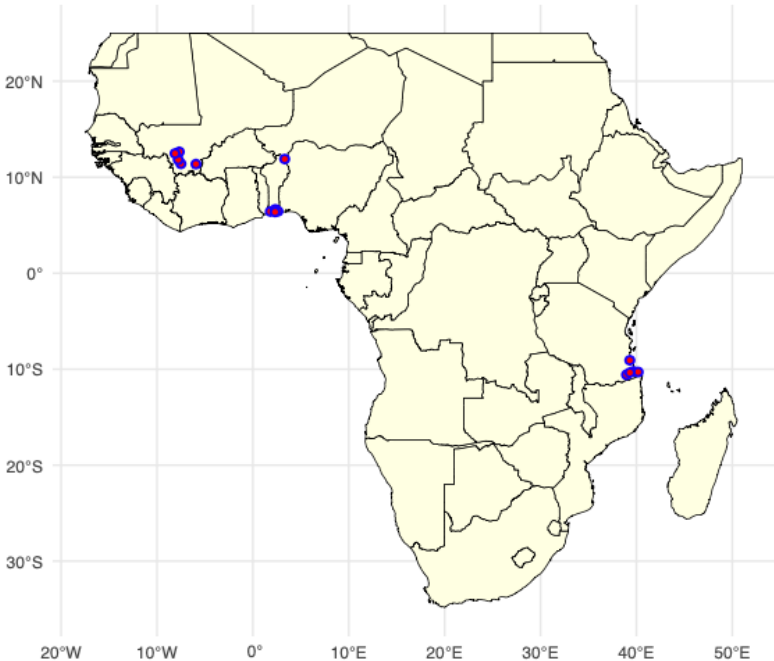
^a Node 2 includes participants from Hausa, Ibo, Igbira, and Tiv groups. Node 3 has participants from the groups Idoma, Igede, and Yoruba. Pr = Probability.

#4 Market segments in traditional vegetables

Amaranth
Benin, Mali, Tanzania
14 WorldVeg genebank genotypes

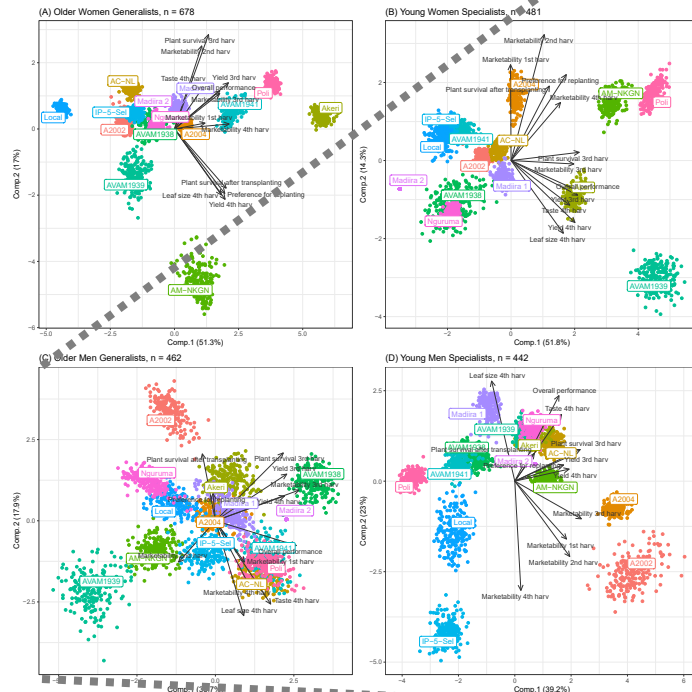
Table 4. Demographic and socioeconomic characteristics of farmers segments in amaranth production in Benin, Mali, and Tanzania.

	Segments			
	Older Women Generalists	Young Women Specialists	Older Men Generalists	Young Men Specialists
Average Age (years)	43	35	45	34
Dominant Gender	Woman	Woman	Man	Man
Who Controls Sale	Woman	Woman	Man	Man
Who Controls Production	Woman	Woman	Man	Man
Avg. Income Crop Share (%)	21.59	35.42	14.17	29.01
Avg. Experience with Crop (years)	1.18	6.2	5.52	8.95
Characteristics	Women with significant control over both sale and production, moderate income share from amaranth, relatively less experience in amaranth farming.	Younger women highly involved in both production and sale, highest income share from amaranth, and substantial experience growing amaranth, indicating specialization.	Predominantly men with considerable experience in amaranth farming, control over both production and sale, but the lowest average income share from the crop.	Younger men with high experience, significant income share from amaranth, control over both production and sale, indicating specialization.



#4 Market segments in traditional vegetables

Farmers' socio-economic data reveals different segments to inform participatory crop improvement



(C) Older Men Generalists, n = 462



In summary

- Tricot is a citizen science approach built on a multi-institutional partnership.
- It enables scaling of decentralized trials by offering a robust experimental design and straightforward data capturing approach.
- Farmers are exposed to crop diversity and assess it under their local conditions.
- On-farm/consumer preference data can be linked to several other datasets to explain how and why farmers/consumers take decisions.

The image is the cover of a book titled 'the tricot approach'. It features a photograph of two farmers, a woman on the left and a man on the right, both wearing red shirts and working in a field. The woman is wearing a patterned headscarf and a blue and yellow patterned skirt. The man is wearing dark trousers and black boots. They are both bent over, working with the soil. The background shows a cloudy sky and some trees in the distance.

*Thousands of farmers
doing research together*

the **tricot** approach

Guide for large-scale participatory experiments

Further reading

<https://1000farms.net>

<https://community.1000farms.net>

https://climmblog.net/blog/wiki/?post_type=st_faq

<https://climmblog.net/blog/wiki/climmblog-and-tricot-resources/>



Thank you!

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