Integration of new digital technologies into efficacy evaluations to enhance data quality & delivery

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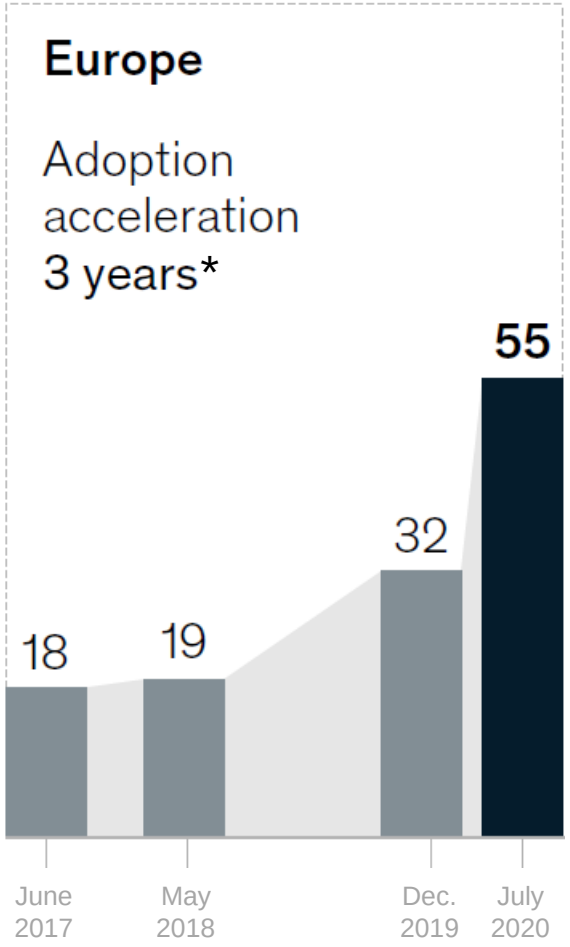
Why digital knowledge?

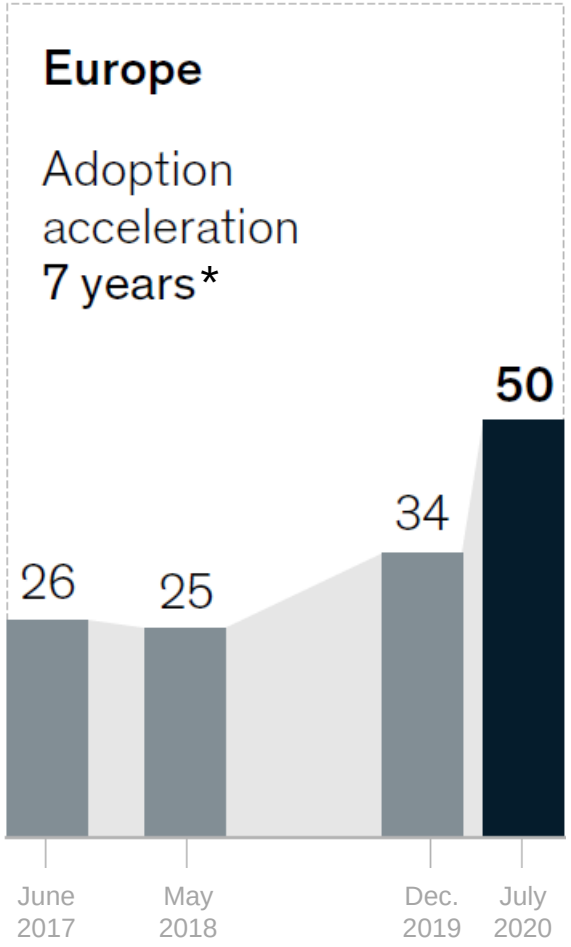
"The development and application of digital tools worldwide has been **accelerated by at least 5 years** compared with pre-COVID times. Business and technology strategies are becoming inseparable. The **confluence of digital technologies** is driving forward the transformation process. We must now capitalise on such **digital transformations** to speed up **innovation**, and deliver **effective solutions for society**".

Prof. Sa'ad Medhat, CEO *Institute of Innovation and Knowledge Exchange*

Digital adoption has taken a quantum leap at the organizational level



Average share of customer interactions that were digital (%)



Average share of products and/or services that are partially or fully digitized (%)

Precrisis COVID-19 crisis

* *Years ahead of the average rate of adoption for 2017 - 2019*

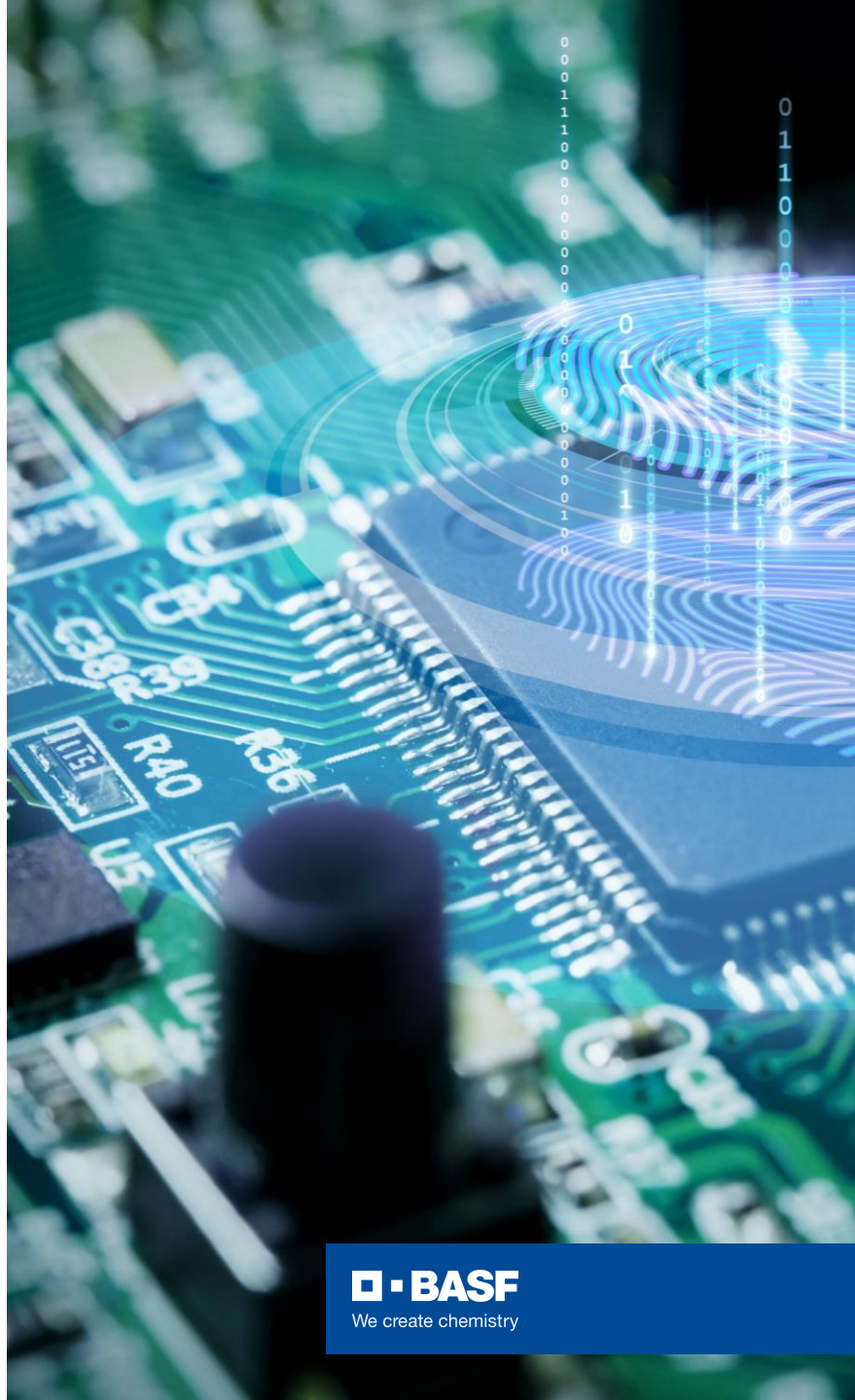
Survey carried out by McKinsey Digital and Strategy & Corporate Finance Practices.

How Covid-19 has pushed companies over the technology tipping pint – transformed business forever. Published by McKinsey & Company, Oct. 2020

Examples of confluence in digital technologies – non-agriculture

- **Intelligent networking of machines and processes**
  - Just-in time part availability for automotive industry and supply chain logistics
  - Replacement ink cartridges for commercial and domestic printers
  - Driverless vehicles

- **Industry 4.0** - connectivity, automation, artificial intelligence, machine learning, real-time data transfer
  - Facial recognition software
  - Rapid drug screening
  - 5G networks and Cloud computing



Examples of confluence in digital technologies – agriculture

- **Intelligent networking of machines and processes**
  - Satellite-based, real time weather forecasting
  - Precision application and mapping, data recording and management - on farm
  - Automated fruit and vegetable picking, vertical farming

- **Industry 4.0** - connectivity, automation, artificial intelligence, machine learning, real-time data transfer
  - Ripeness recognition in horticultural sector e.g. strawberries
  - Image recognition and machine learning for plant and disease identification
  - In-house database integrations and process/data connectivity

Existing digital technologies supporting efficacy assessments

Weather stations

- Rainfall, humidity and temperature sensors

- Wind speed and direction sensors

Continuous data via automated stations around the UK.
Data accessed remotely via Cloud technology

Sensor systems provided by www.sencrop.eu

In-field, real-life examples – photos from BASF Development Centre, Cambridge (courtesy of Mr Jonathon Reed)

Existing digital technologies supporting efficacy assessments

Harvest stations

HarvestMaster
BY JUNIPER SYSTEMS

- Grain-gages collect plot weight, moisture, and test weight measurements
- Data is collected and stored, then transferred to in-house databases

In-field, real-life examples – photos from BASF Development Centre, Cambridge (courtesy of Mr Jonathon Reed)

Existing digital technologies supporting seed and trait development

- Seed counter - count grains into packets for specific variety and phenotyping trials.
- Ensures every packet contains the exact same number of seeds rather than calculating on weight and TGW.

In-field, real-life examples – photos from BASF Development Centre, Cambridge (courtesy of Mr Jonathon Reed)

Efficacy assessments – the human brain vs. digital tools

The **human brain thinks** –

- which disease,
- which part of the plant,
- how much of a plot etc. and records the value/s.

This is based on experience, mental arithmetic and training

The **sensor identifies**

- disease based on “learning” from 1,000s of images,
- compares how much of the leaf/plot etc. is the disease and how much not
- it quantifies the difference and records the value.

This is based on algorithms and machine learning

An algorithm is a procedure used for solving a problem or performing a computation

Experience, mental arithmetic and training is analog

Algorithms and machine learning are digital

The outcome is the same – high quality efficacy data

Quality of a mode of action

Section 2.4 from EPPO 152 (4), Design and analysis of efficacy evaluation trials

“Modes of observation can be distinguished by a number of qualities” – how can these be addressed using digital approaches ?

Accuracy	less bias when not involving human subjectivity, calibration based on many assessments and observations including machine learning
Reliability	automated approach will be reliable, care needed to continue to calibrate and maintain equipment
Precision	observations can be made at different special scales depending on requirements – whole plot, single plant, leaf, fruiting body etc.
Sensitivity	sensitivity will be based on algorithms and assessment requirements – adjustable as needed
Repeatability	once calibrated and algorithms developed, high level of repeatability is possible
Reproducibility	digital and automated approaches less prone to human error and highly reproducible

Survey of members of the Crop Life Europe Efficacy Technical Sub-Group

Member company views on the use of digital tools to support efficacy assessments for the evaluation of plant protection products (survey completed 10th June 2022)

Survey summary based on feedback from seven CLE companies

- Numbers of efficacy trials carried out by member companies per year
  - ►4 companies carry out between 3,000 – 5,000 trials per year
  - ►3 companies carry out less than 3,000 trials per year

- All Contractor Research Organizations (CROs) that companies work with are able to offer digital tools and approaches for efficacy assessments

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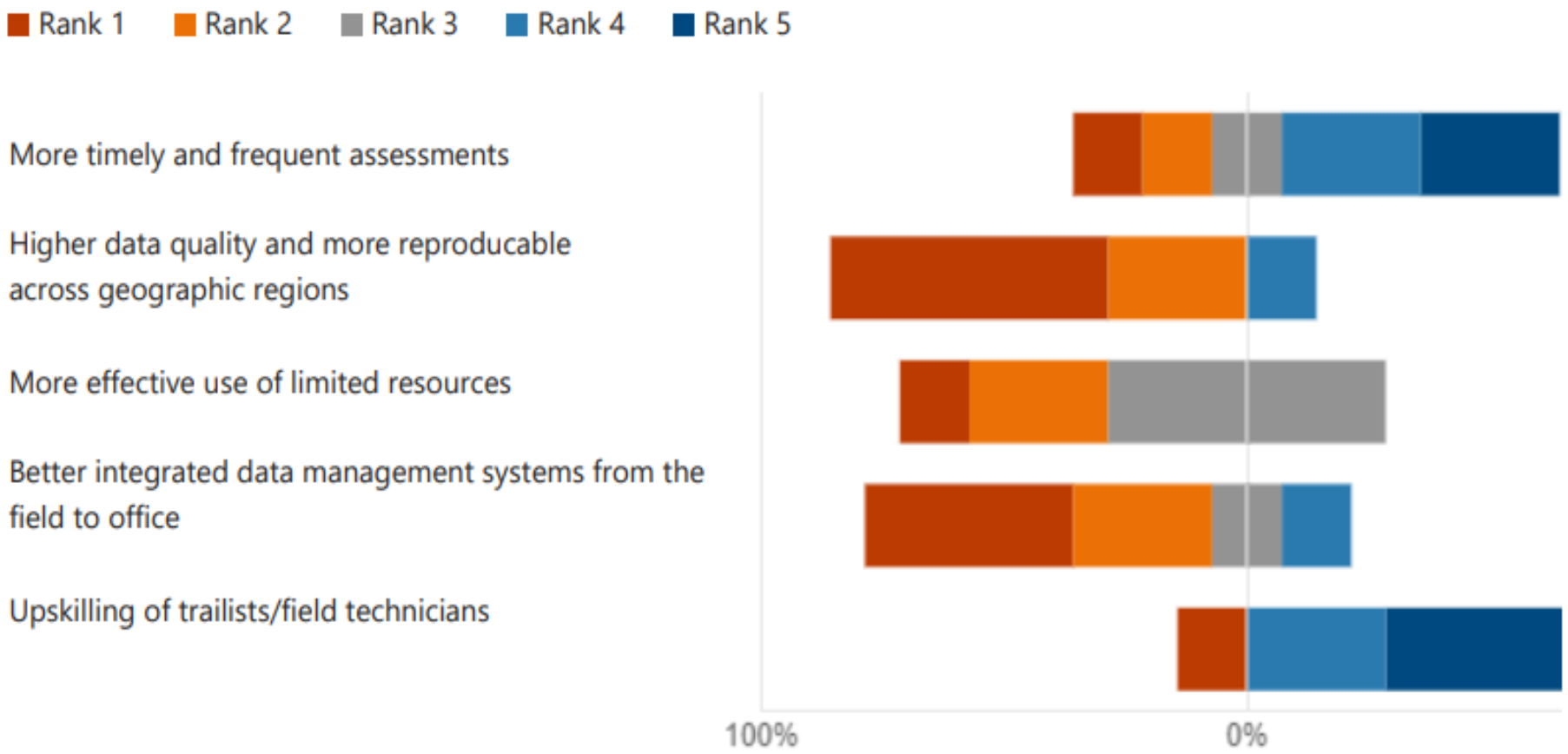
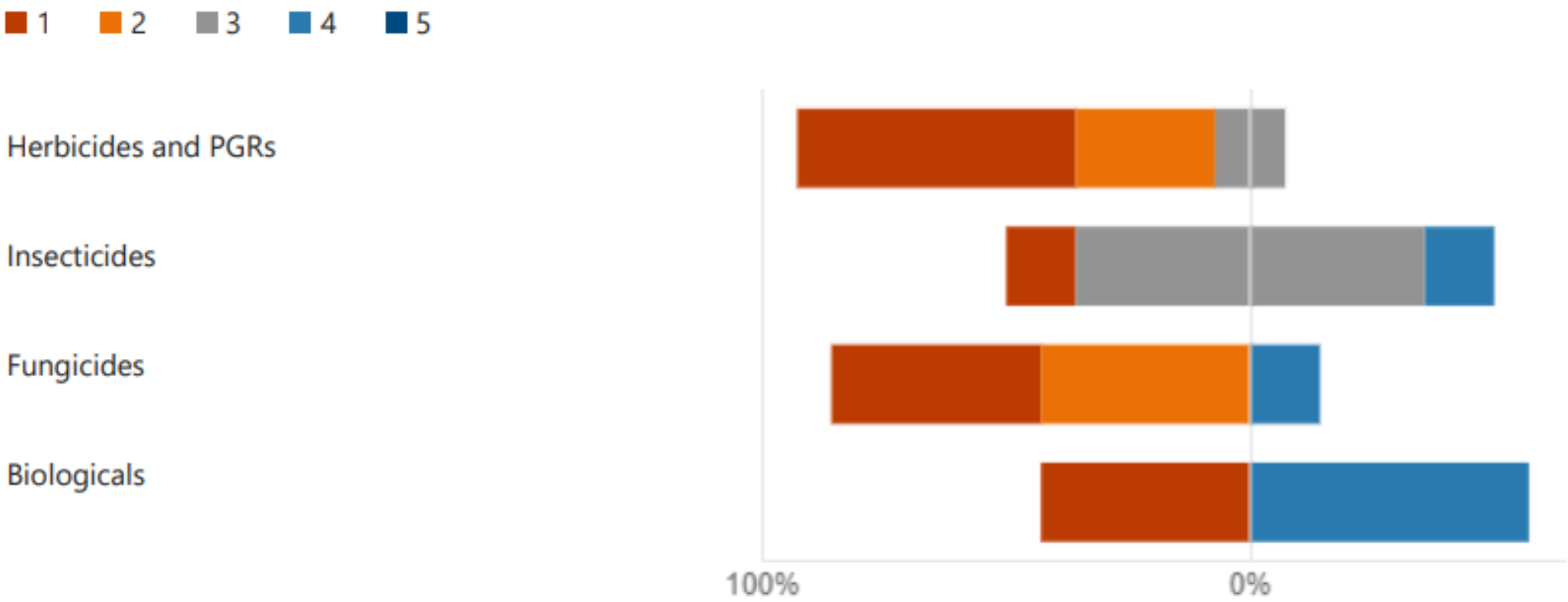
Value of new digital assessment tools for efficacy trials

(Ranking: 1 = Highest, 5 = Lowest)



Indication expected to benefit from use of digital assessment tools within 5 years

(Ranking: 1 = Highest, 5 = Lowest)



Main limitations to the use of new digital tools for assessment of efficacy trials at the present time

(Unedited comments)

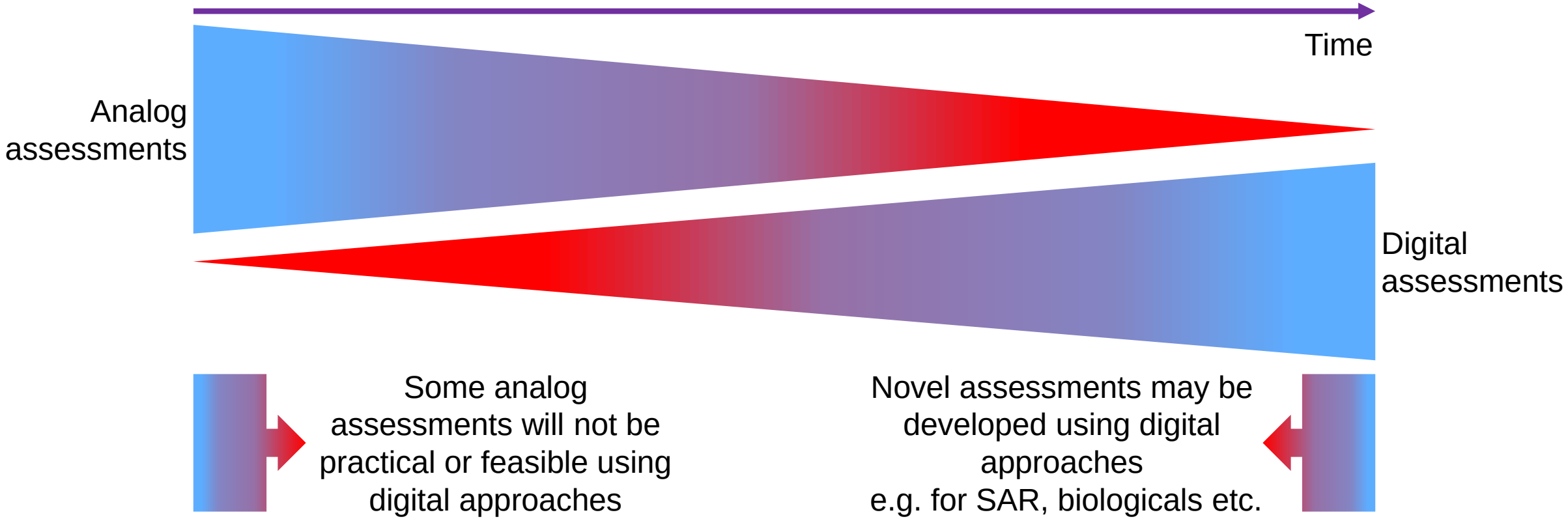
Authority Acceptance

- No EPPO guideline to proceed with these technologies.
- Uncertainty about the acceptability of methods by evaluators.
- Digital assessments not recognized by authorities as can be used in BADs – will increase amount of available data which may cause issues for some smaller authorities
- Acceptance by regulatory bodies of the data for registration of products

Method(s) calibration and standardization

- Up today: Common methodology and approach processes to assess and validation assessment.
- Process validation
- Establish link between assessment parameter and biological meaning.
- No standardized equipment available.
- Can the new technologies already be used to differentiate between different diseases and pests?
- Can the technology handle (differentiate between) presence of more than one pest or disease occurring at the same time?
- Can new technologies already address sufficiently well the high requirements for each crop-pest or crop-disease combination?
- How to handle and agree on the calibration between 'human eye' and available digital tools and how to implement/accept in official guidance

Analog (human/manual) and digital assessments will need to be part of future data packages to support efficacy evaluations



Proposed next steps and discussion

Set out timetable for “Digital Transformation” of efficacy assessments to allow them to form part of the efficacy data package for BADs

Set out a roadmap for assessment types that are already developed and should form part of the first wave of digital tools within the next 3-5 years

Investigate how digital tools and future digital assessment data acquisition can be incorporated into EPPO Guidelines 152 (4) Design and analysis of efficacy evaluation trials

Develop an approach to recognize the evaluation and calibration of digital assessments within Good Experimental Practice (GEP) certification

→ PP1/181 (5) Conduct and reporting of efficacy trials, including good experimental practice

Acknowledgements

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