Integrating late blight management strategies in potato production for enhanced efficacy and sustainability in Africa

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AsiaBlight meeting, May 2 2024

CIP INTERNATIONAL POTATO CENTER

OVERVIEW

- Importance of Potato in Africa
- Late blight of Potato
- Factors influencing LB management
- LB management strategy
- Concluding remarks

Potato in Africa (SSA)

- Food security and cash crop for ~ 5 million potato farmers
- Short cropping cycle of 3-4 months; 1-3 growing seasons/year
- An important crop for the "hunger months"
- Area has increased 2-6x in past 25 years, ~1.6 million ha
- Average yield 6-10 t/ha vs potential yield 40 t/ha

Potato Production Challenges in SSA

- Moderate use of inputs
- Limited knowledge on proper production practices, no-crop rotation
- Limited access to seed, re-use seed over and over
- Informal seed system, 97%
- Limited amount of quality assured and disease free seed

Consequently,
low yield 6-10 t/ha

Phytophthora infestans : Plant destroyer

- Irish potato famine in 1845-49 when 1.5 million people died and a million more emigrated: 8.4 million in 1844 had fallen to 6.6 million by 1851, and still is.
- Loses of up to 10 billion USD/year worldwide*.
- Loses in Sub-Saharan Africa are estimated 2.75 billion/year: Uganda 40-100%, Kenya 22-80%, Ethiopia up to 70%, etc.
- The main mode of reproduction is asexual and variable numbers of clonal lineages exist in different countries and regions.
- Populations are constantly evolving, and usually more aggressive genotypes appear periodically replacing the previously dominating genotypes.
- Polycyclic disease that explodes under favorable conditions, integrated management strategies are crucial.

* Haverkort, A. J., Struik, P. C., Visser, R. G. F., & Jacobsen, E. J. P. R. (2009). Potato research, 52, 249-264 using 2017 production data

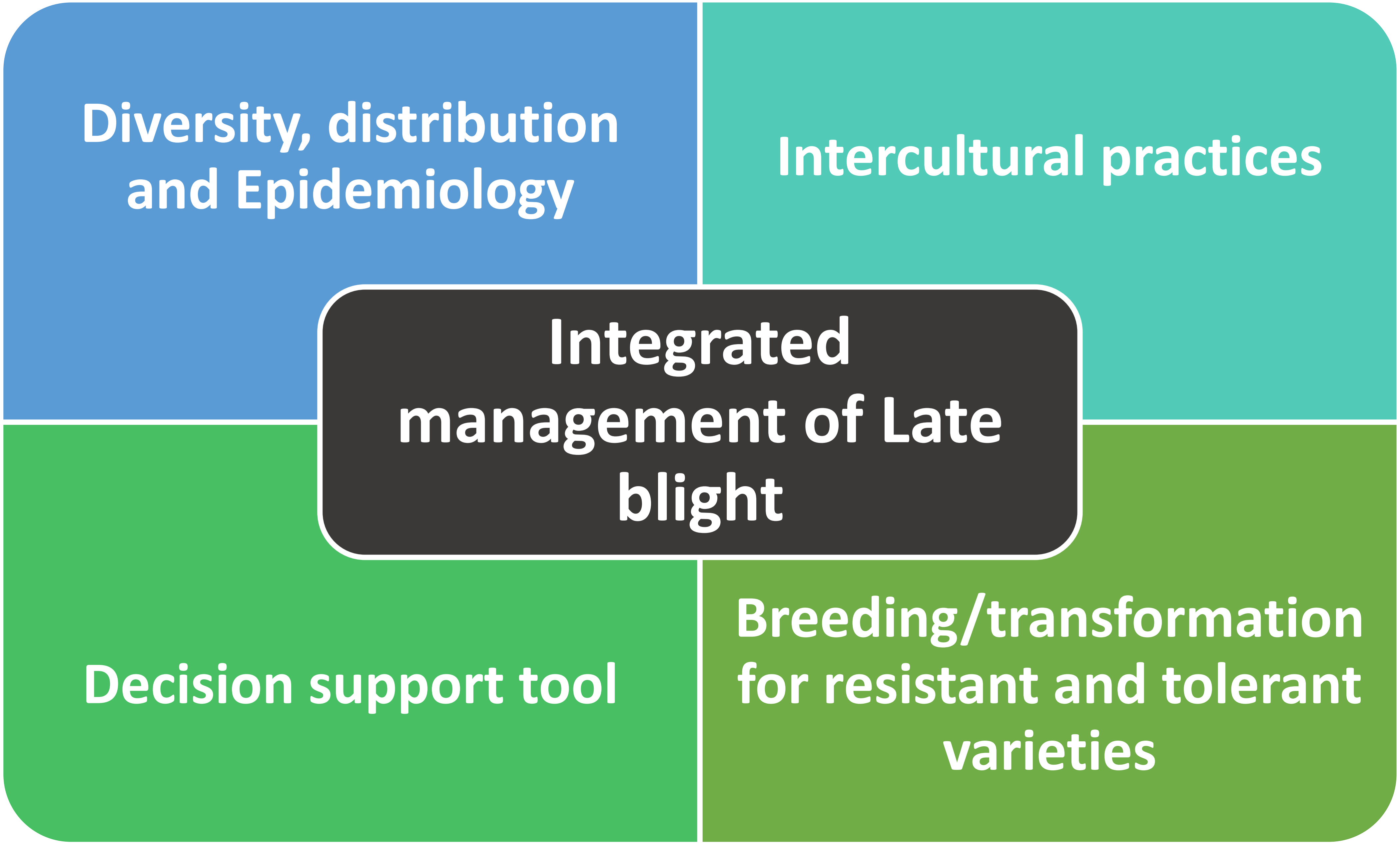
Phytophthora infestans: Increased aggressiveness

- Sexually reproducing population → more variation
- Adapted to higher/lower temperatures
- Better survival on tubers
- Shorter latent period
- Higher production of spores
- Breaking of cultivar resistance
- Wider host range

* Haverkort, A. J., Struik, P. C., Visser, R. G. F., & Jacobsen, E. J. P. R. (2009). Potato research, 52, 249-264 using 2017 production data

Consequences for control strategies?

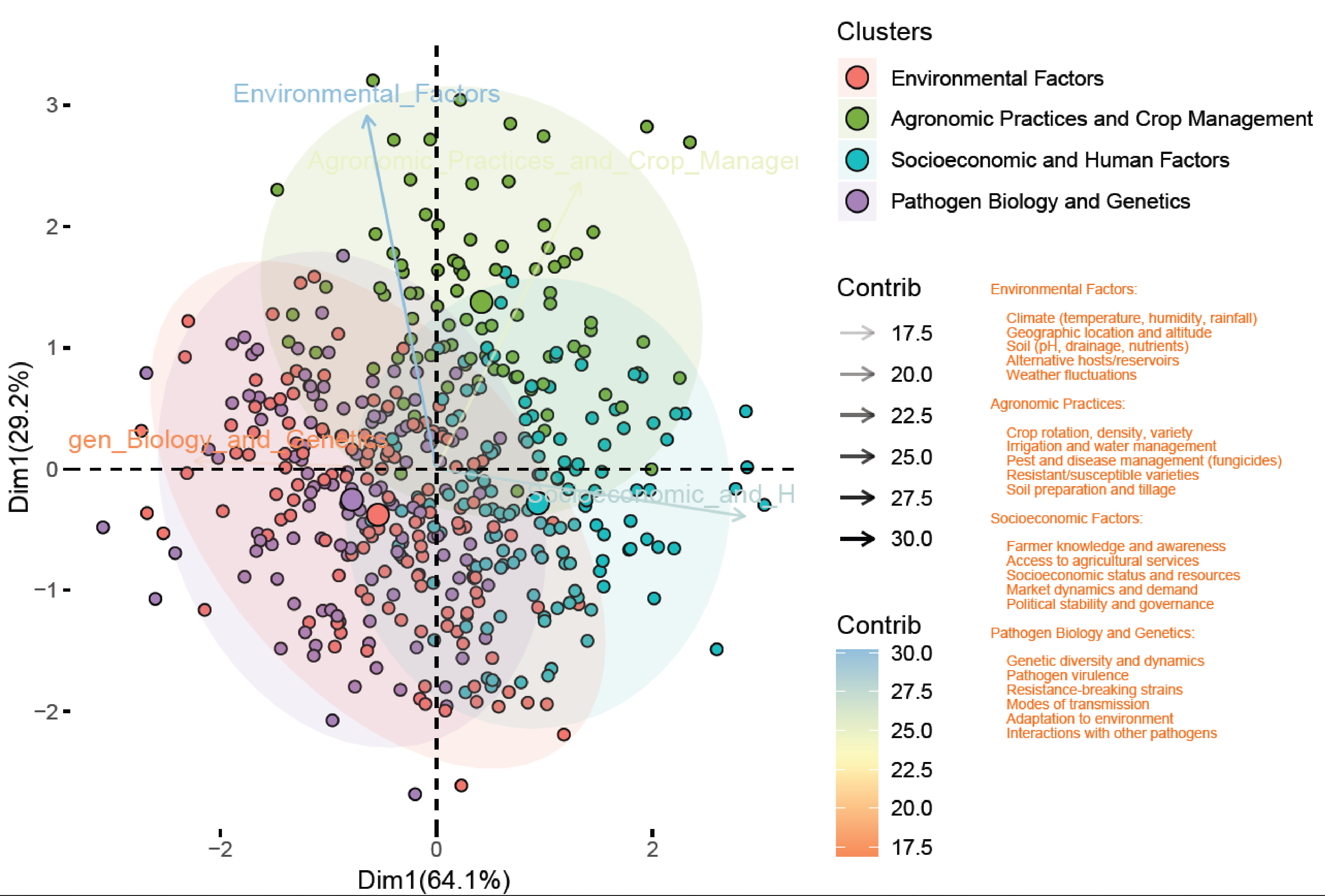
- Earlier spray start (Hannukkala, 2007)
- Influence of rotation (Bødker, 2005)
- Shorter spray intervals?
- More need for protection of new growth (preventive + curative)?
- Tuber protection?
- Stem blight?


Diversity, distribution and Epidemiology
Intercultural practices
Integrated management of Late blight
Decision support tool
Breeding/transformation for resistant and tolerant varieties

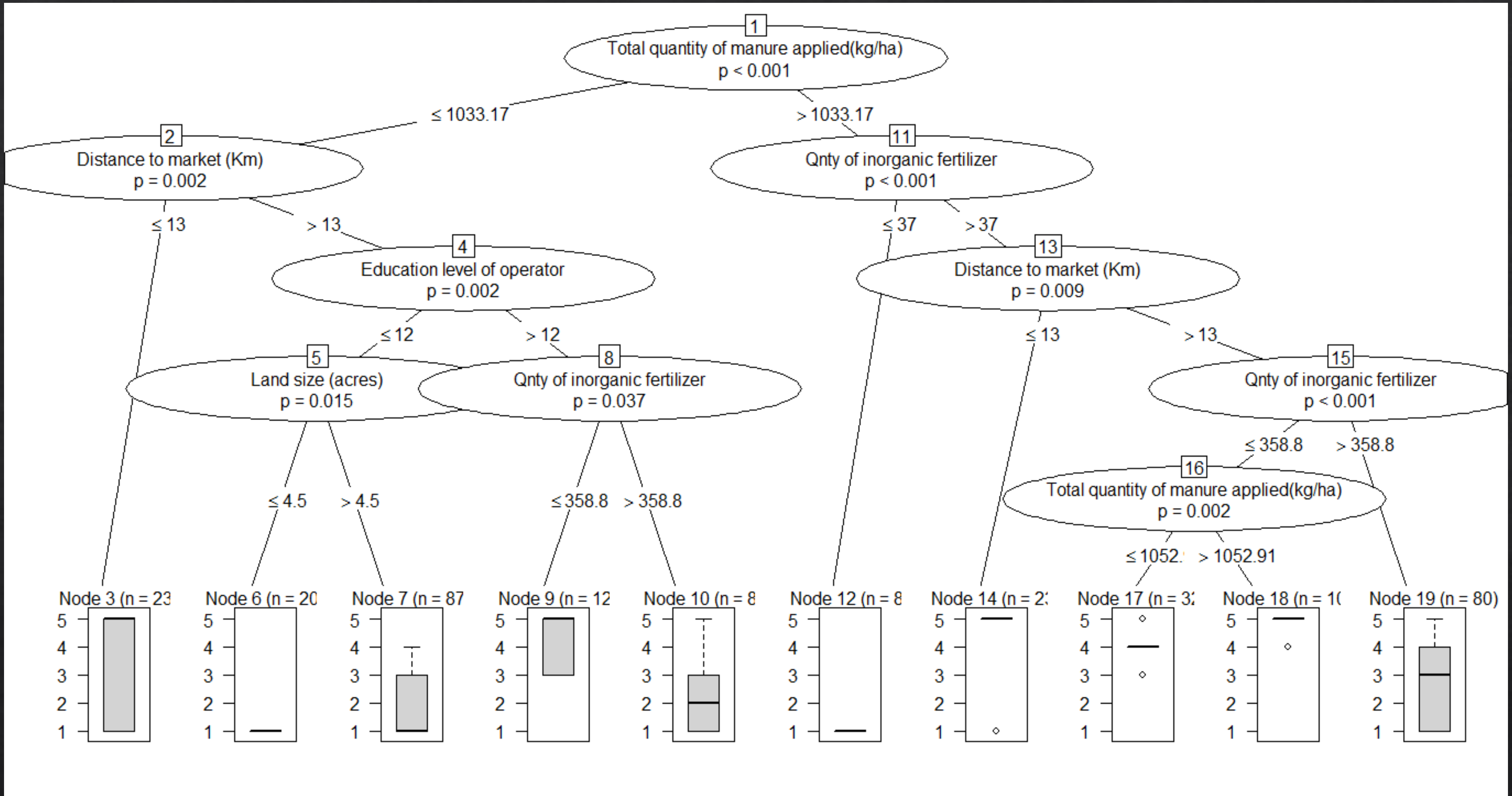
Diversity, distribution and Epidemiology

Factors Influencing LB management in SSA: Case of Central Kenya

Understanding the factors influencing LB development is paramount for designing sustainable LB management strategies



Biophysical and Socioeconomic factors influencing LB management: Case of Kenya Highland



- Quantity of manure application
- Distance to mkt
- Land size
- Education levels of farm operators
- Quantity of inorganic fertilizer

P. infestans population in EAC (2016)

TABLE 2. Summary of multilocus genotype diversity found in the *Phytophthora infestans* subpopulations found in different countries and on different hosts for the 2017 full dataset

Country	Lineage[b]	Potato		Tomato		All samples[a]	
		N[c]	eMLG[d]	N[c]	eMLG[d]	N[e]	All eMLG[f]
Burundi	2_A1	68	8.11	...	...	...	...
	US-1	11	10	...	...	...	...
	All					79	49
Kenya	2_A1	232	7.19	31	9.61	...	...
	US-1	...	...	12	9.32	...	...
	2_A1REF	22	7.68	...	...	...	...
	All	...	...	...	...	275	44.5
Rwanda	2_A1	151	7.35	...	...	...	...
	US-1	29	9.12	8	5	...	...
	All	...	...	...	...	188	41.1
Uganda	2_A1	260	6.57	...	...	...	...
	US-1	75	9.73	56	9.77	...	...
	All	...	...	...	...	391	46.9
Tanzania	2_A1	30	8.27	...	...	...	...
	US-1	46	9.79	4	3	...	...
	All	...	...	...	...	80	64.3

[a] Number of all *Phytophthora infestans* samples in the respective countries.
[b] Denotes the *P. infestans* clonal lineage; 2_A1REF represents the reference samples.
[c] Number of samples from each clonal lineage in each country on either potato or tomato.
[d] Expected number of multilocus genotypes (eMLGs) for each clonal lineage after rarefaction (or genetic richness at the largest shared sample size) on either potato or tomato.
[e] Total number of samples from each country.
[f] eMLGs for all samples after rarefaction for each country.

› Phytopathology. 2019 Apr;109(4):670-680. doi: 10.1094/PHYTO-07-18-0234-R. Epub 2019 Feb 15.

Genotyping of Phytophthora infestans in Eastern Africa Reveals a Dominating Invasive European Lineage

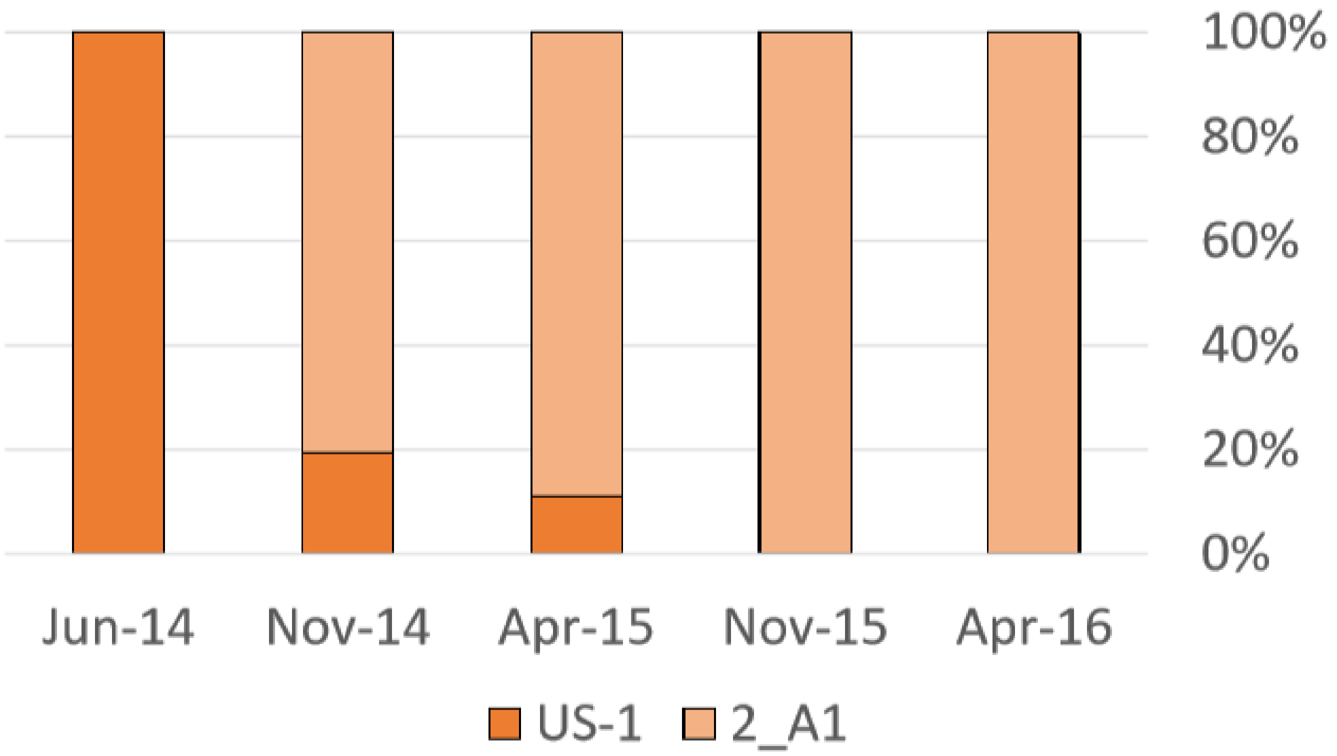
Anne W Njoroge [1 2], Björn Andersson [2], Alison K Lees [3], Collins Mutai [4], Gregory A Forbes [5], Jonathan E Yuen [2], Roger Pelle [4]

Affiliations + expand

PMID: 30253119 DOI: 10.1094/PHYTO-07-18-0234-R

P. infestans population in Uganda (2016)

- Genotyping carried out using standardized multiplex markers (12 SSR markers)
- No virulent Pi strain found expression of Pi effector genes: avrblb1 (Ipio-1, Ipio-2, Ipio-3, Ipio-4), avrblb2 (Ala69, Ile69, Phe69, Val69), avrvnt1 (Vnt1).
- Shift from US-1 (2014) to 2_A1 (2016) lineage (no A2 mating type).




Plant Pathology
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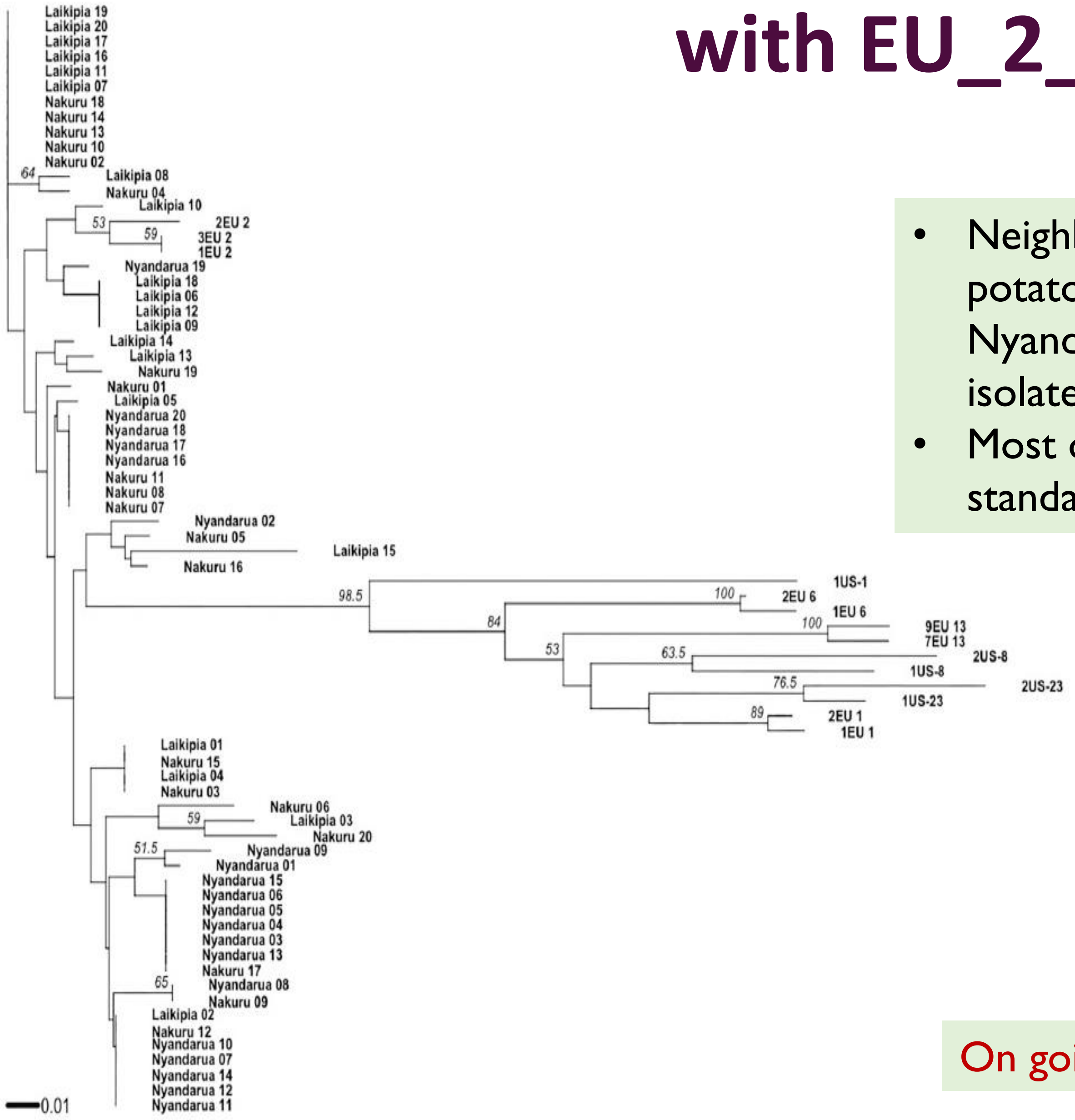
Original Article | Free Access

Displacement of US-1 clonal lineage by a new lineage of *Phytophthora infestans* on potato in Kenya and Uganda

A. W. Njoroge, G. Tusiime, G. A. Forbes, J. E. Yuen

First published: 01 September 2015 | https://doi.org/10.1111/ppa.12451 | Citations: 16

Kenyan isolates of *P. infestans* cluster most closely with EU_2_A1 (2022)



- Neighbour-joining tree for *P. infestans* populations from potato collected in three counties (Nakuru, Laikipia and Nyandarua) in Kenya along with European and US standard isolates.
- Most of the isolates clustered closer to the EU_2_A1 standards than others.

On going work on PI survey and distribution study from EAC

Intercultural Practices/Interventions

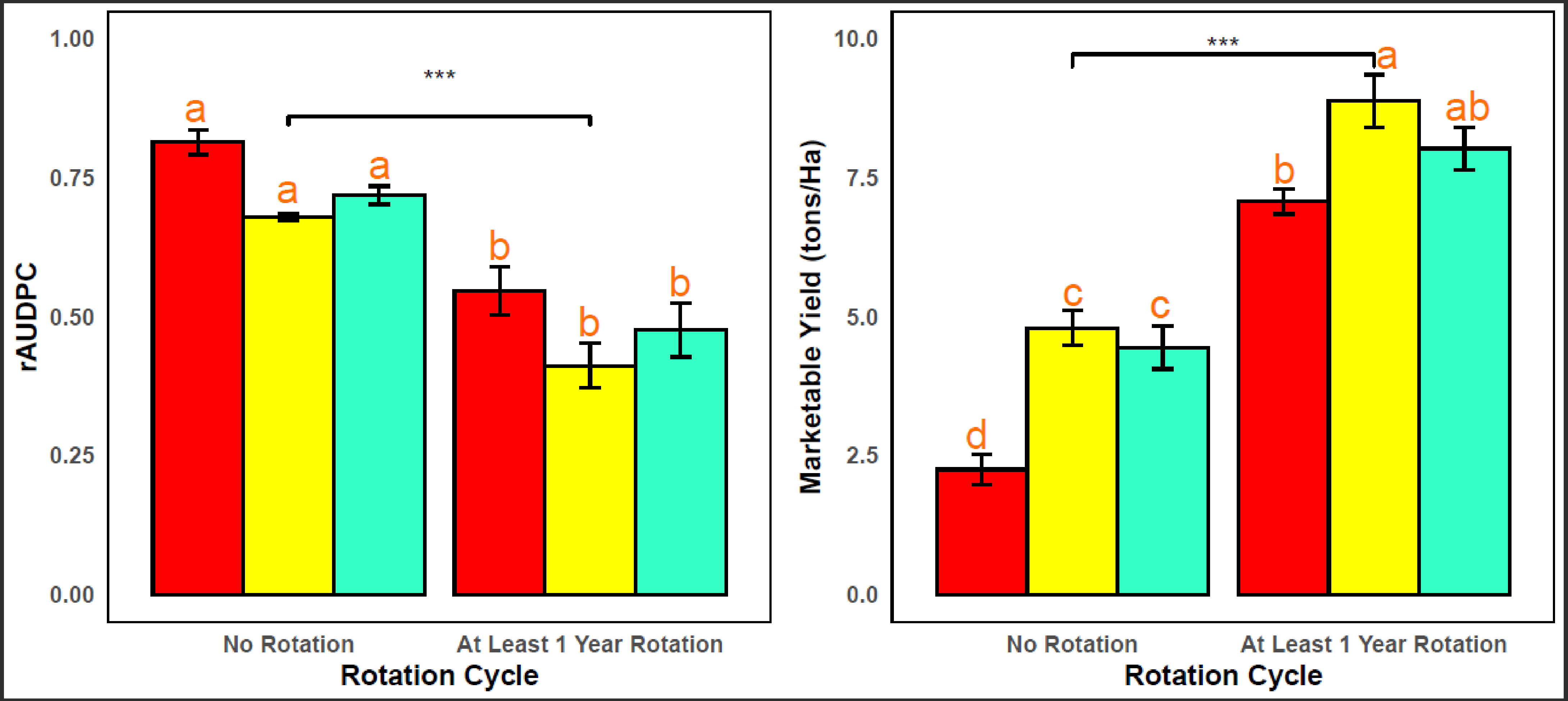
ToT, demonstration and training

- Use recommended contact and systemic fungicides
- Reduce primary inoculum
- Use resistant/tolerant varieties
- Using healthy seed not infected with late blight
- Remove volunteers from the garden prior to planting and space plants far enough apart to allow for plenty of air circulation.
- Water in the early morning hours, or use soaker hoses, to give plants time to dry out during the day — avoid overhead irrigation.
- Crop rotation

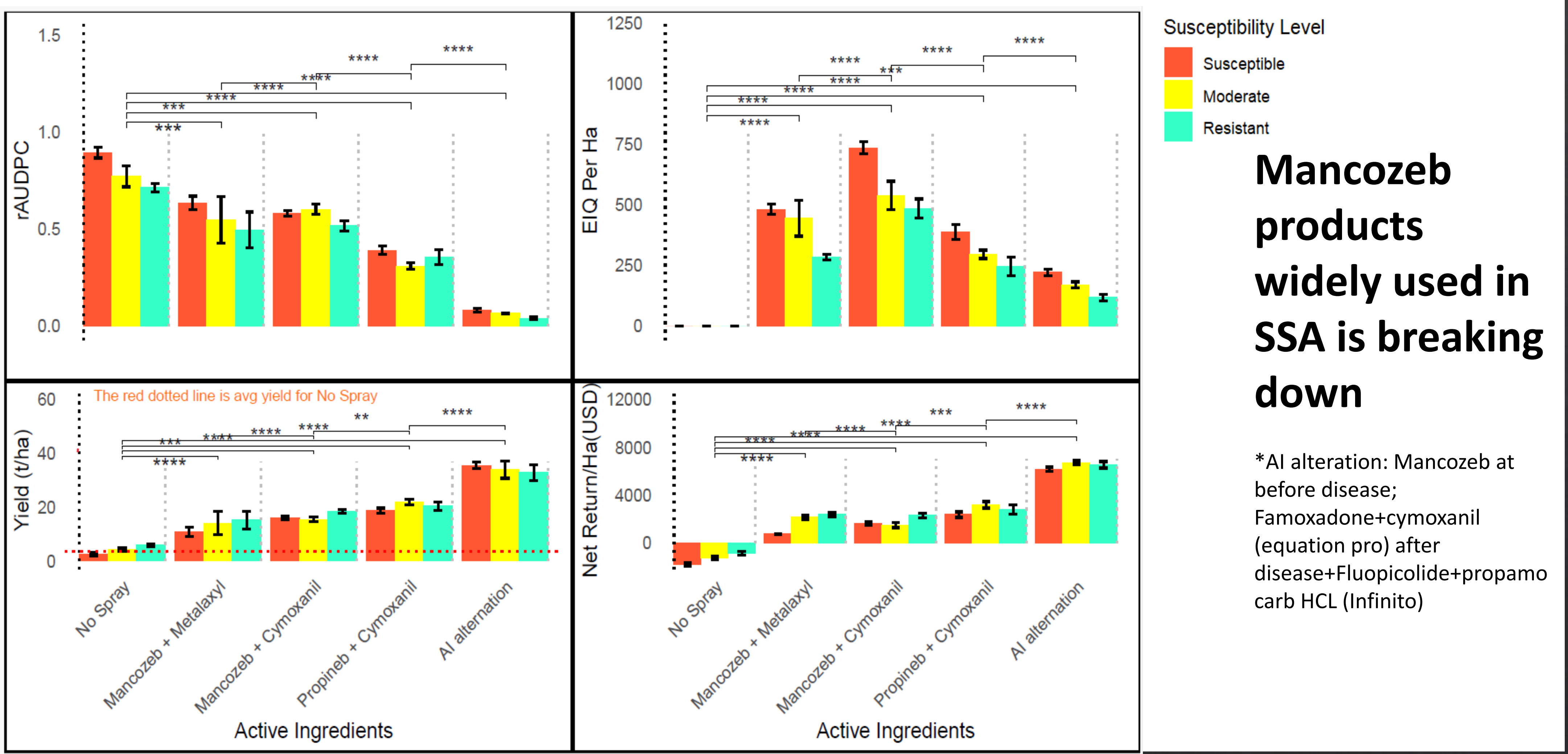
Cultural practices..

- We subset 20 farmers practicing No Spray, but with or without rotation program in central Kenya.

Rotational practices significantly reduced disease pressure, pointing to inoculum buildup with inadequate or lack of rotation



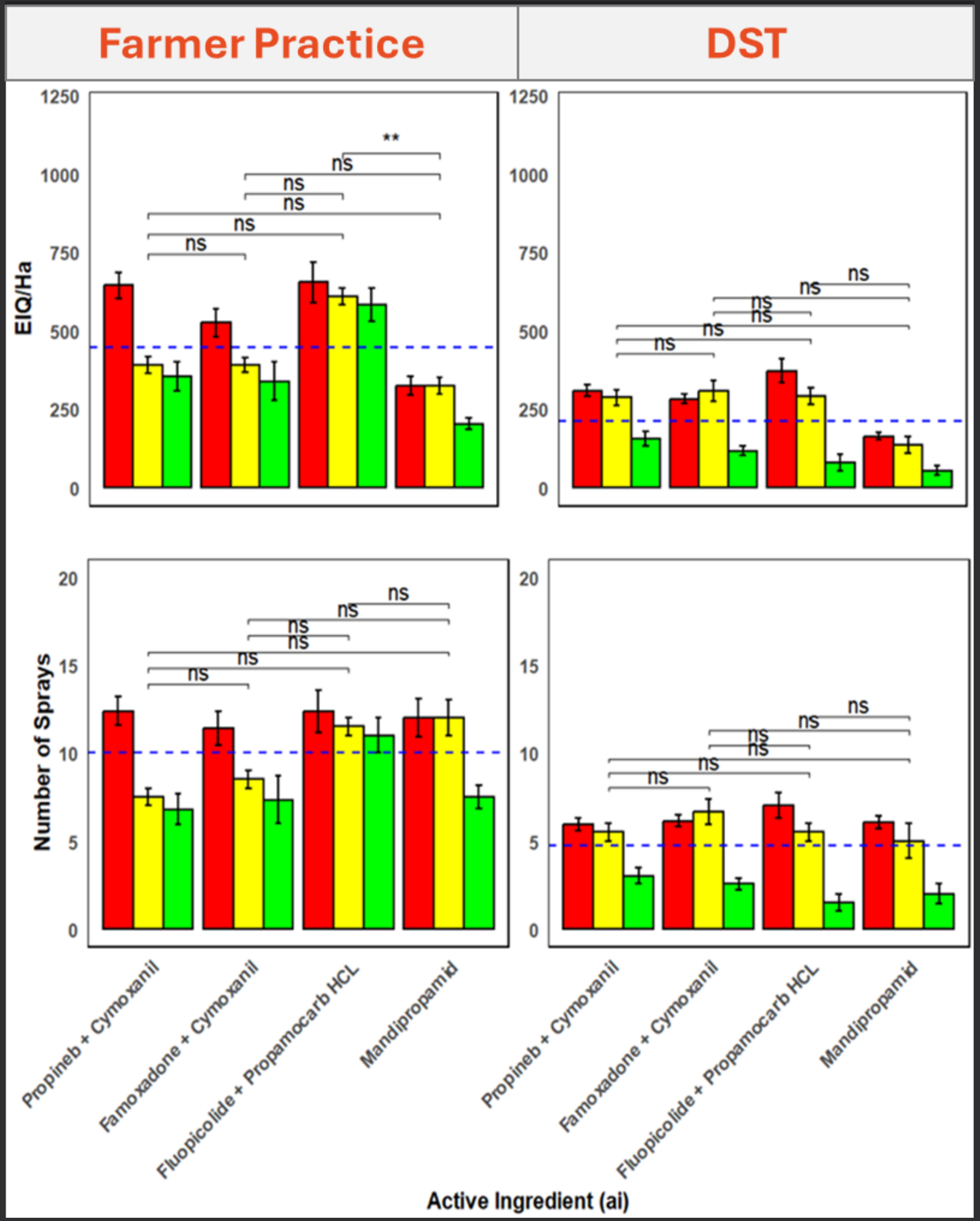
Comparison efficacy of ai and Costs- a case of Kenya with 97 farmers



Mancozeb products widely used in SSA is breaking down

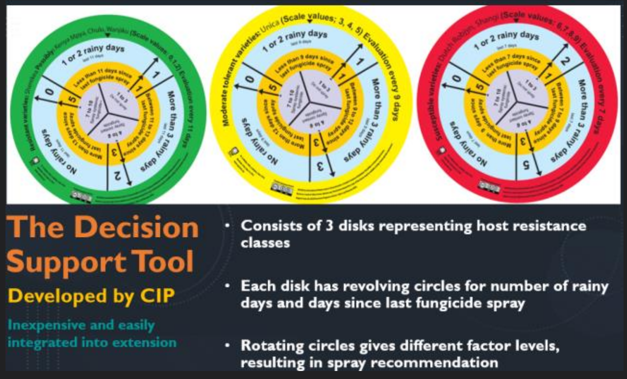
*AI alteration: Mancozeb at before disease; Famoxadone+cymoxanil (equation pro) after disease+Fluopicolide+propamocarb HCL (Infinito)

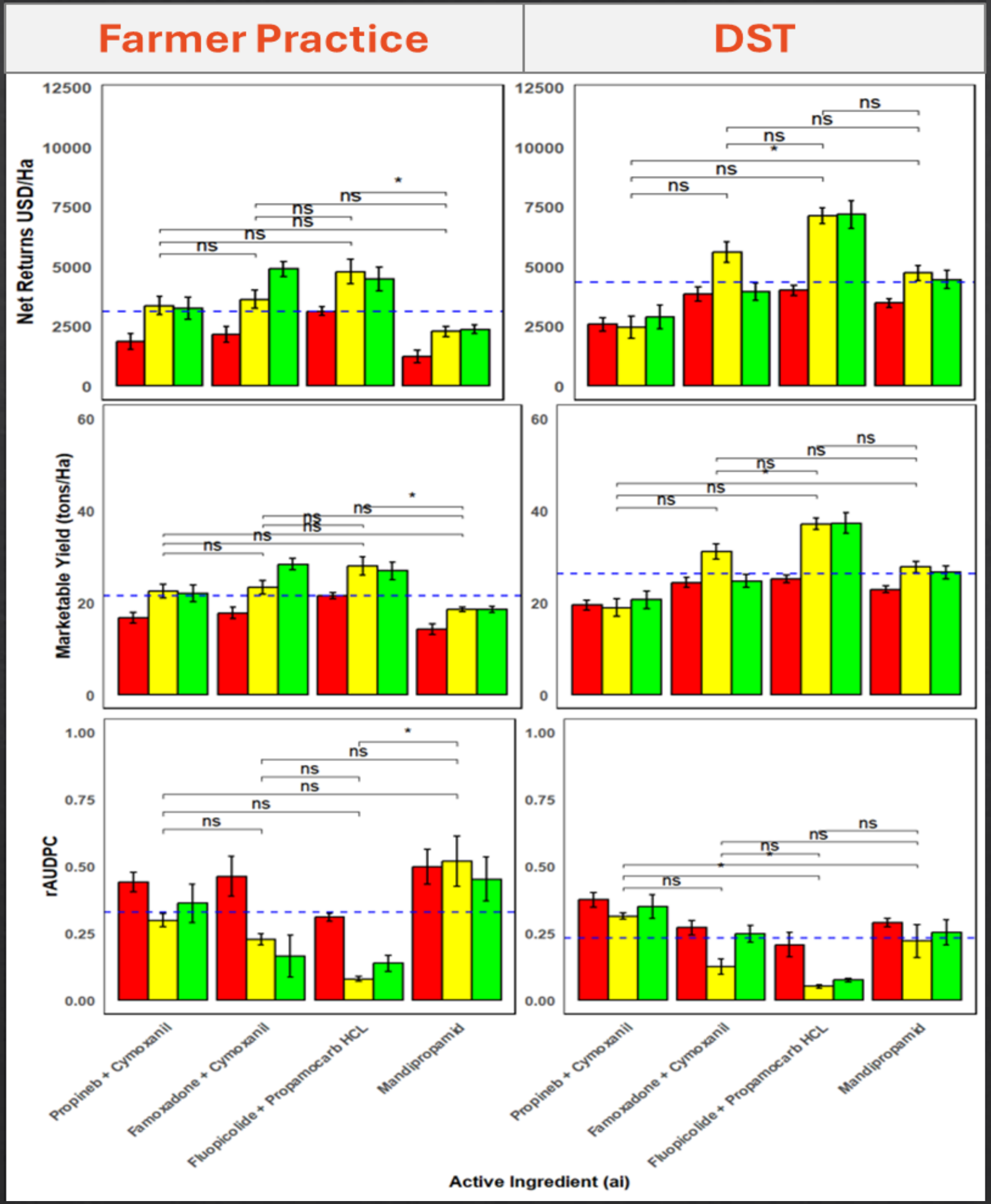
Alternating active ingredients proves more effective, cost-efficient and environmentally friendly.



Empowering Farmers Through Decision Support

- DSS cut down the number of sprays with no yield loss
- User-friendly interfaces are necessary for DSS to be suitable for smallholders-an example is the portable disk developed by CIP
- The DSS has potential to empower farmers with timely guidance for proactive LB management.

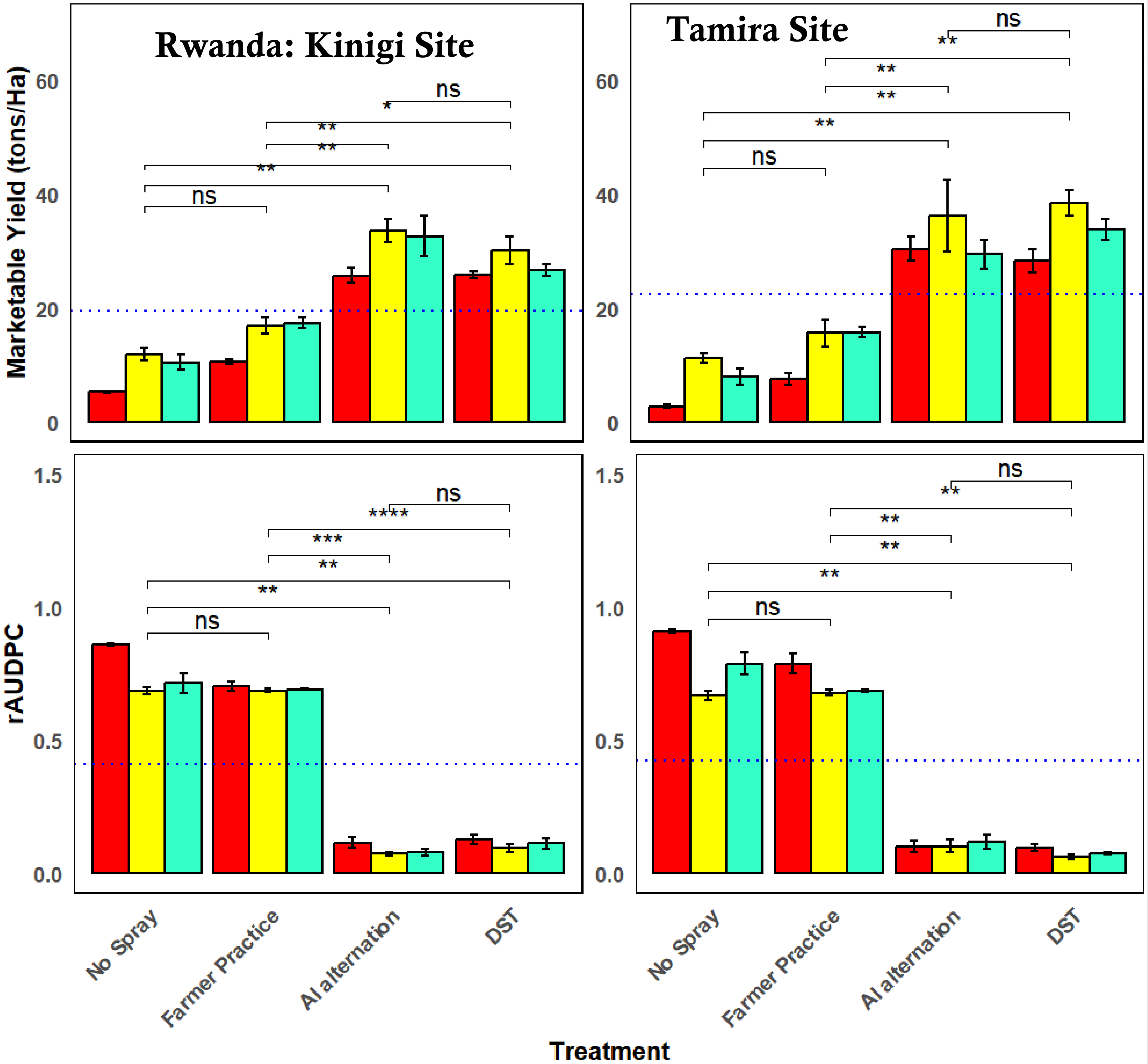




Integrated use of low EIQ products and DSS

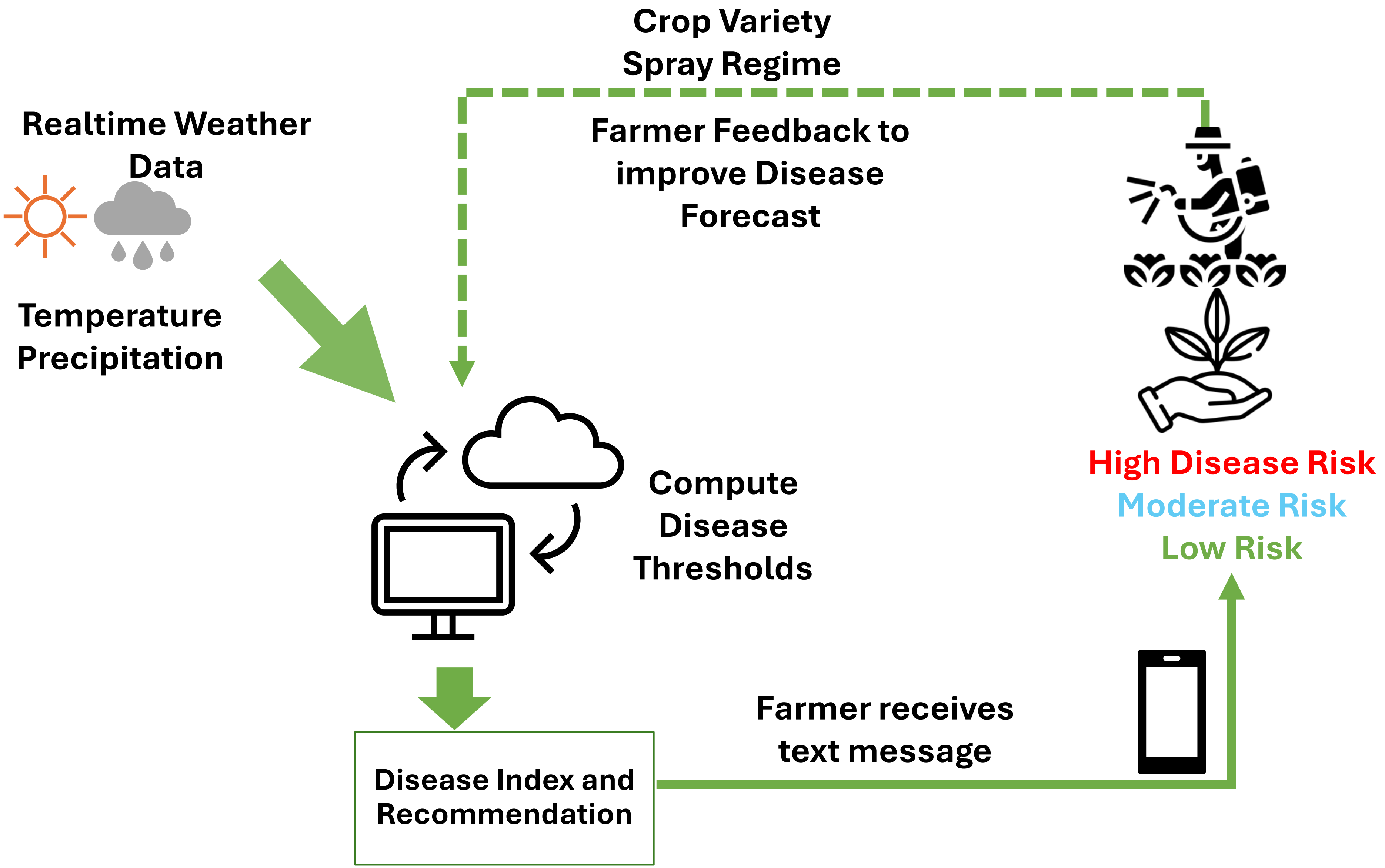
- DSS superiority over conventional farmer practices, improving yields, eco-friendliness, and profitability
- Resistant genotypes by low EI ai interactions yield better returns.

Change of Phytophthora resistance-case of Rwanda

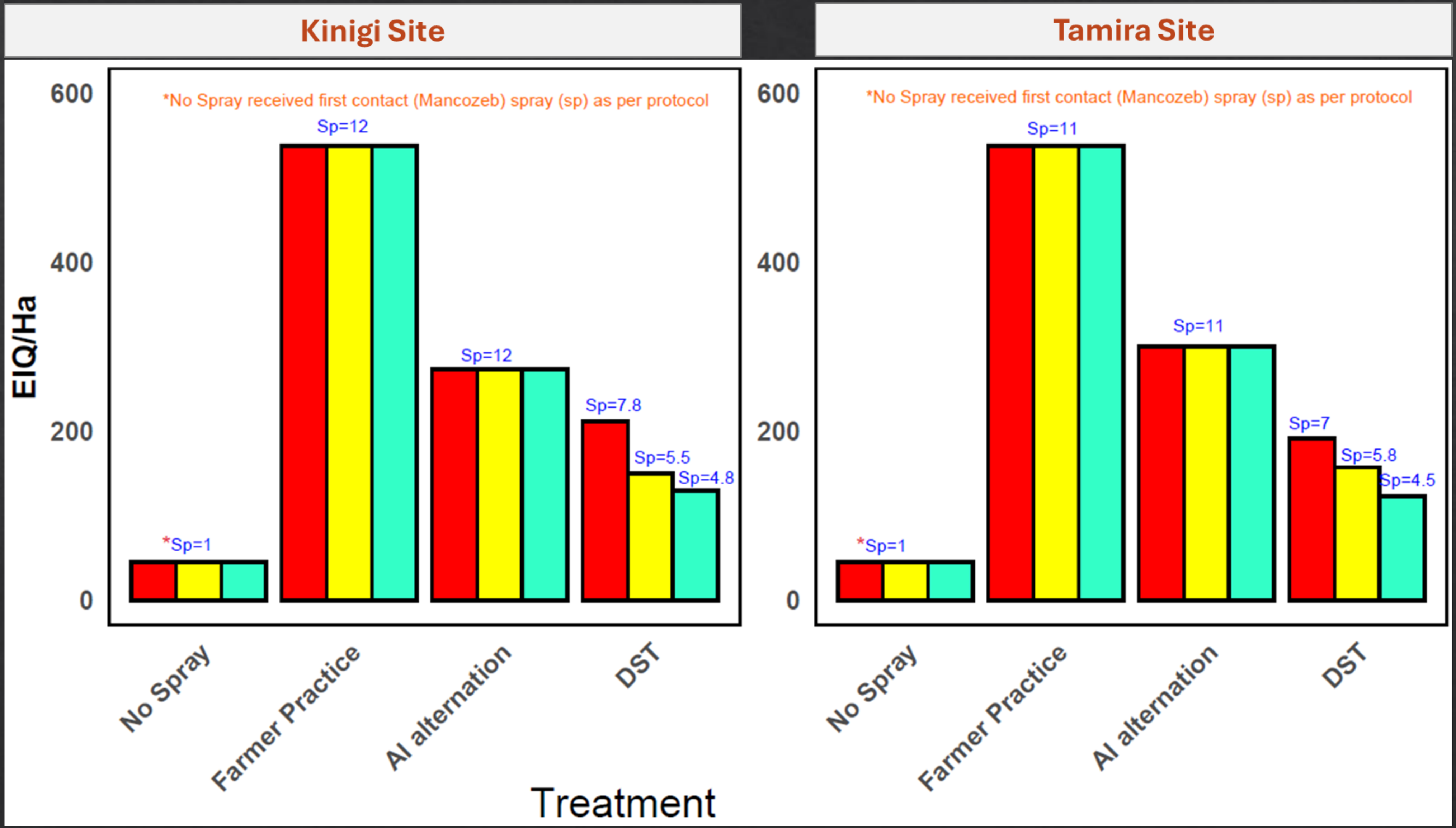


- In Rwanda, govt policy allows only the mancozeb/ metalaxy/Mefenoxam products-farmer practice, but no alternation
- Test results 2023 show metalaxy/mefenoxam breakdown in Rwanda, prompting further disease management investigations.

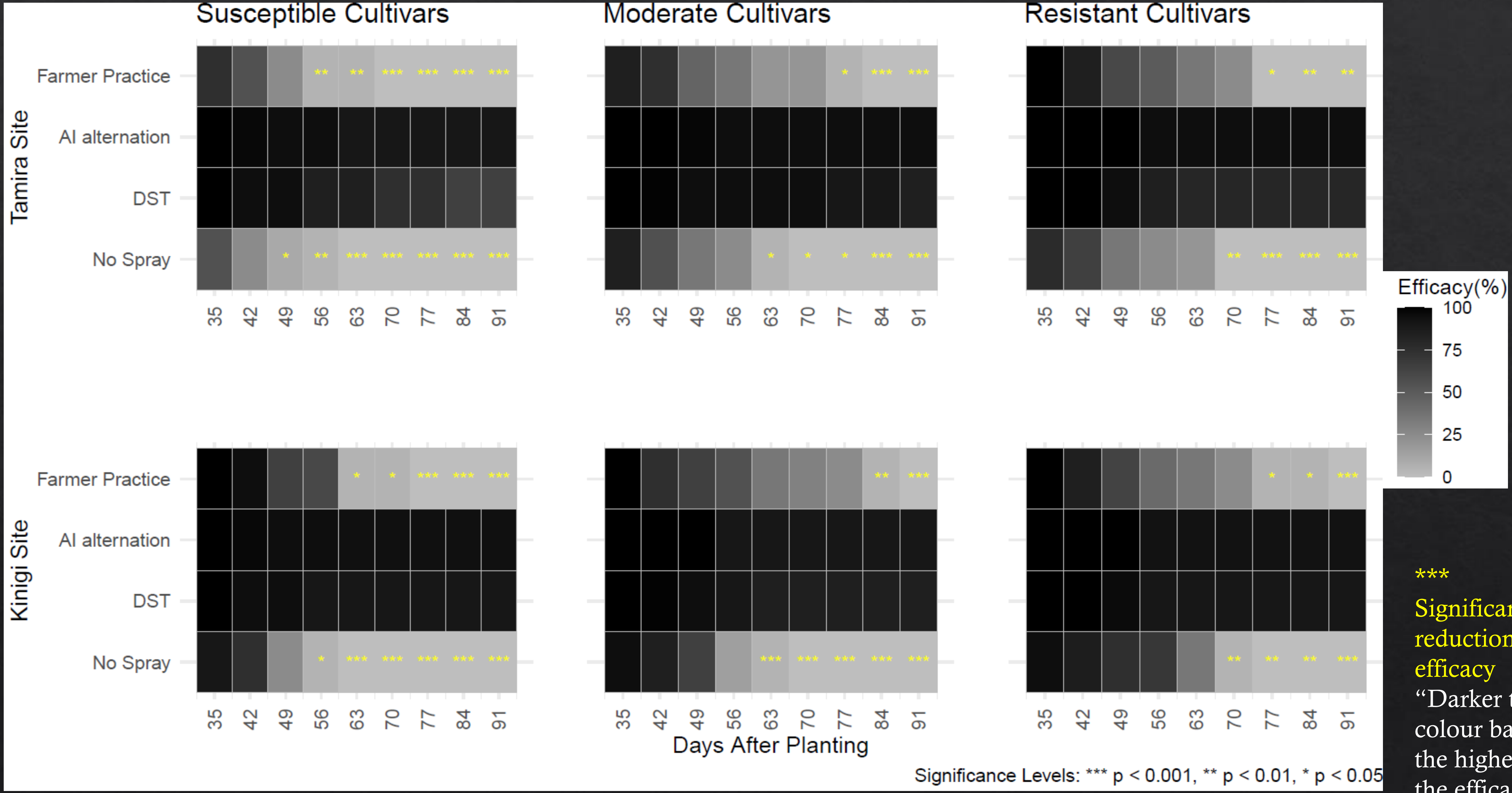
Decision Support System on Late blight Management



Farmer practice in Rwanda is results in adverse envt. impact!

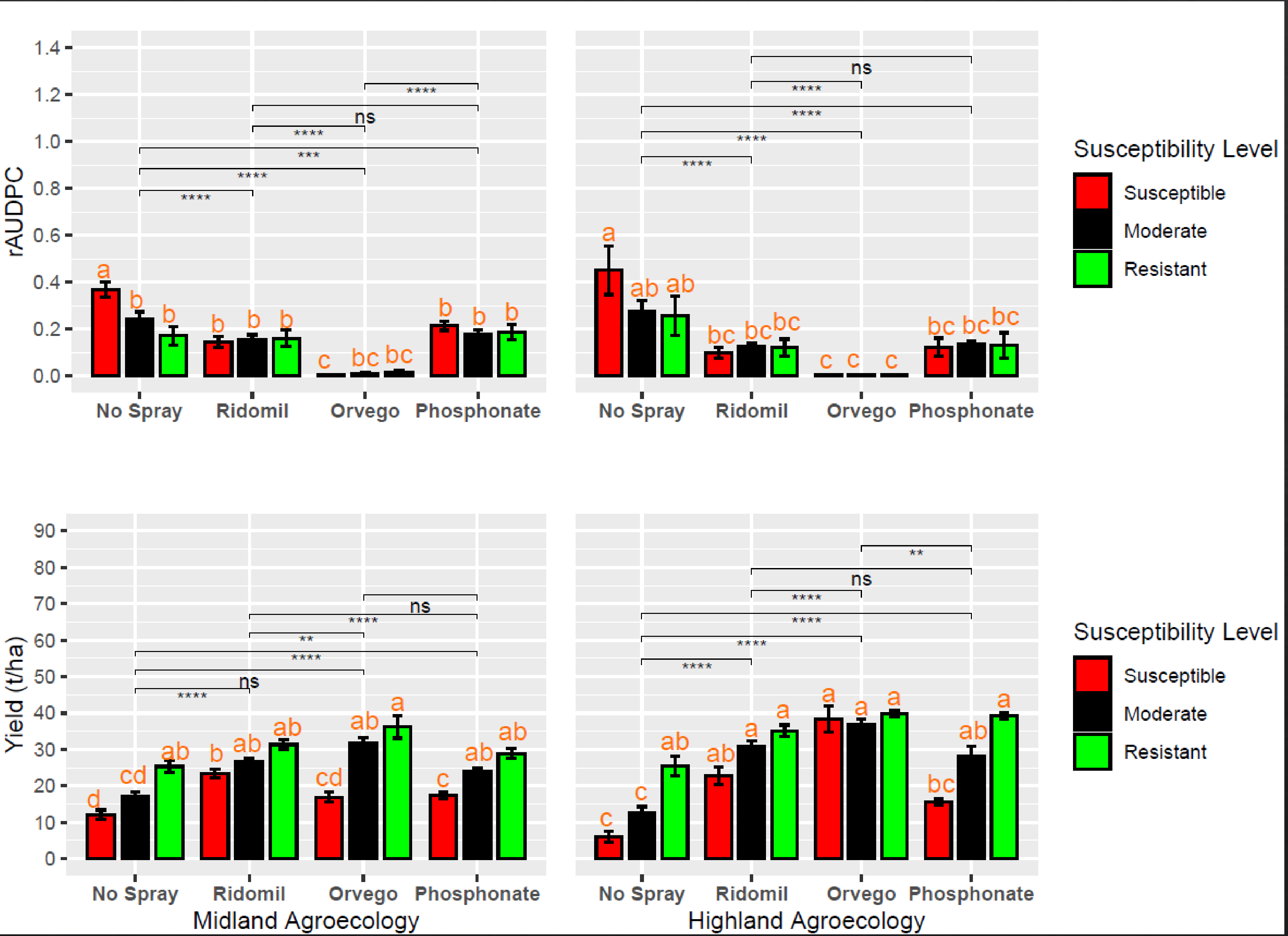


The efficacy of Ridomil-mancozeb product generally broke down from 56 DAP



*** Significant reduction of efficacy

"Darker the colour bars the higher the efficacy"

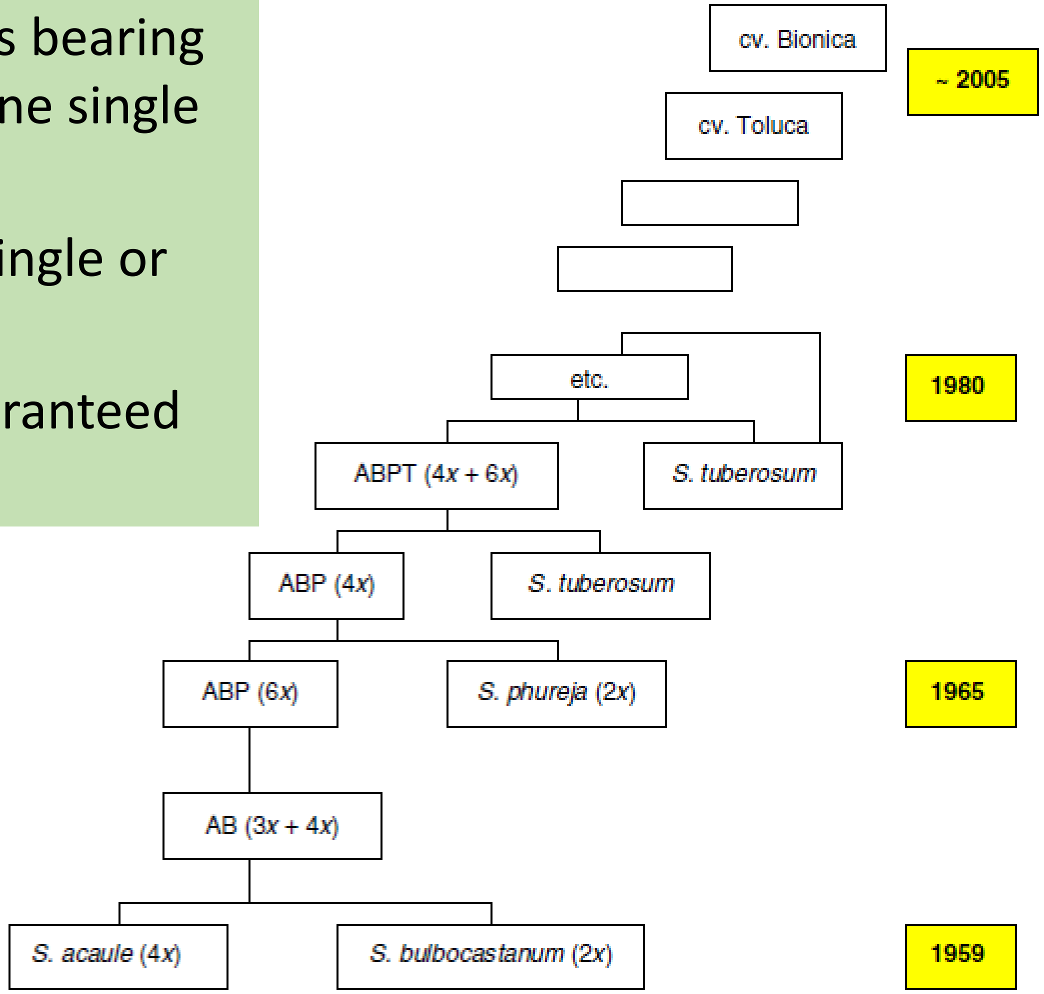


Phosphonates as alternative low environmental impact option, example from Kenya

Breeding/transformation for resistant and tolerant potato varieties

Genetic improvement of potato varieties

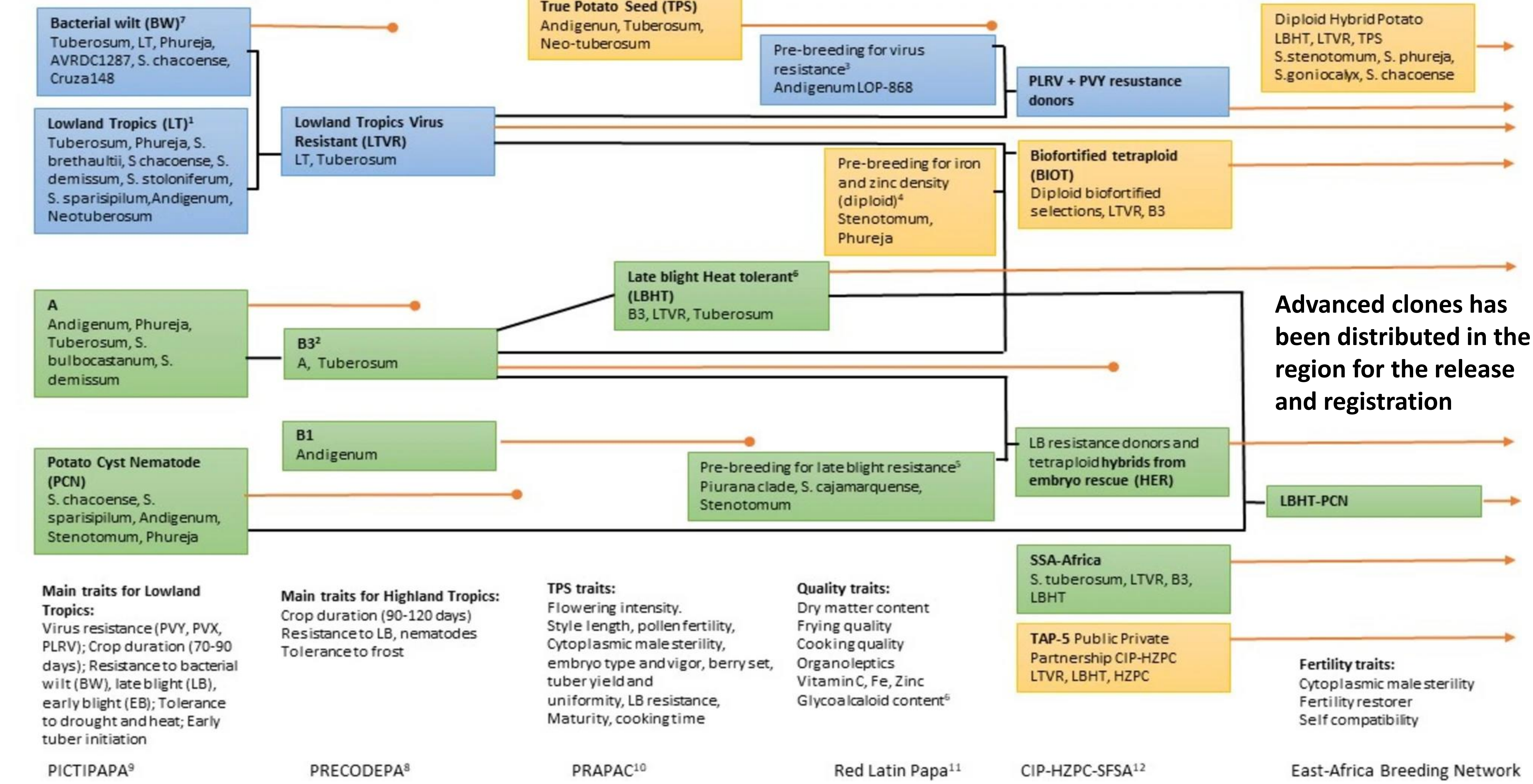
- Breeding/Crossing and selection using wild species bearing LB resistance genes took **46 years*** to introgress one single *R* gene.
- About **50 potato varieties**** were found to bear single or multiple R genes.
- Long development timeline and durability not guaranteed



*Haverkort, A. J., Struik, P. C., Visser, R. G. F., & Jacobsen, E. J. P. R. (2009). Applied biotechnology to combat late blight in potato caused by Phytophthora infestans. Potato research, 52, 249-264.

**Paluchowska, P., Śliwka, J., & Yin, Z. (2022). Late blight resistance genes in potato breeding. *Planta*, *255*(6), 127.

Eric Magembe, Molecular Biologist; Thiago Mendes, Breeder Africa

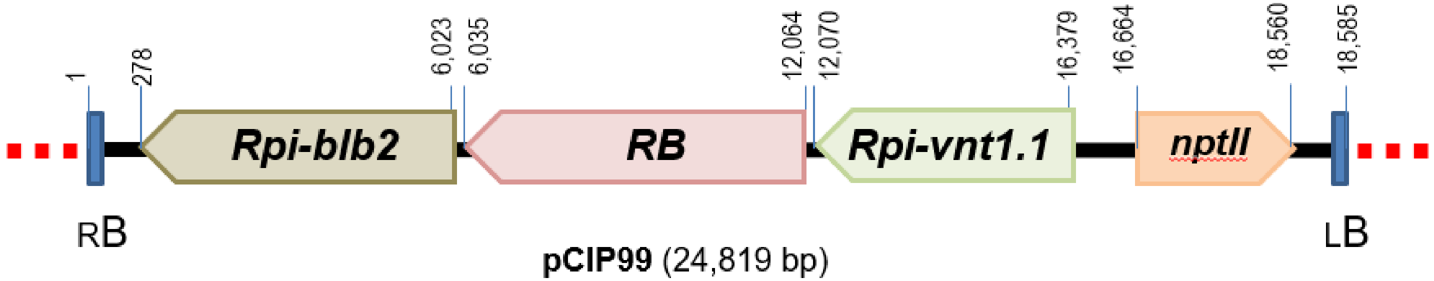


Advanced clones has been distributed in the region for the release and registration

3 R-gene LBR GM potato

Stack of 3 *R* genes from wild relatives:

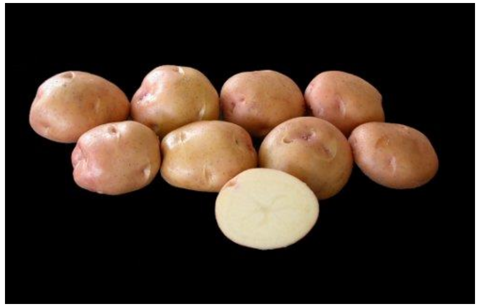
- ***RB*** (*Rpi-blb1*) and ***Rpi-blb2*** from *Solanum bulbocastanum*
- ***Rpi-vnt1.1*** from *Solanum venturii*



2 - 4 years

Farmer-preferred varieties:

Victoria/Asante, Shangi, Tigoni, Desiree, Jalene, and Diamant



Target Countries:

Uganda, Kenya, Nigeria, Rwanda, and Ethiopia

Ghislain *et al.,* 2019. Plant Biotechnology J, 17:1119-1129

Concluding Remarks

- IPM increases efficacy of control, reduces costs and environmental side effects
- Lack of fungicides and LB management options in global south, more investment for favorable policy investment
- Climatic shifts are also contributing to the expansion of LB, more research in this area
- Favorable political and environmental conditions to deploy biotec crops
- CapDev at various level, research and partnership with private and public sector
- Pragmatic approach- collaboration with local, regional and international expert

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