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Technical Working Party on Testing Methods and Techniques **TWM/2/9**

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USE OF ARTIFICIAL INTELLIGENCE–BASED MARKERS FOR VARIETY TRACEABILITY

Document prepared by an expert from Argentina

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The annex to this document contains a copy of a presentation “Use of Artificial Intelligence–based Markers for Variety Traceability”, to be made by an expert from Argentina, at the second session of the Technical Working Party on Testing Methods and Techniques (TWM).

[Annex follows]

USE OF ARTIFICIAL INTELLIGENCE-BASED MARKERS FOR VARIETY TRACEABILITY

Dra. Ana Vicario
alvicario@inase.gob.ar

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Ministerio de Economía
República Argentina

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AGENDA

2024

- ✓ BACKGROUND
- ✓ RESULTS
- ✓ CONCLUSIONS

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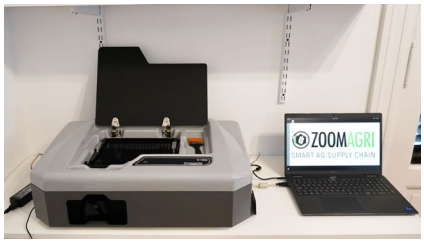
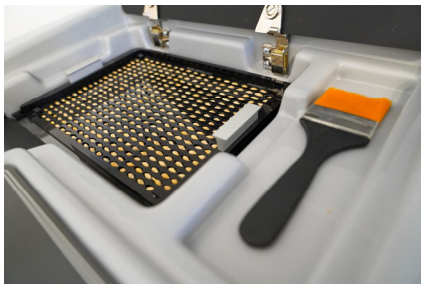
BACKGROUND 2024

Artificial intelligence is a powerful tool for a wide range of uses.
A few years ago, a hardware device and a software were developed for testing varietal identification/verification in seed samples, allowing varietal traceability.

Software development and further implementation requires two different stages:

- first the **training** of the artificial intelligence models that will perform the analysis, and second
- the **validation** of the system by testing known seed samples





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BACKGROUND 2024

Training

- Convolutional neural networks algorithms were specifically built to learn the characteristics of seeds morphology.
- Training must be done in order to adjust them to the different varieties of each country or region, different harvesting years and locations.
- The algorithm fine tunes all the network parameters in order to minimize the error.

running an algorithm that presents to the network thousands or even millions of images of different varieties and the variety to which each image belongs to. → the image of each individual kernel is stored in a database. → the model is tested against new samples that were not previously used at the training stage. → When high accuracy is reached, the model is made available to be used to test samples for the final validation

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BACKGROUND 2024

Validation Objectives

- Test the impact of a single seed on the percentage identity of the sample.
- Test the variation of results using wheat varieties already included in the algorithm
- Tests varieties not included in the system.
- Define identification thresholds for decision making

- Variety sets:
  43 breeder's seed samples
  40 1st multiplication seeds
  22 farmer's seed

  several replicates
  test on seed mixtures

Only data on breeder's seeds samples are shown.

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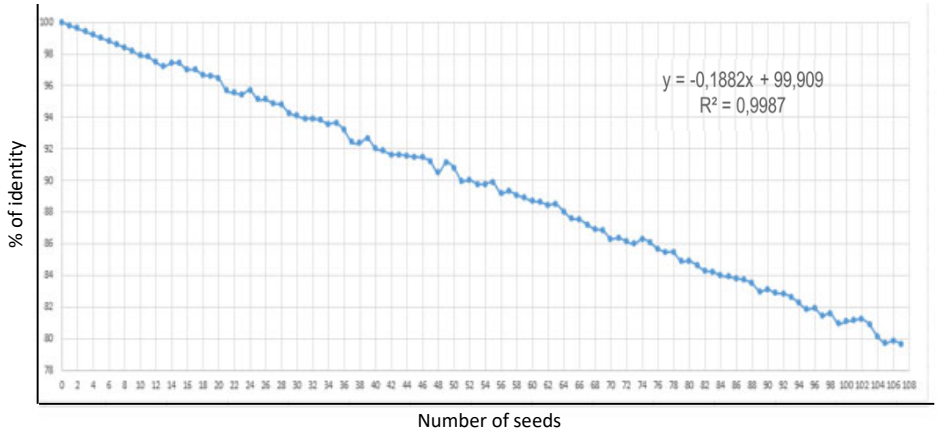
RESULTS 2024

Spiking test: testing the impact of 1 single seed on the % of identity



Each dot correspond to the identity value obtained after taken out one seed from the grid and replace it by a seed from another variety. The "intercept" value is closed to the expected 0.2% value, which is the % of each seed in a 500 seeds grid (1/500).

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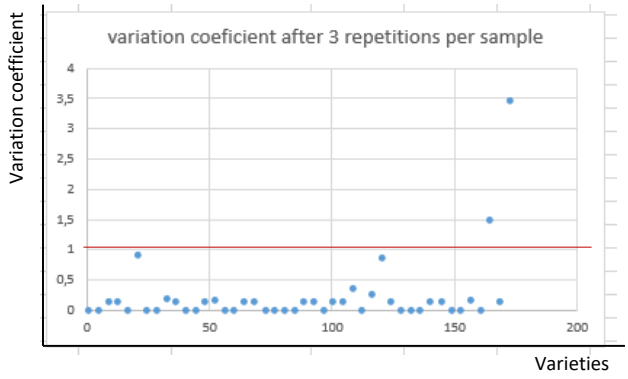
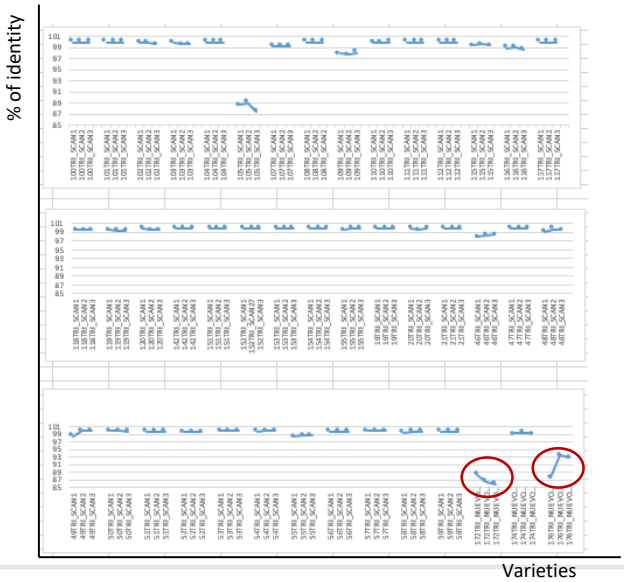
RESULTS 2024

Repeatability test

Each group correspond to a variety, tested 3 times. Less than 5% of the samples presented variation of results higher than 1.





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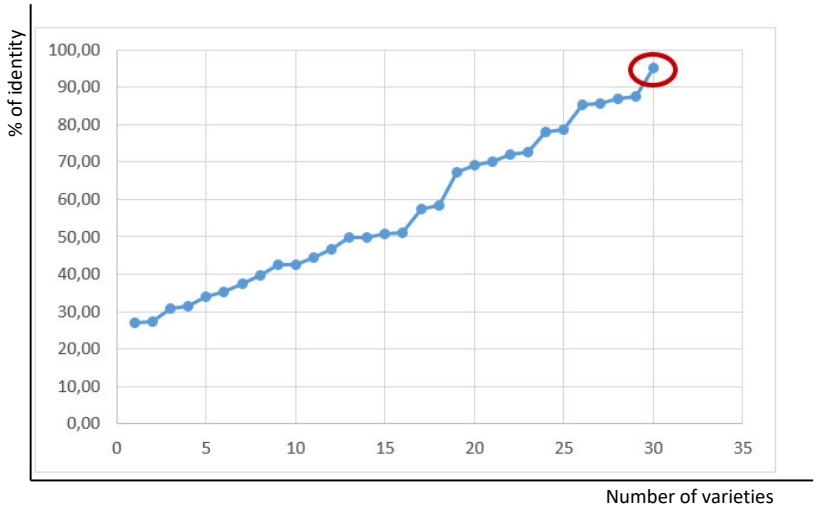
RESULTS 2024

Unknown varieties test



Red circle identify a sample with an identity value above the threshold.
This means that an unknown sample may fall within the identity threshold giving an error of less than 5%.

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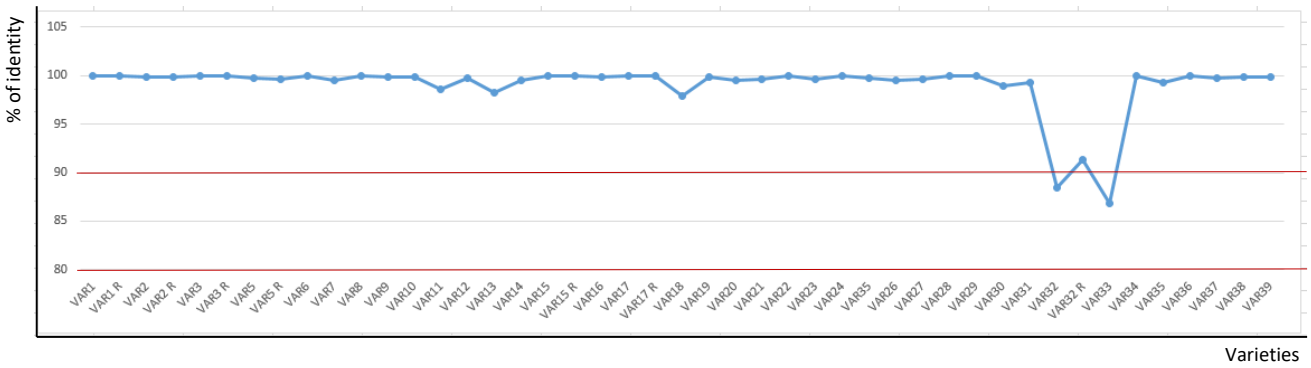
RESULTS 2024

Setting thresholds test



Each dot correspond to a variety or its replicate. For most samples, identity values fall above 98%.
For a threshold of 90% identity, less than 5% of the samples would be wrongly identified.

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RESULTS 2024

INASE regulation 459/2023

Test will be conducted by LCAS (Laboratorio Central de Análisis de Semillas) and labs from the SiTeLAS (Sistema Territorial de Laboratorios de Análisis de Semillas)

Will be used for trade control and other activities related with law 20.247.

Test conditions: al least 300 seeds tested

Thresholds:

- if identity value is equal or higher than 90%, the sample has the identity to the stated variety
- if the identity value is below 80%, the sample has no identity to the declared variety
- if the identity value is between 90%-80%, the result is uncertain

After registration, breeders have to provide 30 samples of 500g each from different harvesting years and locations.

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CONCLUSIONS 2024

This methods allow us to identify wheat varieties giving some advantages compared with other methodologies:

- Non-destructive method
- Cheaper than DNA-Based tests
- Quicker test, only takes a few minutes
- Requires very little work load for sample preparation
- Software easy to use and adaptable to customer
- Requires non sophisticated facilities.

Disadvantages:

- Requires a development for each variety set (country or region)
- Not possible to test on treated seeds or damaged seeds.

Barley

NEW DEVELOPMENTS

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THANKS FOR YOUR ATTENTION

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[End of Annex and of document]