UPOV
International Union for the Protection of New Varieties of Plants

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Technical Working Party on Testing Methods and Techniques **TWM/3/27**

Third Session
Beijing, China, April 28 to May 1, 2025

Original: English
Date: April 23, 2025

DEVELOPMENT OF DUS PHENOTYPING TOOLS FOR AND WITH EXAMINATION OFFICES: EXPERIENCE GAINED

Document prepared by an expert from the Netherlands (Kingdom of the)

The annex to this document contains a copy of a presentation “Development of DUS phenotyping tools for and with examination offices: experience gained”, to be made by an expert from the Netherlands (Kingdom of the), at the third session of the TWM.

[Annex follows]

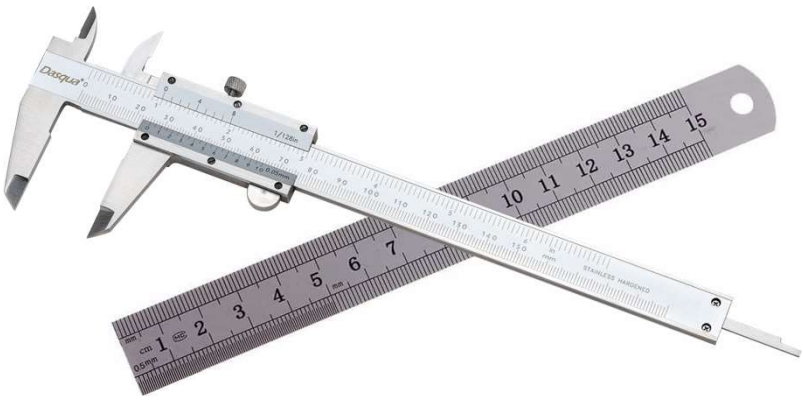
Development of DUS phenotyping tools for and with examination offices: experience gained

27-03-25, Joseph Peller

Source: Adobe firefly

1

Traditional Phenotyping tools

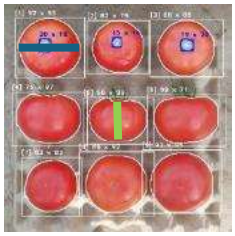


Source: yellingatbikes.com

2

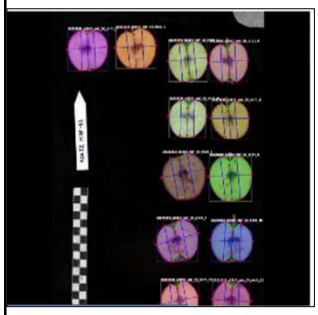
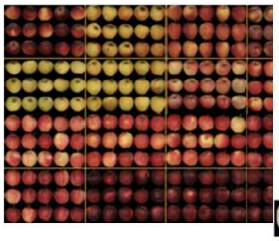
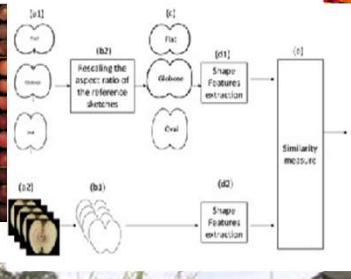
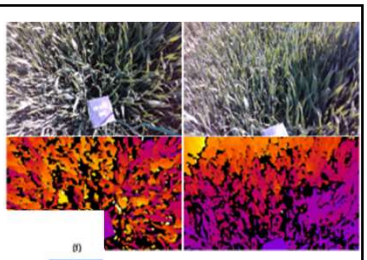
What Digital Phenotyping tool must do

- Benchmark is to Human Phenotyper
  - Fast
  - Accurate
  - Quantifiable

3

Academic Tooling

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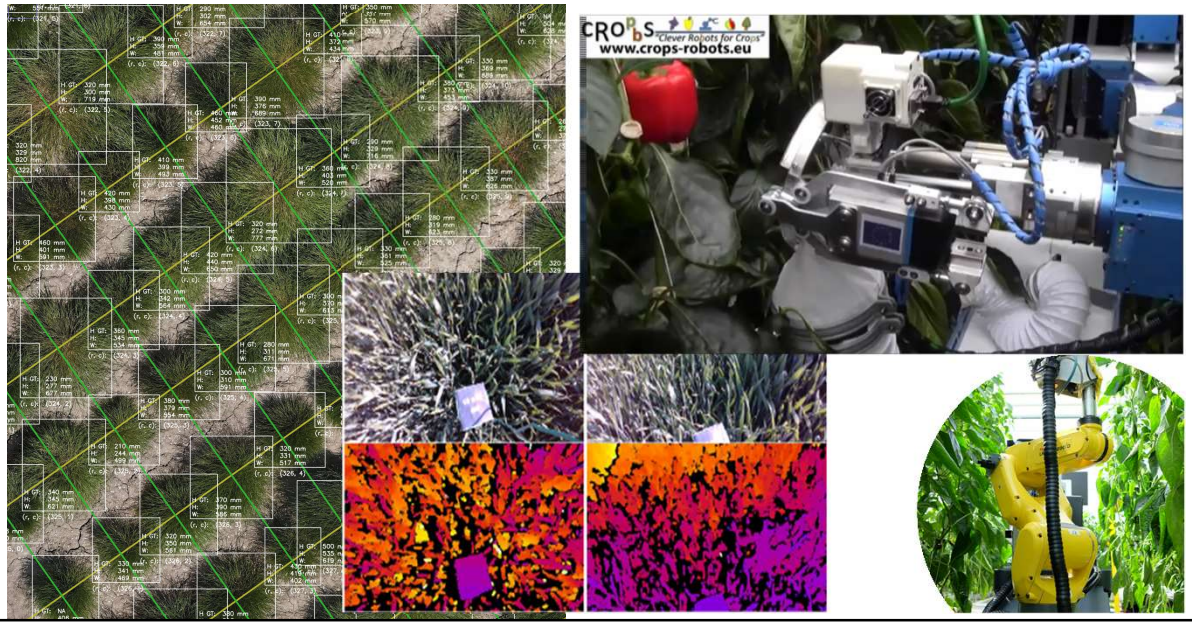
Drone Imaging and Harvesting Robots



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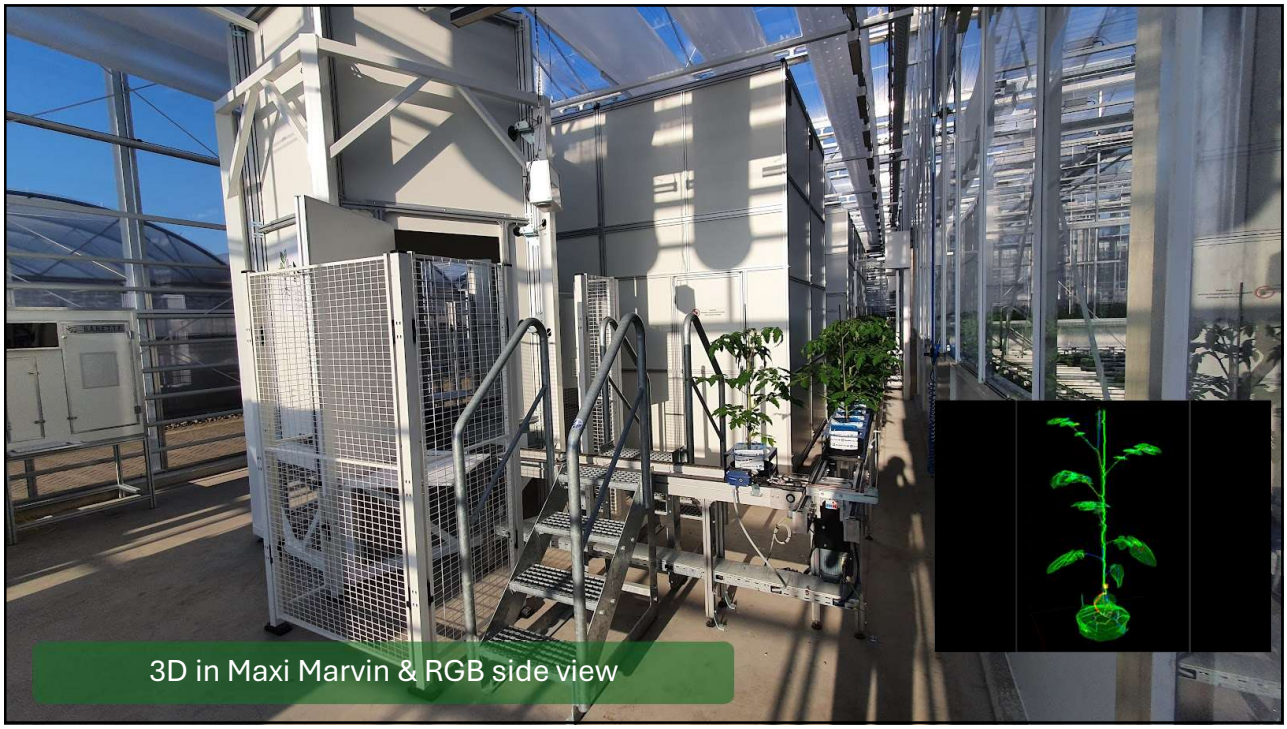

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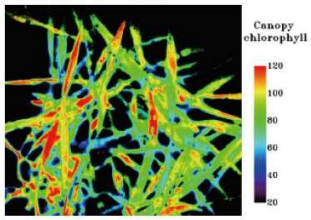
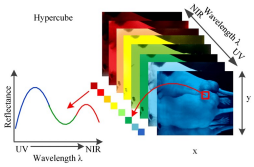
Major Problem (Cost and Complexity)

VS

40,000 Euro





200 Euro

7

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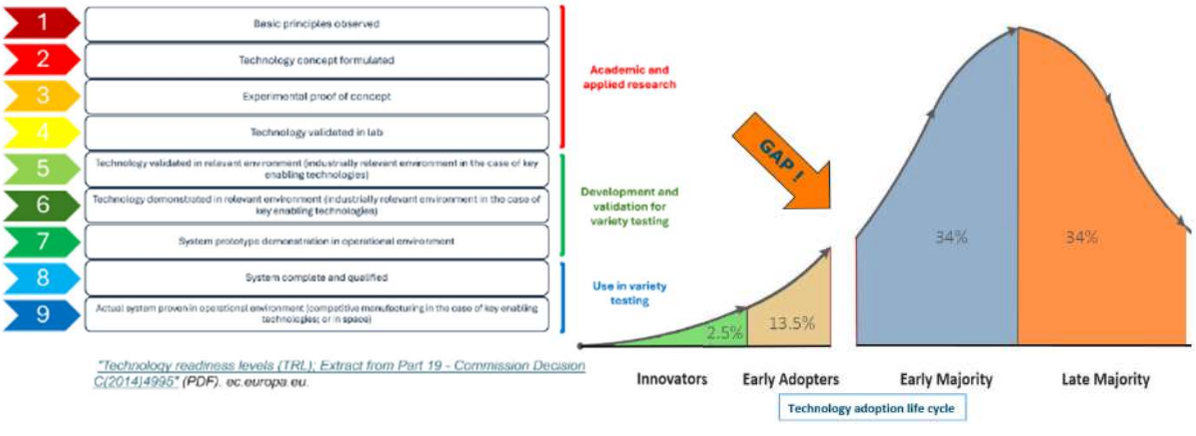
So where are all the high tech tools?



"Technology readiness levels (TRL); Extract from Part 19 - Commission Decision C(2014)4995" (PDF). ec.europa.eu.

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So, How do we encourage adoption?

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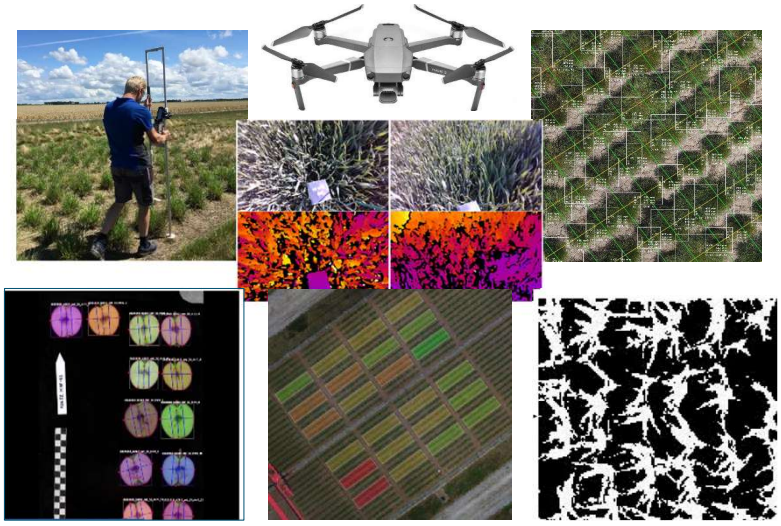
Who are the end Users?

- Examination Offices
- Post-registration offices
- Examiners

- Breeders
- Researchers



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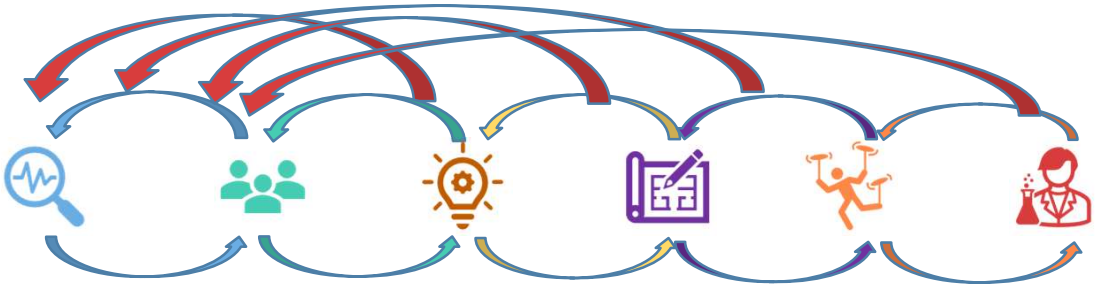
User-centred design in MVP cycles



User Research
- ✓ Identify users
- ✓ Needs
- ✓ Behaviour
- ✓ Challenges
- ✓ Pain points
- ✓ Desires
- ✓ Values and norms

Create Personas
- ✓ Fictional representers of users

Concept development
- ✓ Generate ideas
- ✓ Brainstorm ideas
- ✓ Consider needs and technical restrictions
- ✓ Consider business and ELSA aspects
- ✓ Match the values
- ✓ **interdisciplinary**

Design and demonstrate
- ✓ Prototypes
- ✓ Sketches
- ✓ Visuals

Implement and evaluate
- ✓ Identify evaluation method
- ✓ Newer version
- ✓ Involve multiple stakeholders

Test
- ✓ With end-users (farm workers)
- ✓ Feedback
- ✓ With other stakeholders
- ✓ Observe

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EU HORIZON INVITE (overview)

There are **more than 1300 accessions of tomatoes** in the Netherlands and all of their characteristics have to be documented in order to find the best varieties.

https://www.frontiersin.org/articles/10.3389/fpls.2019.01606/full
https://www.wur.nl/en/Research-Results/Statutory-research-tasks/Centre-for-Genetic-Resources-the-Netherlands-1/Plant-Genetic-Resources/Genebank/CGN-crop-collections/CGN-fruit-vegetables-collection/CGN-tomato-collection-1.htm

WP2
Setting up mobile high-throughput phenotyping tools to measure existing and new bioindicators

As main objective, WP2 will develop mobile HT phenotyping tools to measure bioindicators related to better adaptation to more sustainable crop management practices, and to variable climatic conditions. WP2 will also develop such tools for DUS and VCUCharacteristics for which automation of the measurement procedure can lead to significant improvement of speed, precision, and efficiency.

Leader David ROUSSEAU (UA) and co-leader Rick van de Zedde (WR)

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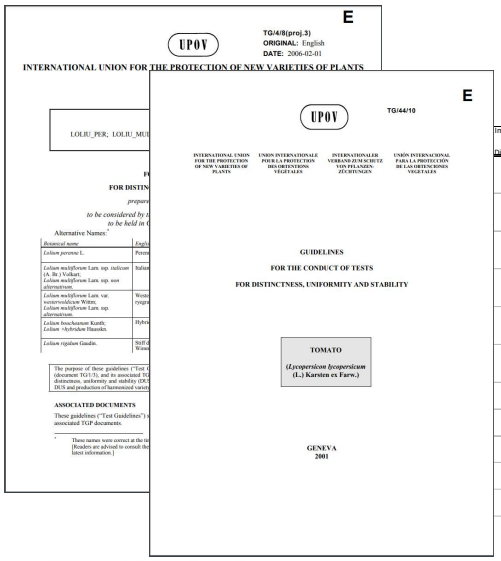
invite Surveying and Feedback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TG/4/8(proj.3)
ORIGINAL: English
DATE: 2006-02-01

INTERNATIONAL UNION FOR THE PROTECTION OF NEW VARIETIES OF PLANTS

LOLIU_PER; LOLIU_MUL

FOR DISTIN

prepare

to be considered by t
to be held in t

Alternative Names:*

Botanical name	Engl
Lolium perenne L.	Peren
Lolium multiflorum Lam. ssp. *italicum* (A. Br.) Volkart; *Lolium multiflorum* Lam. ssp. *westerwoldicum* Wittm.	Italian
Lolium multiflorum Lam. var. *westerwoldicum* Wittm; *Lolium multiflorum* Lam. ssp. *alternativum*.	Westerwo ryegra
Lolium boucheanum Kunth; *Lolium* ×*hybridum* Hausskn.	Hybrid
Lolium rigidum Gaudin.	Stiff d Wimm

The purpose of these guidelines ("Test G
(document TG/1/3), and its associated TG
distinctness, uniformity and stability (DU
DUS and production of harmonized variety

ASSOCIATED DOCUMENTS

These guidelines ("Test Guidelines") s
associated TGP documents.

* These names were correct at the ti
[Readers are advised to consult the
latest information.]

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TG/44/10

INTERNATIONAL UNION FOR THE PROTECTION OF NEW VARIETIES OF PLANTS | UNION INTERNATIONALE POUR LA PROTECTION DES OBTENTIONS VÉGÉTALES | INTERNATIONALER VERBAND ZUM SCHUTZ VON PFLANZENZUCHTUNGEN | UNIÓN INTERNACIONAL PARA LA PROTECCIÓN DE LAS OBTENCIONES VEGETALES

GUIDELINES

FOR THE CONDUCT OF TESTS

FOR DISTINCTNESS, UNIFORMITY AND STABILITY

TOMATO

(*Lycopersicon lycopersicum* (L.) Karsten ex Farw.)

GENEVA
2001

Important ce to Discrimin	Ranking	Characteristic Name	Difficulty Of Measure	Time Needed to	Important ce to Discrimin	Ranking
1	16	Leaf: Type of blade	9	8	9	26
1	6	Leaf: Size of Leaflets	4	7	2	13
7	17	Leaf: Intensity of green color	4	7	1	12
8	16	Leaf: Glossiness	3	7	7	17
7	17	Leaf: Blistering	3	7	7	17
1	11	Leaf: Attitude of petiole	8	7	4	19
4	19	Inflorescence: type	8	5	5	18
7	16	Flower: Colour	7	7	7	21
7	16	Flower: Pubescence of style	5	5	9	19
4	13	Fruit: Glossiness of Skin	4	7	4	15
8	17	Time of Maturity	7	1	2	10

Important ce to Discrimin	Ranking	Characteristic Name	Difficulty Of Measure	Time Needed to	Important ce to Discrimin	Ranking
1	13	Peduncle : Abscission Layer	7	5	1	13
1	21	Peduncle : length	7	7	7	21
4	10	Fruit: Green Shoulder	4	5	1	10
5	17	Fruit: Extent of Green Shoulder	5	5	7	17
5	17	Fruit: Intensity of Green color of shoulder	5	5	7	17
5	15	Fruit: Intensity of green color outside	5	5	5	15
9	24	Fruit: Green Stripes	9	8	7	24
7	11	Fruit: Size	7	3	1	11
7	17	Fruit: Ratio length (d)	7	7	3	17
7	21	Fruit: Color of Flesh	7	7	7	21

Important ce to Discrimin	Ranking	Characteristic Name	Difficulty Of Measure	Time Needed to	Important ce to Discrimin	Ranking
7	17	Fruit: Shape in longitudinal section	7	7	3	17
5	15	Fruit: ribbing at peduncle end	5	7	3	15
5	20	Fruit: depression at peduncle	5	7	8	20
5	20	Fruit:Size of peduncle sc	5	7	8	20
5	20	Fruit: Size of blossom	5	7	8	20
5	20	Fruit: Shape at blossom end	5	7	8	20
5	20	Fruit: diameter of core in	5	7	8	20
5	20	Fruit: Thickness of	5	7	8	20
7	11	Fruit: Number of	7	3	1	11
9	19	Fruit: Color at Maturity	9	9	1	19

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invite Important characteristics

Characteristics of interest:

1. **Peduncle scar size**
2. **Color**
3. **Shape ratios**
4. **Volume**
5. **Blossom-end scar size**
6. **Ribbing**

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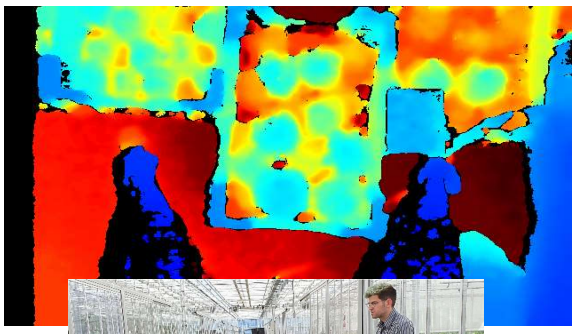
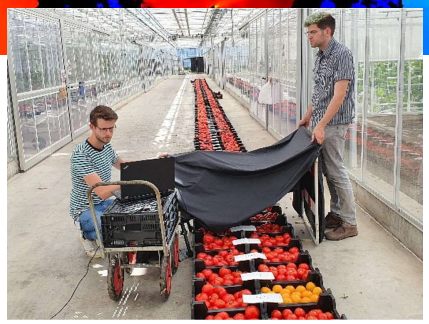
Initial Attempts – 3D Cameras





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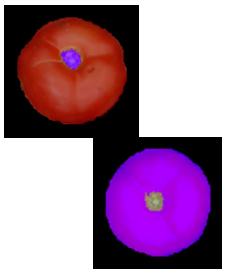
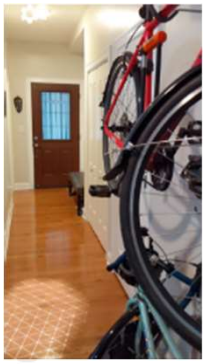
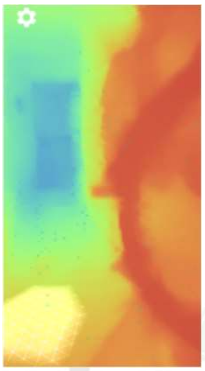
MoRPH - Tomato Phenotyping by phone

Required two technologies to deploy:

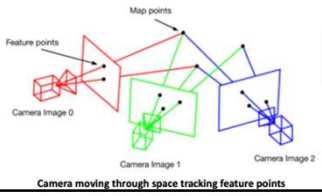
- Segmentation
- 3D measurements







Source: Guido Jansen



Camera moving through space tracking feature points

Source: Kudan.io; SLAM: An Introduction

h2020-invite.eu

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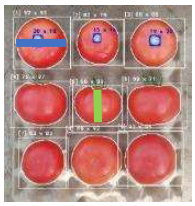
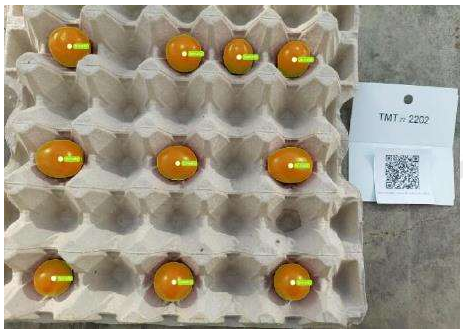
MoRPH – Tomato Phenotyping by phone

- App to automatically measure characteristics in field
  - Does not replace fixed Systems! Same Characteristic Algorithms
  - Uncontrolled Lighting, more flexibility.
- AI segmentation of fruits, "General Fruit Detector"

2 years of data:
7 trials
>200 varieties
Cherry, beef, heritage, odd





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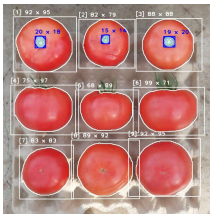
But did we succeed?



- Kind of, not really
- App was functional on only a few platforms
- Bugs couldn't be squashed and features added to get minimum viable product.
- BUT App platform is functional for further development
- Focus on getting whats there working 100%

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Lessons for future projects

- Technology adoption in agriculture works best when addressing an ***existing problem***.
- People will not adopt a new technology is the existing method is some combination of ***faster, cheaper,*** or ***easier***.
- Adoption requires ***trust*** and can be built with exceptional products, or more likely slowly convincing people over time.

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Thank you

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[End of Annex and of document]