# Digital trial evaluation: from images to data – the path of automated field efficacy evaluation

**V. Bosco**, N. Freitag, A. Huber, M. Salas

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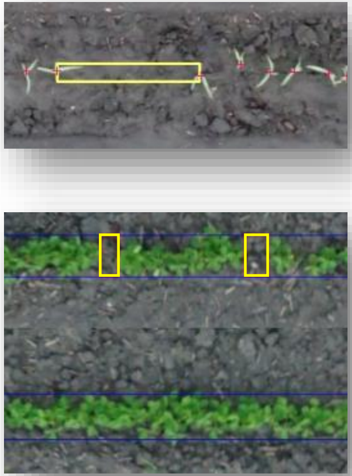
# Outline

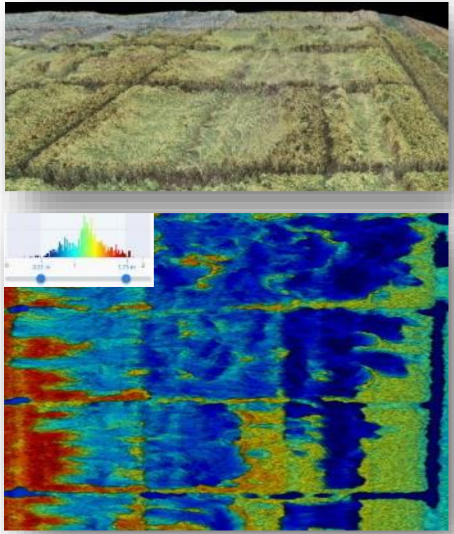
- Highlights of current Corteva digital tools
- Example of Corn Plant Counting Algorithm Development
- Example of a Vegetative index Algorithm Development
- Key learnings
- Conclusions and perspectives

# Digital trial evaluation at Corteva Agriscience

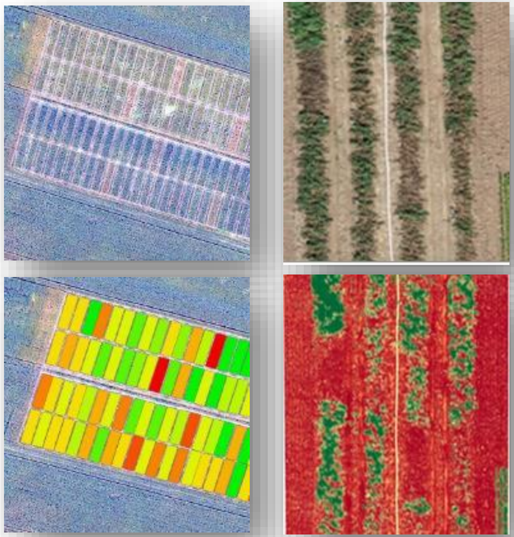
Plot quality



Plant height and 3D models



Canopy health



Counting & differentiation

**From image to data**: Automated plot rating to identify reliable and objective differences between product concepts across various crops.

Allert for optimal pest control, inform about spatial weed distribution to pre-select products for precision spot-and-spray technologies.

# Example of a Corn Plant Counting Algorithm Development

1° trait developed: 2012
5 years of improvements; ~1MM plots used in validation
Accuracy metric: +/- 2%
Used today also in commercial platforms

- Count
- Row Length
- Plant Spacing

- Gap Size
- Gap Variability

==> **plot quality**

Robust Across Different Environments

# Example of a Vegetative index Algorithm Development

Possible Vegetable Index usable from standard RGB (Red-Green and Blue) camera sensors:

| Acronym | Vegetative Index[1] | Equation |
|---|---|---|
| NGRDI | Normalized green red diff. index | $(\rho_g - \rho_r)/(\rho_g + \rho_r)$ |
| GLI | Green leaf index | $(2*\rho_g - \rho_r - \rho_b)/(2*\rho_g + \rho_r + \rho_b)$ |
| VARI | Visibile atmosph. resistant index | $(\rho_g - \rho_r)/(\rho_g + \rho_r - \rho_b)$ |
| IRG | Red–green Ratio index | $\rho_r - \rho_g$ |
| RGBVI | Red–green–blue veg. index | $(\rho_g * \rho_g) - (\rho_r * \rho_b) / (\rho_g * \rho_g) + (\rho_r * \rho_b)$ |
| RGRI | Red–green ratio index | $\rho_r / \rho_g$ |
| MGRVI | Modified green–red veg. index | $(\rho_g^2 - \rho_r^2) / (\rho_g^2 + \rho_r^2)$ |

[1]https://www.indexdatabase.de/

[2]$\rho_r$, $\rho_g$, $\rho_b$ are respectively canopy reflectance at Red, Green and Blue bands in 0-255 values

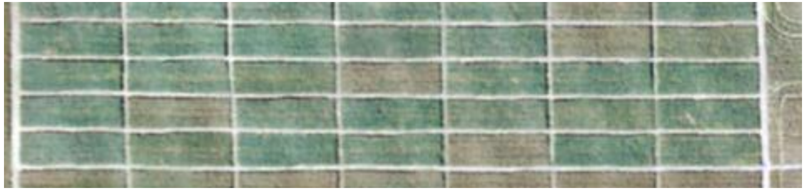
$$\textbf{GLI} = \frac{(2*\rho_g - \rho_r - \rho_b)}{(2*\rho_g + \rho_r + \rho_b)} = -1 / +1$$

**GLI** has strong correlation to leaf chlorophyll content.
Negative values tended to be soil/non-living while positive values were green leaves and stems.

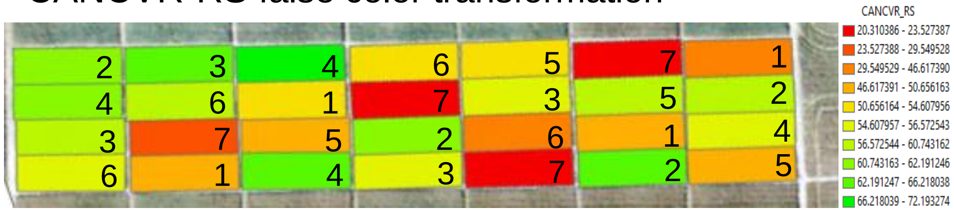
**Corteva UAS Pipeline:**
**GLI => CANCVR-RS**

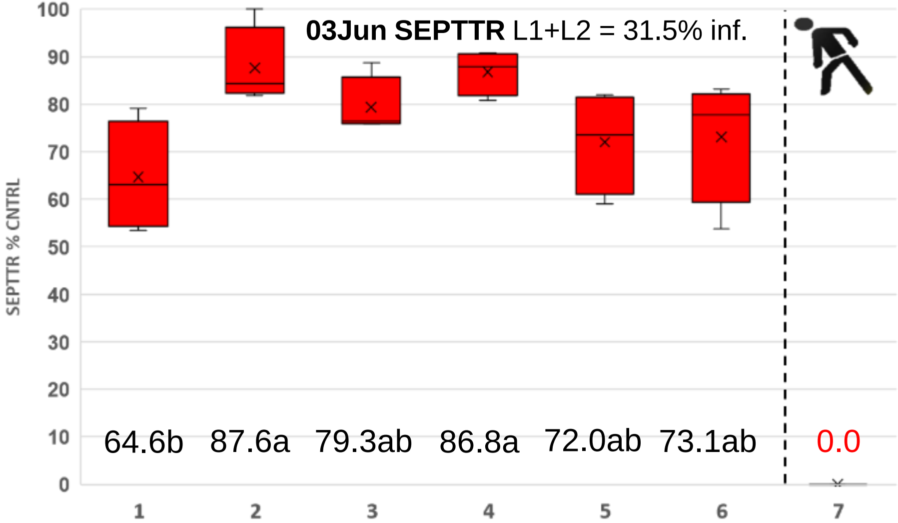
# Example of using CANCVR-RS in wheat fungicide trials

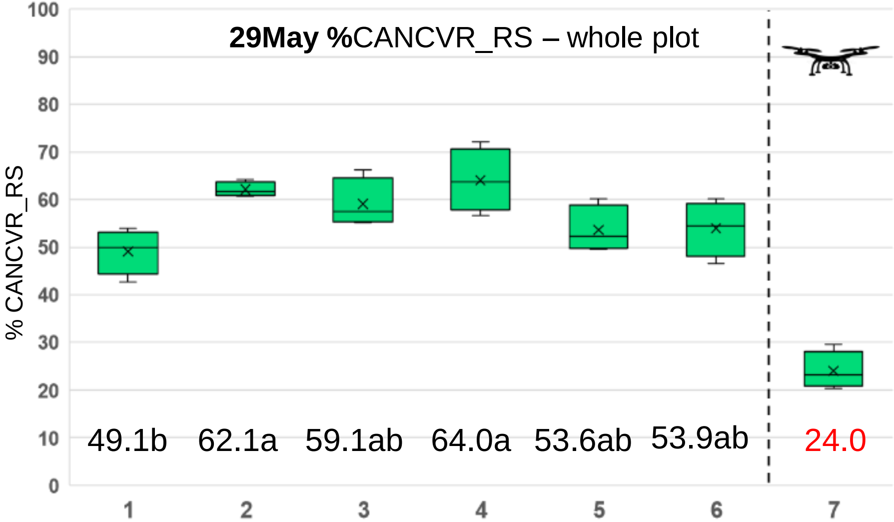
RGB (Standard Red/Green/Blue Color photo)



CANCVR-RS false color transformation



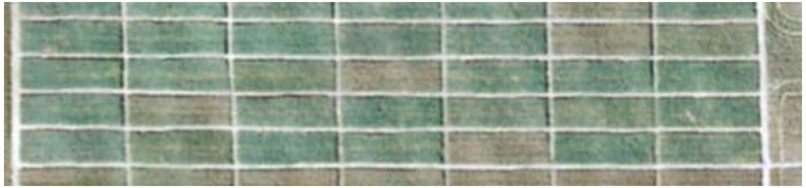



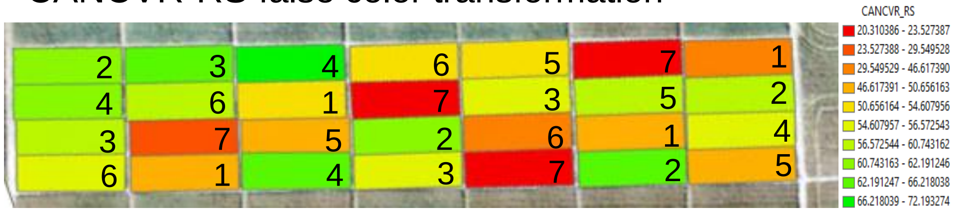

Tukey@ 0.05
UNT. sign. diff. and excluded

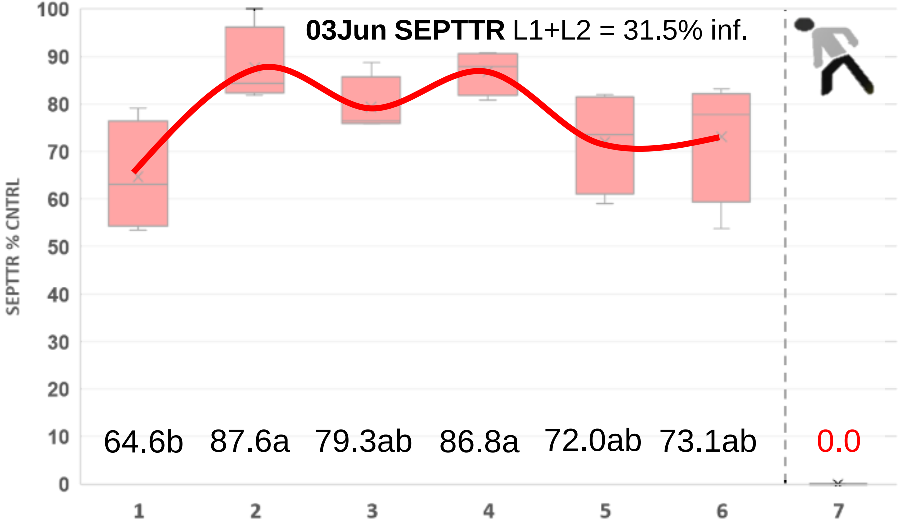
# Example of using CANCVR-RS in wheat fungicide trials

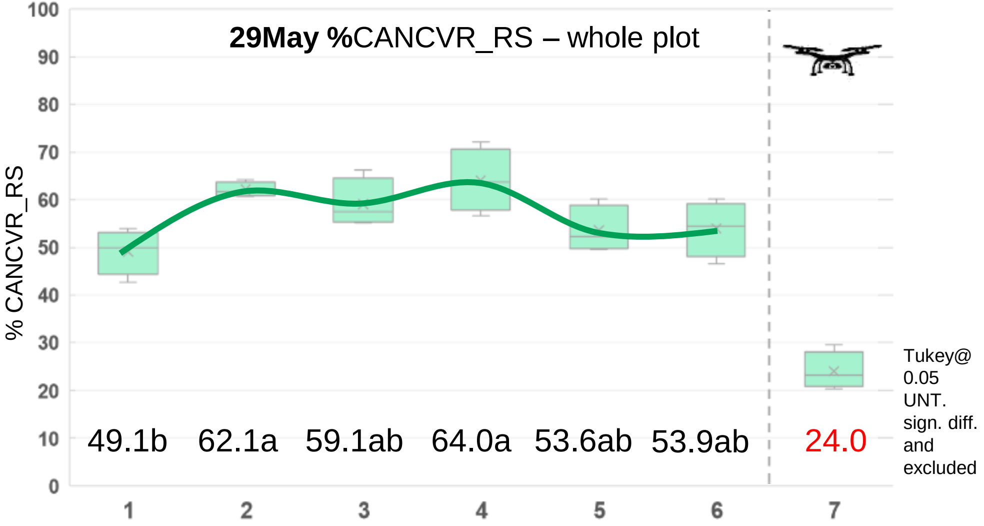
RGB (Standard Red/Green/Blue Color photo)



CANCVR-RS false color transformation



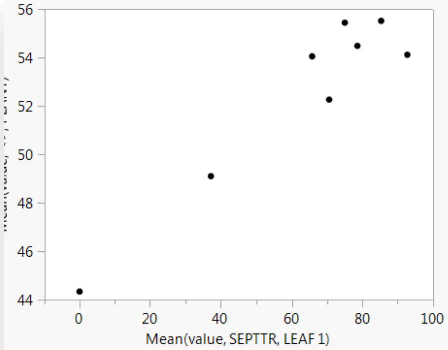




- ➢ Equivalent treatment discrimination (CANCVR_RS **earlier** & faster)
- ➢ Less variability in CANCVR_RS
- ➢ Whole plot assessments
- ➢ Not (yet) able to differentiate between pathogens

# CANCVR-RS in wheat fungicide trials: correlation analyses across trials

Wheat SEPTTR
4 trials 2020 from Italy
SEPTTR: UNT. = 12.4 – 36.7% inf.

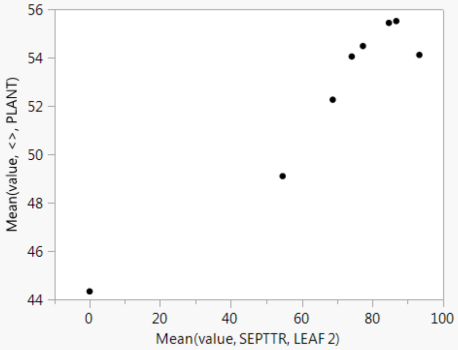
%Cntrl **L1** vs. %CANCVR_RS




Summary Statistics

| | Value | Lower 95% | Upper 95% | Signif. Prob |
|---|---|---|---|---|
| Correlation | 0.954546 | 0.763304 | 0.991975 | 0.0002* |

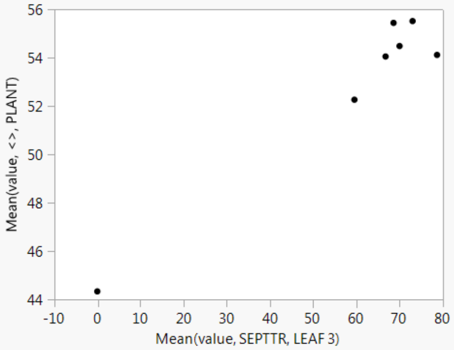
%Cntrl **L2** vs. %CANCVR_RS




Summary Statistics

| | Value | Lower 95% | Upper 95% | Signif. Prob |
|---|---|---|---|---|
| Correlation | 0.960858 | 0.793366 | 0.993107 | 0.0001* |

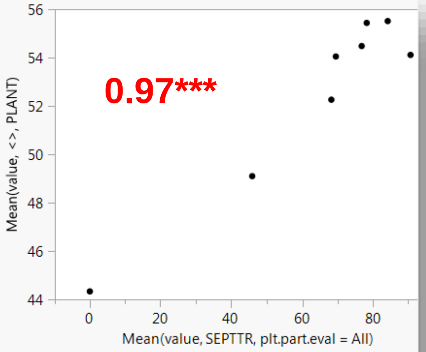
%Cntrl **L3** vs. %CANCVR_RS




Summary Statistics

| | Value | Lower 95% | Upper 95% | Signif. Prob |
|---|---|---|---|---|
| Correlation | 0.97385 | 0.82807 | 0.996275 | 0.0002* |

%Cntrl **L1-L3** vs. %CANCVR_RS




Summary Statistics

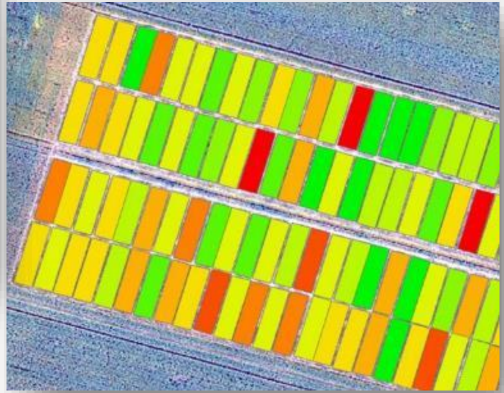
| | Value | Lower 95% | Upper 95% | Signif. Prol |
|---|---|---|---|---|
| Correlation | 0.965307 | 0.815057 | 0.993902 | 0.0001 |

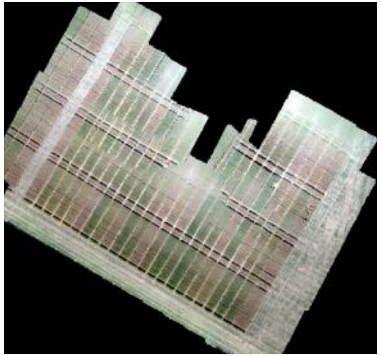
➢ High correlation between visual evaluation of SEPTTR control (%) on different leaf levels and CANCVR_RS from the whole plot across trials

# Key learnings (Pros and Cons)

- Efficient, objective and non-destructive plot assessments
- Retrospective analyzes (algorithm training, archive the original situation in the field, not "just" archiving numbers in ARM reports)
- More accurate micro plot statistics
- Standardized trial reports and data available almost in real-time
- Easy integration of 3PP

- Additional costs for trainings, insurances and upgrades to newest equipment
- New limitations (time of flight, no flight areas, farmer tracks, lodging, regulatory hurdles?)
- Not (yet) suited for 3D crops (orchards/vines)
- No leaf level separation possible, but not needed anymore (?) -> high correlation between L1-L3 assessments and remote sensing





# Conclusions

- Digital assessments allow for objective treatment differentiation, retrospective analyses, high repeatability but require regulation and acceptance by Authorities.

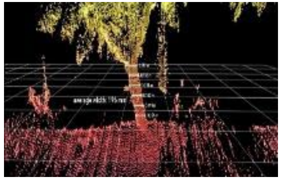
- Fast development area with possibility to cross-leverage algorithms between disciplines and business.

- Need to validate algorithms for digital assessments and make common training data and pictures for algorithm development available with minimum accepted discriminating test statistics.

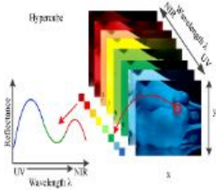
- Corteva will continue to use & develop new digital solutions (multispectral, hyperspectral sensors), using and combining different platforms (drones, rovers, handheld sensor and satellites).

**New RGB and Multispectral RTK Drones**

**New Sensor Types**



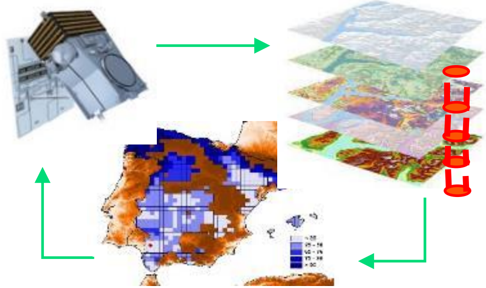
Lidar



Hyperspectral

**Data Collected on Mobile/handheld Devices**

**Proximal and Satellite Data in GIS environment**



# Thanks for your attention

Contact:

valentino.bosco@corteva.com

niclas.freitag@corteva.com