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Hyperspectral imaging in Breeding Program

Characterisation of cooking ability of boiled cassava

24ème Rencontres HélioSPIR
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Karima Meghar, Qualisud, CIRAD

Contributors
CIRAD : Thierry Tran, Fabrice Davrieux.
CIAT : Luis Fernando Delgado, Maria Alejandra Ospina, Jhon Larry Moreno, Jorge Luna, Luis Londoño.

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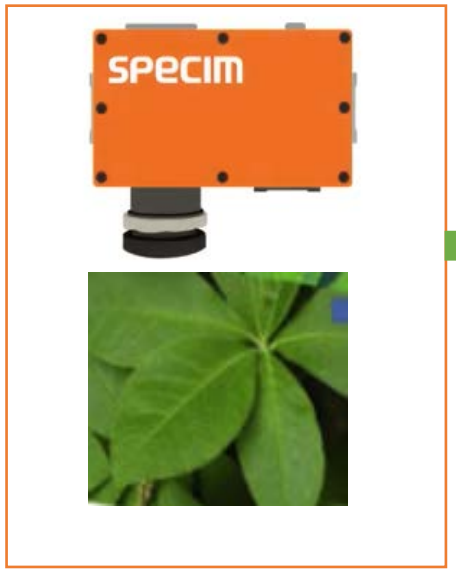
Challenge and objectives

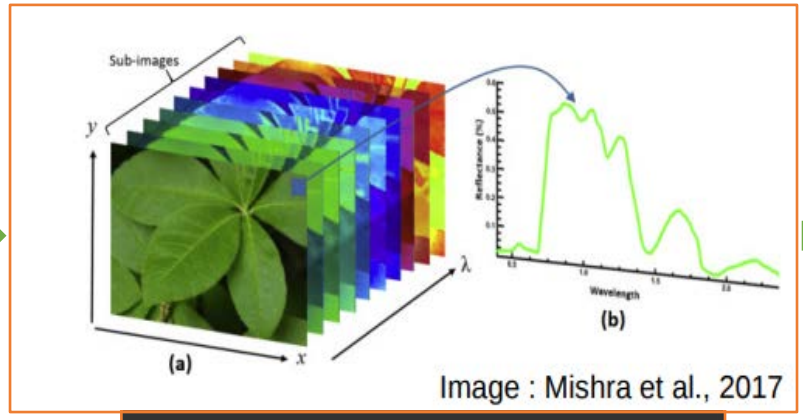
1. Could HSI be used as HTTP to discriminate between contrasting cassava genotypes in terms of cooking behavior ?
2. Explore the potential of HSI to replace traditional measurements (DMC, WA30) to determine cooking quality of boiled cassava.
3. - Develop the Models for DMC and WA30
   - Produce maps for the visualization of DMC and WA30 distribution.

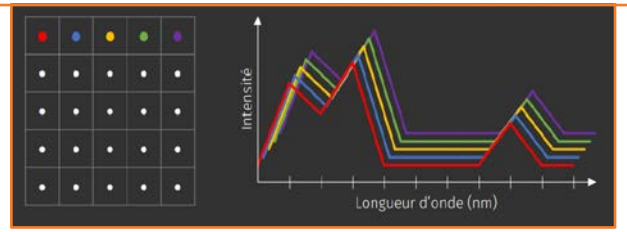
What hyperspectral imaging provides ?

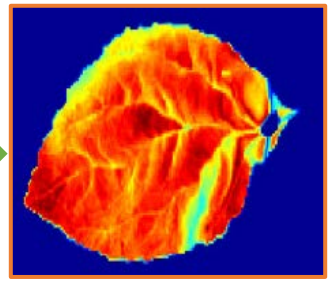
- Hyperspectral imaging combines spectroscopic and imaging techniques to enable direct identification of different components and their spatial distribution within the sample.

- Each plan is one image acquired for one wavelength.
- Each pixel in hyperspectral image represents one spectrum.









Advantages :

- Non destructive and chemical free;
- Less time consuming than conventional methods;
- Spatial visualization of different biochemical constituents of the sample.

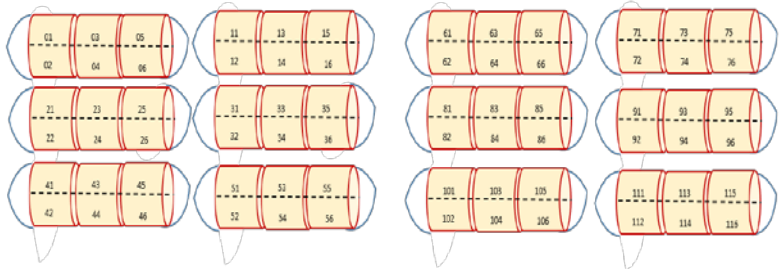
Plant material and Samples preparation

Cassava roots from 31 genotypes (RTBfoods progenitors) harvested in march 2022 at CIAT (Colombia)

12 roots selected per genotype, washed and peeled.

Each root was divided into 6 half-cylinders, 6×12=72 half-cylinders per genotype

central semi-cylinders number 03,43,103, 114 were selected for HSI, DM and WA30

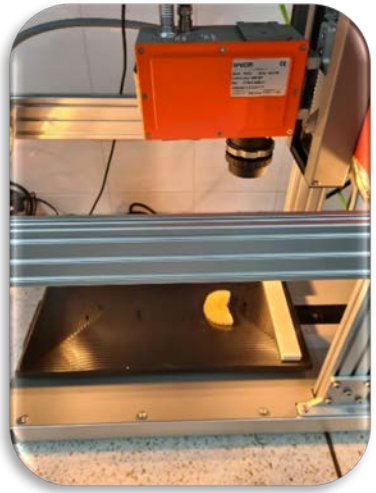


Protocol of measurements

4 half cylinders per genotype

Fresh

Cook



One transversal slice per half cylinder was cut and used immediately for HSI then DM measurements

+

One independent root per genotype was used for HSI measurement on longitudinal fresh slices

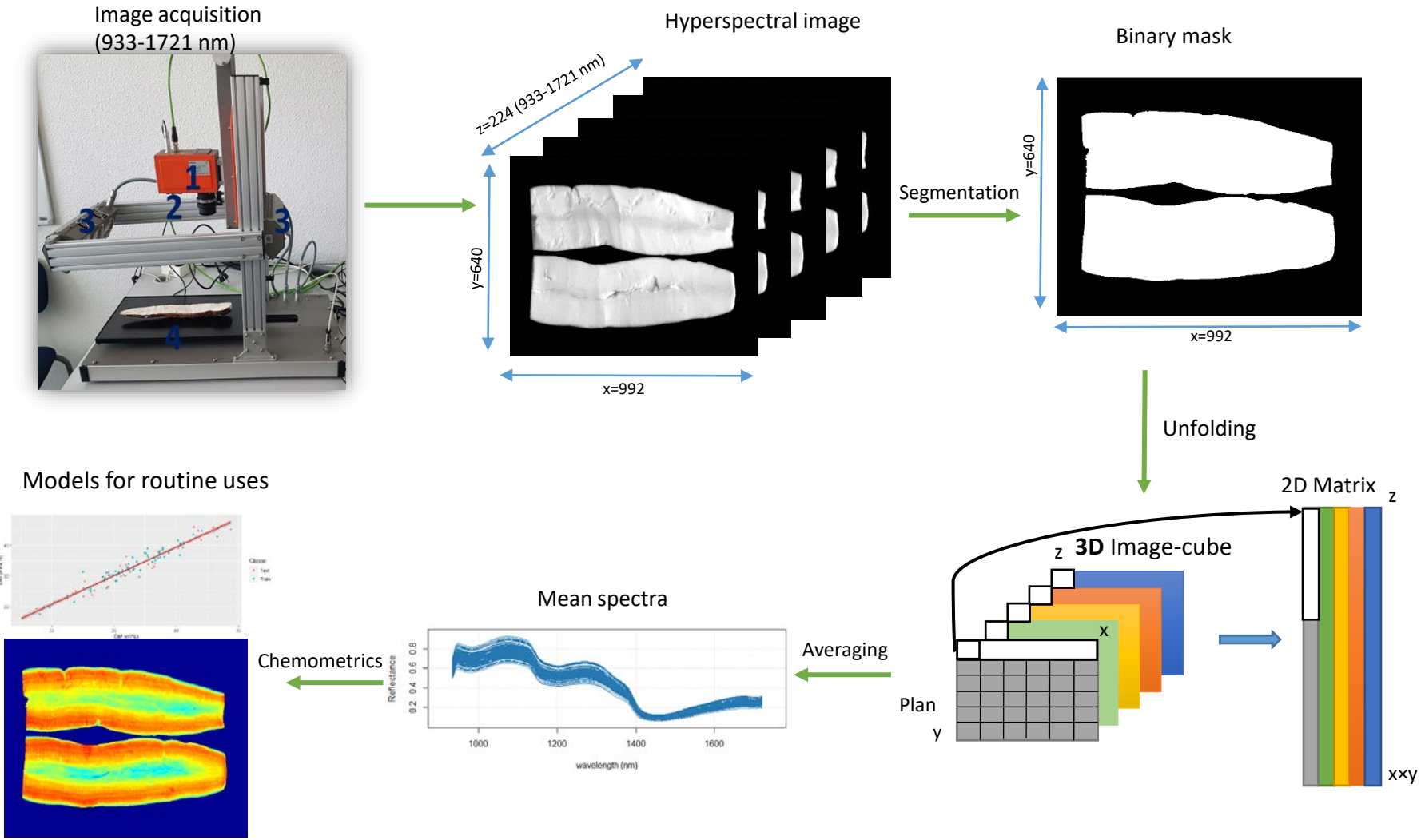
124 HSI and DM + 31 HSI longitudinal

The rest of the half cylinders were cooked during 30 min for WA30 measurement

One transversal slice per half cylinder was cut for HSI & DM measurements on cooked samples

124 HSI and DM,
31 average WA30

Hyperspectral images processing

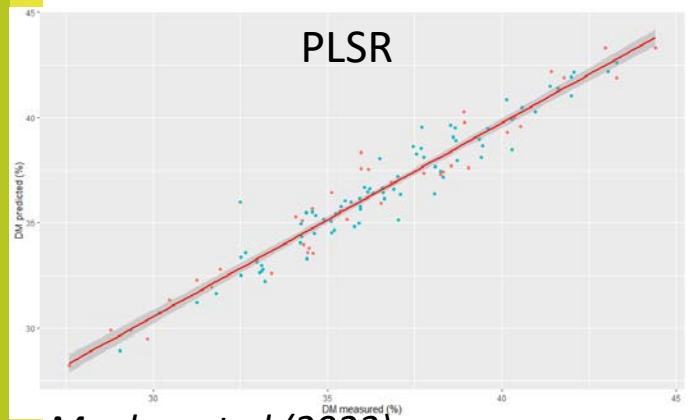


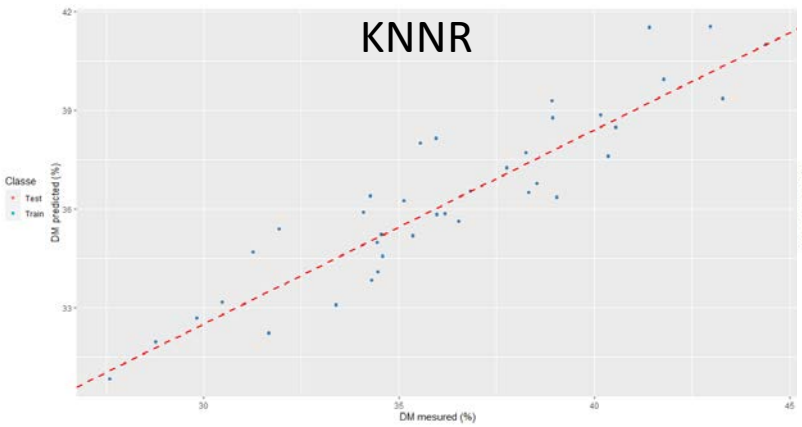
Meghar et al (2023)

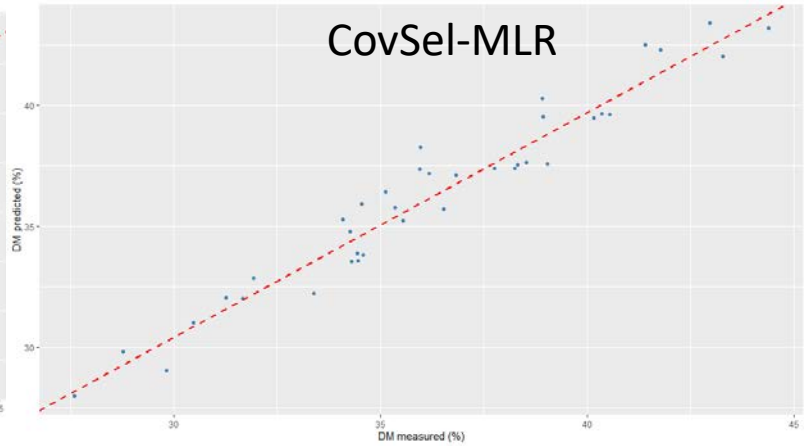
Results : Prediction of DMC in fresh cassava

- Performances of different models developed

	Calibration								Validation			
Model	Ncal	Paramaters	Mean(%)	SD(%)	Min(%)	Max(%)	RMSEC (%)	R^2cal	Nval	R^2p	RMSEP (%)	RPD
PLSR	78	LV=7	36.40	3.46	27.59	44.40	0.78	0.94	38	0.93	1.06	3.26
KNNR	78	nlvdis=5, h=.2, k=40	36.40	3.46	27.59	44.40	0.16	0.99	38	0.77	1.94	1.78
SVMR	78	cost=5, epsilon=0.2, gamma=3	36.40	3.46	27.59	44.40	2.85	0.17	38	0.46	3.63	0.95
Covsel_MLR	78	(932,1021,1130,1169,1222, 1385,1410,1444,1484,1717)	36.40	3.46	27.59	44.40	0.88	0.92	38	0.94	0.96	3.60





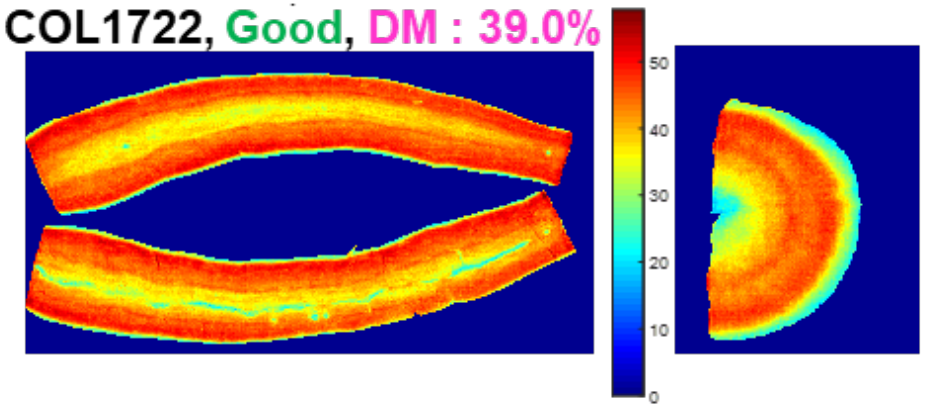


Meghar et al (2023)

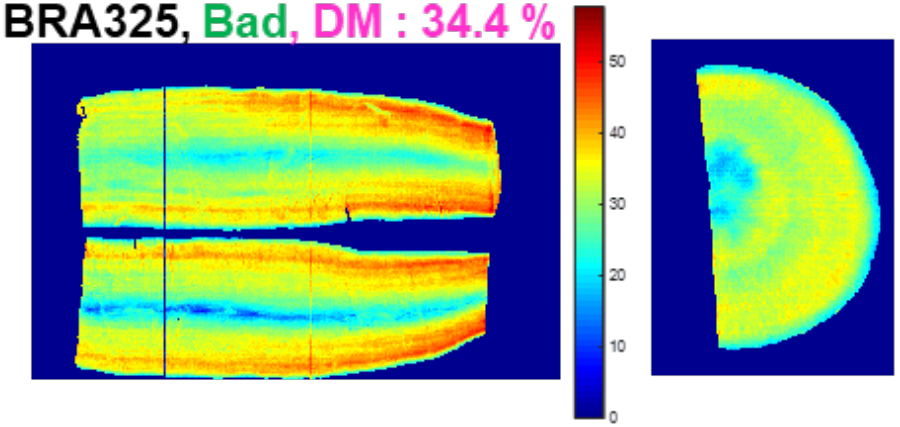
Results : Prediction of DMC in fresh cassava

- Visualization of DMC distribution in contrasting cooking ability of cassava genotypes

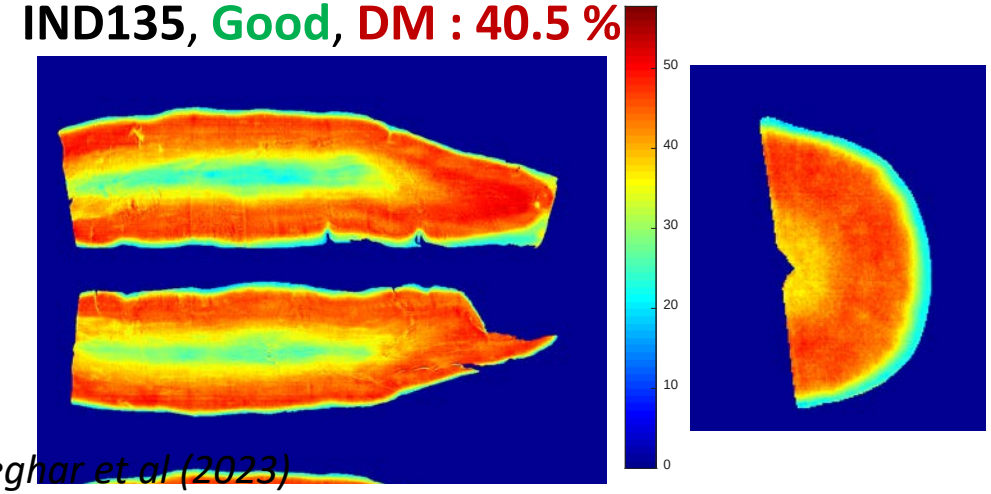
COL1722, Good, DM : 39.0%



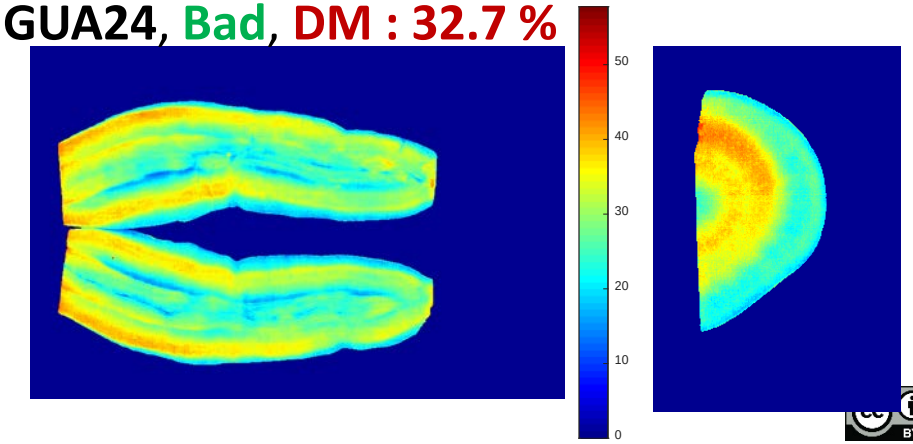
BRA325, Bad, DM : 34.4 %



IND135, Good, DM : 40.5 %



GUA24, Bad, DM : 32.7 %



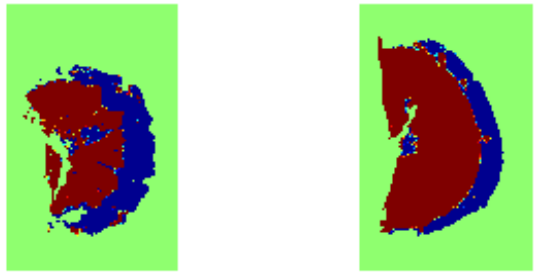
Meghar et al (2023)

Results : Prediction of WA30 in boiled cassava

- Visualization of Water absorption in contrasting cooking ability of boiled cassava

HSI images on boiled cassava → Selection of 1000 pixels per image for PCA model → Projection of all pixels of each image on PC1 axis → Scores images map with false colors

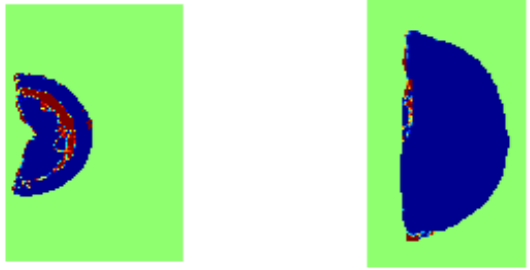
Good (CR63) : WAB=18.31 %, OCT = 20 min



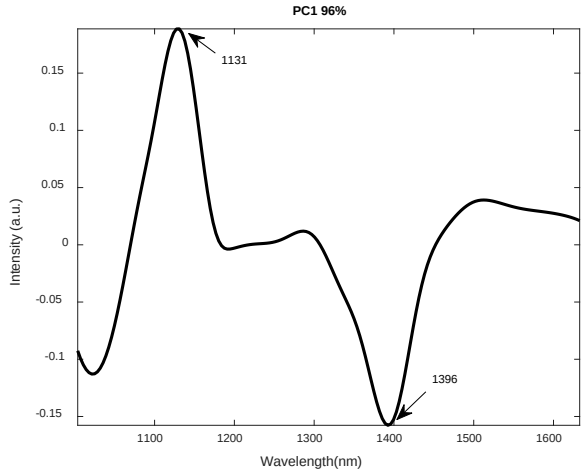
Bad (VEN25) : WAB =0.39 %, OCT=60 min

Good (CUB46) : WAB=13.34 %, OCT = 25 min

Bad (BRA512) : WAB=3.05 %, OCT = 60 min



Loading PC1



Absorption region from 1191 to 1385 nm which is associated with the first overtone of OH band in water (Ignat et al., 2014);

Meghar et al (2023)

Conclusions and perspectives

- High efficient model for visualization of DMC in fresh cassava genotypes, R^2p=0.94, RMSEP=0.96 %, RPD=3.60

- Visualisation of WAB30 using PC1 scores of PCA model.

Perspectives

- Enhance the DMC model accuracy and robustness using more genotypes.

- Implementation of the HSI procedure within CIAT breeding program.

- Define acceptability threshold for WA30 classification model.

Acknowledgements

BILL & MELINDA GATES foundation

RTB foods

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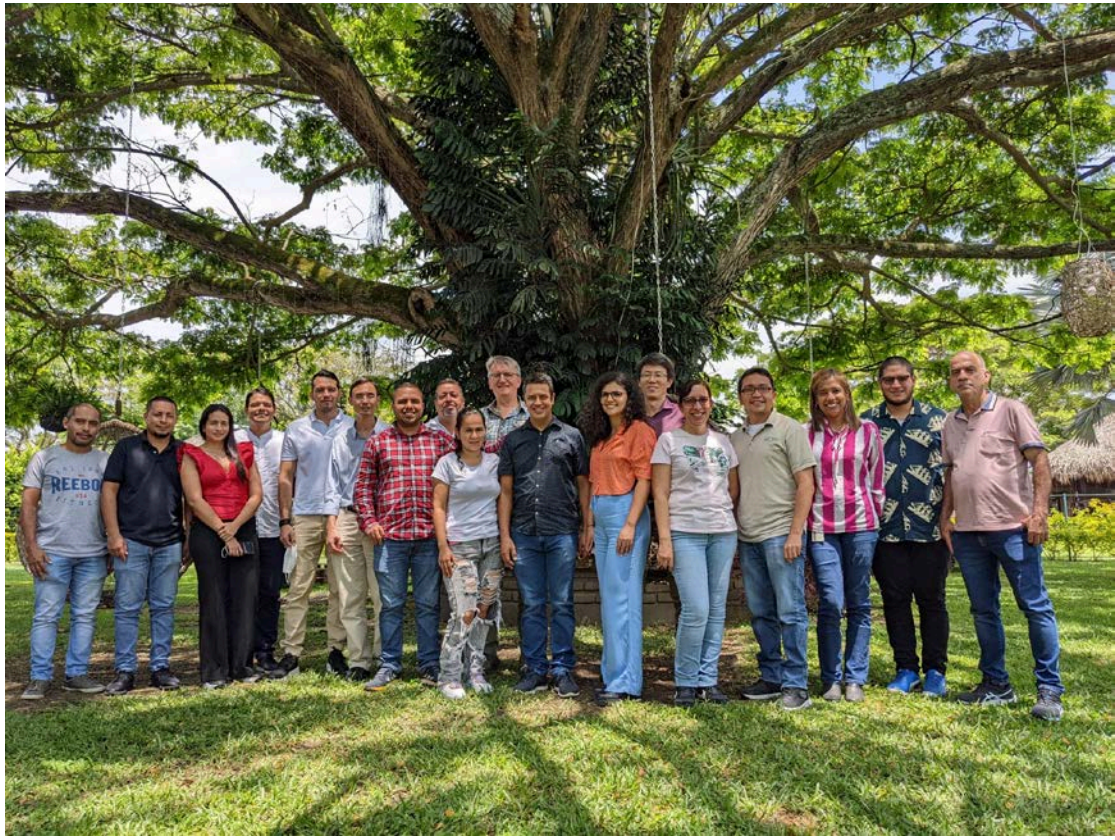

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