AI for Agriculture

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11.16.2023

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My Interest

Growth as a Topic of Research

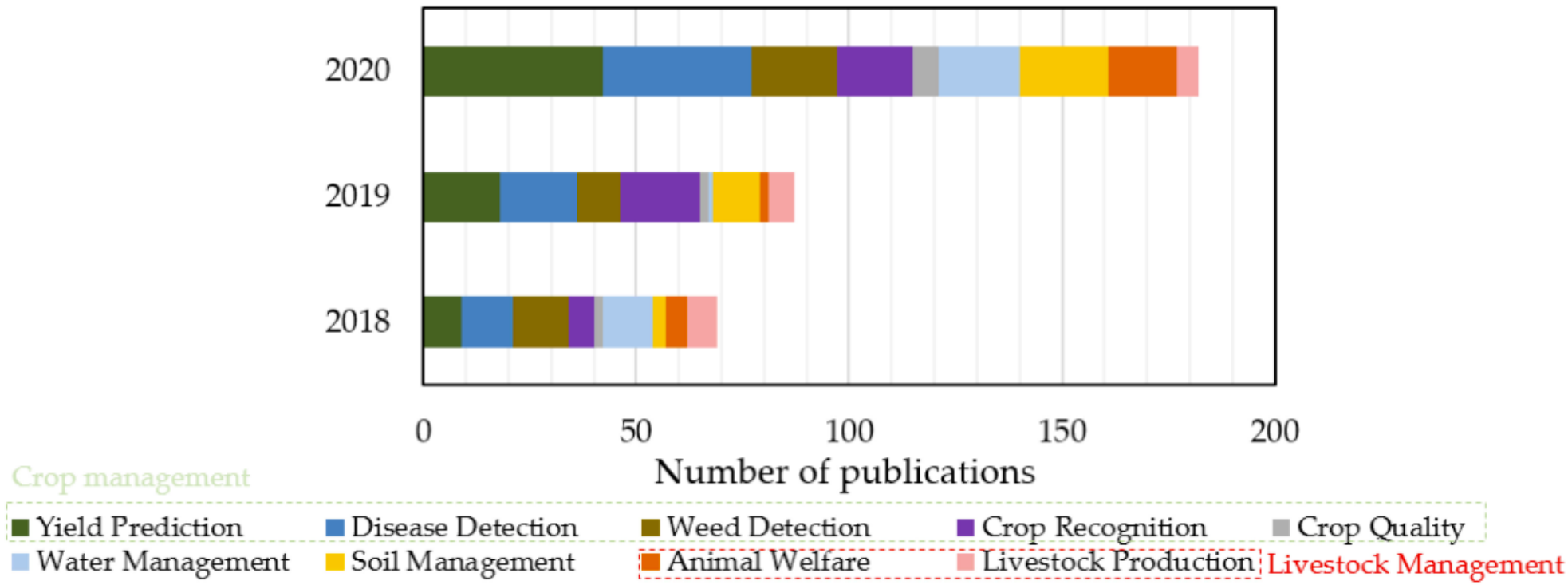


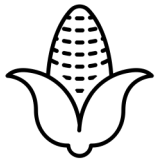
Figure 13. Temporal distribution of the reviewed studies focusing on machine learning in agriculture, which were published within 2018–2020.

Source: Benos, L., Tagarakis, A. C., Dolias, G., Berruto, R., Kateris, D., & Bochtis, D. (2021). Machine learning in agriculture: A comprehensive updated review. *Sensors*, *21*(11), 3758. https://doi.org/10.3390/s21113758

Dichotomy of Agricultural Products

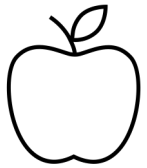
Grains // “commodities”

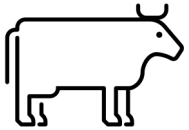
- Diet staple carbohydrates
- Mechanized production, technologically advanced (Ex. GMOs)
- Vast industrial applications
- High acreage competes with grazing
- Middle states



Fruits, veg // “specialty”

- Essential vitamins, minerals
- Manual harvest, variable demand
- Low acreage, high irrigation
- California or import





Source: Colucci, J., Stoddard, P.B. (n.d.). Supply Chain of Agriculture [MOOC]. Coursera. https://www.coursera.org/learn/supply-chain-of-agriculture

Crop Prevalence in Recent Studies

Only three aren't commodities

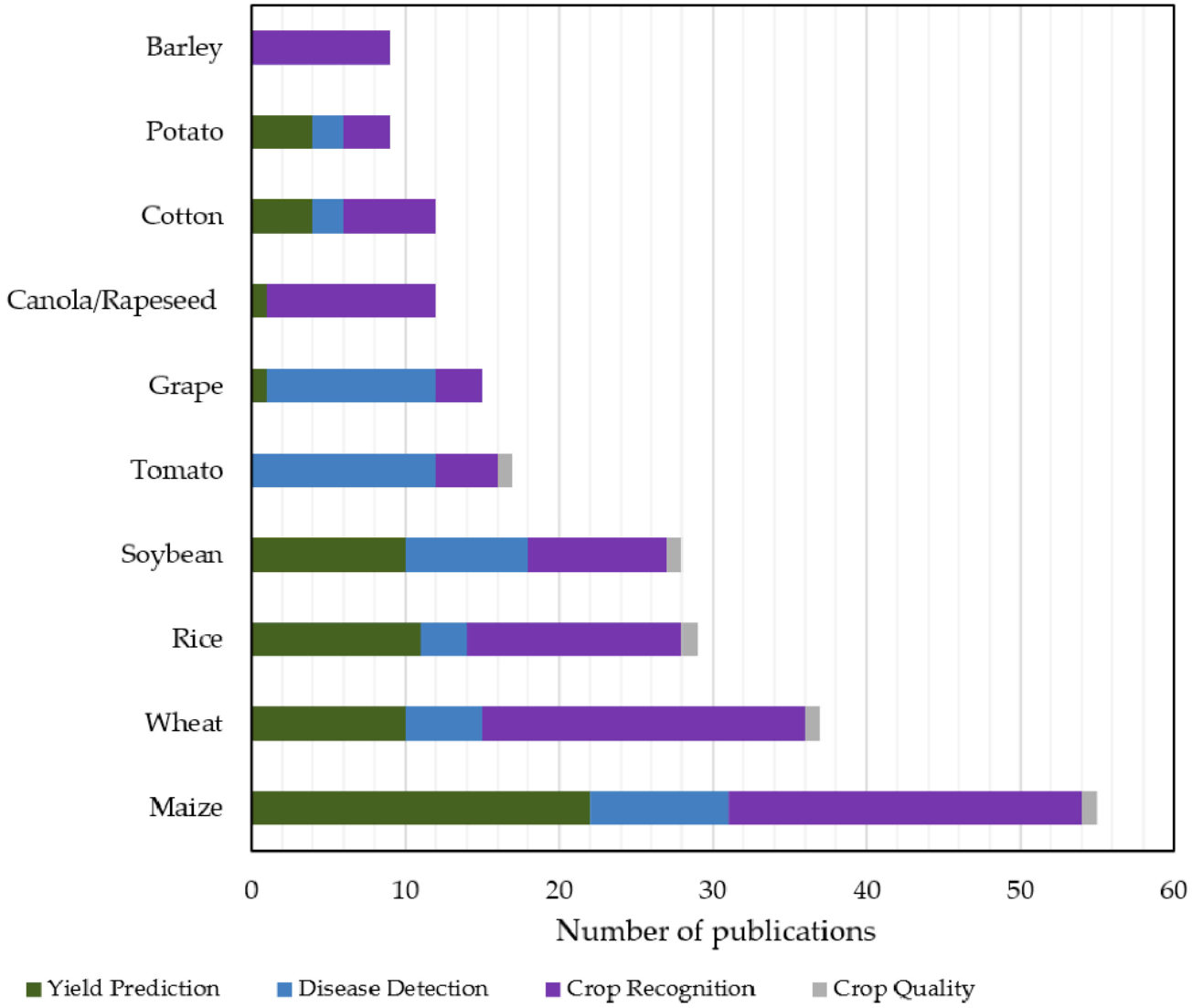
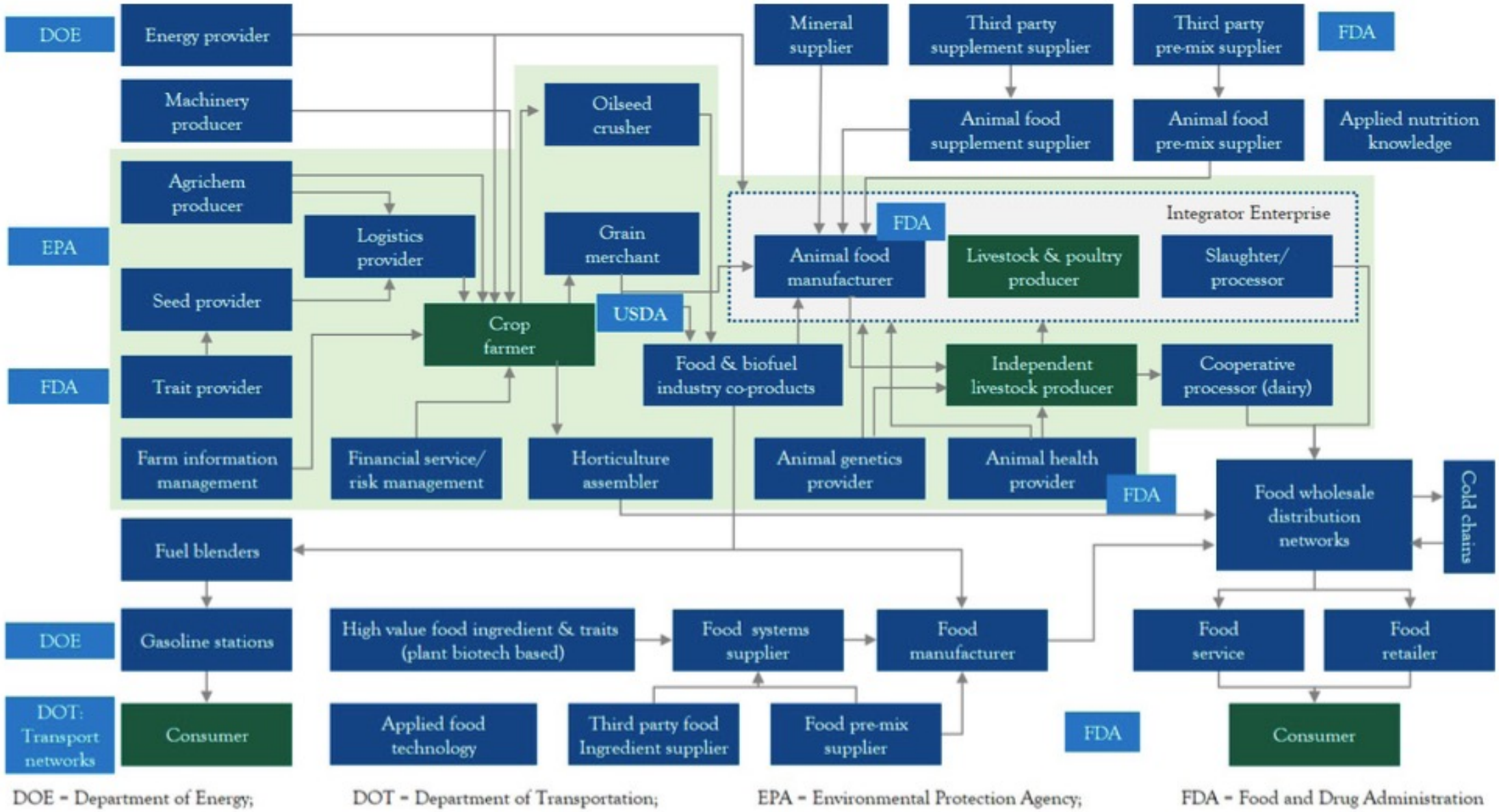


Figure 9. The 10 most investigated crops using machine learning models; the results refer to crop management.

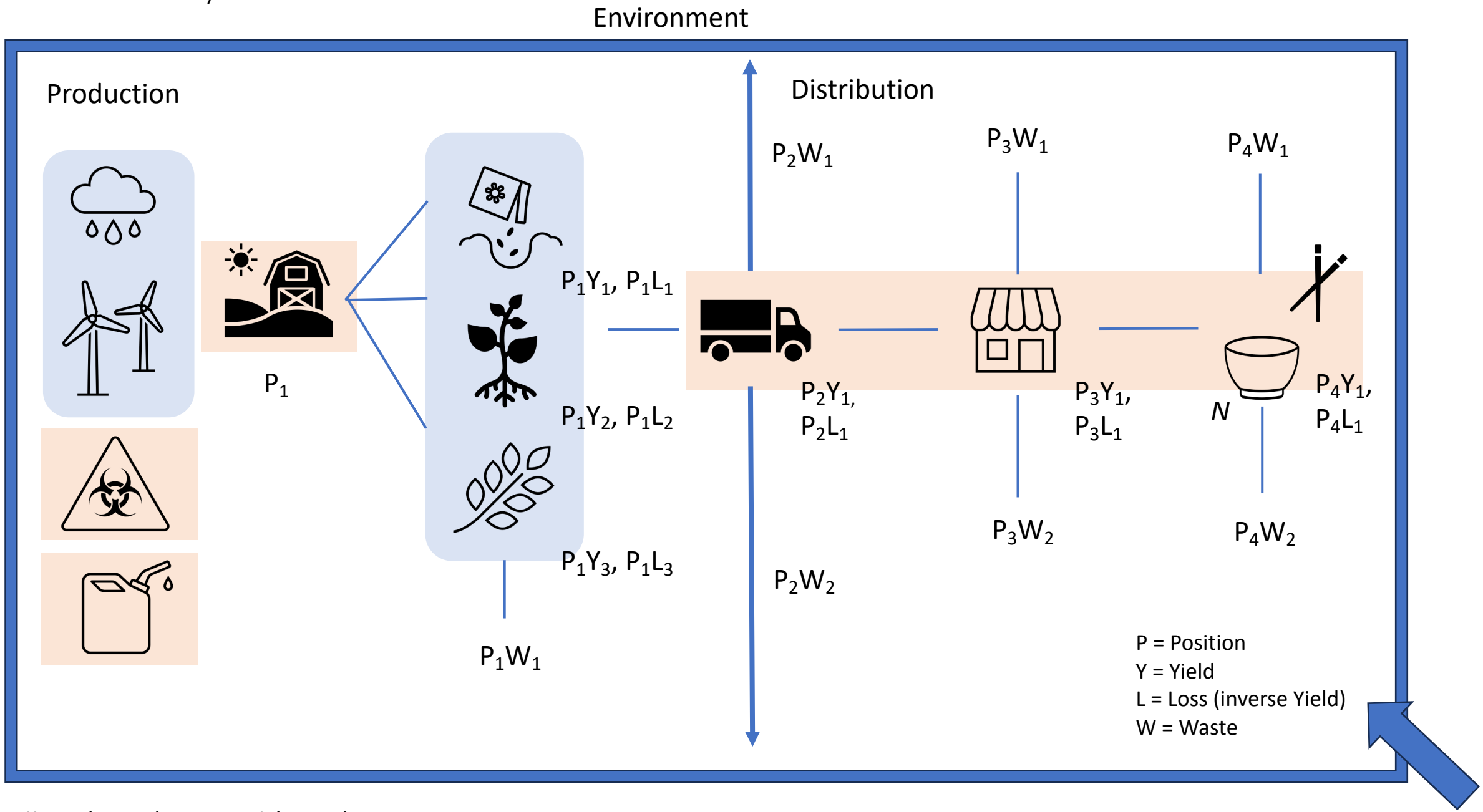
Source: Benos, L., Tagarakis, A. C., Dolias, G., Berruto, R., Kateris, D., & Bochtis, D. (2021). Machine learning in agriculture: A comprehensive updated review. *Sensors*, *21*(11), 3758. https://doi.org/10.3390/s21113758

Figure 2: *Federal agencies have complementary program and regulatory responsibilities in agri-food supply chains; Shaded area shows parts of the agri-food supply chain of primary focus for the USDA and this report. Not all Federal agencies with important program and regulatory responsibilities are shown in the Figure. For example,*



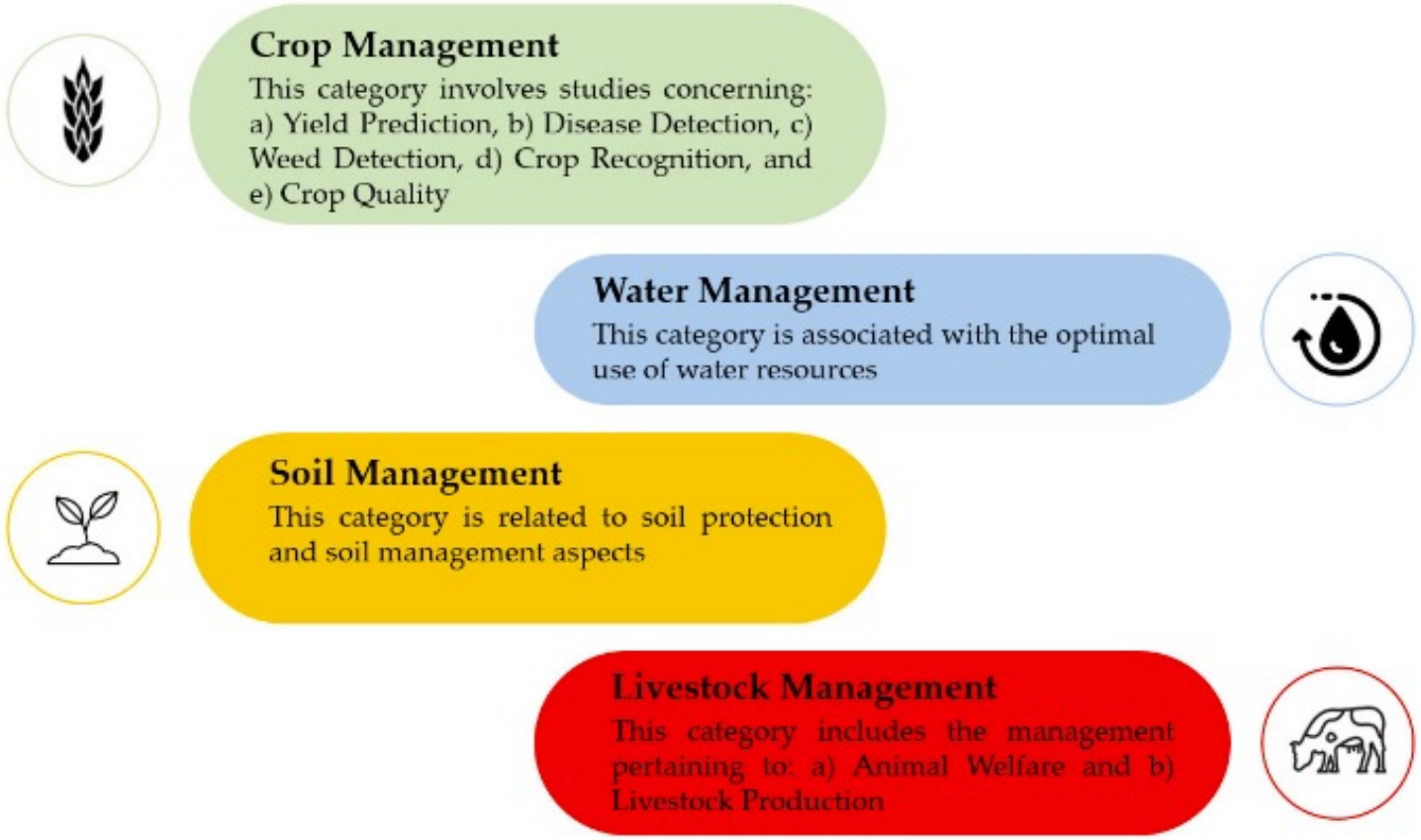
the Department of Labor has responsibilities in labor and workforce issues, the Department of Homeland Security Custom and Border Protection in protecting against the introduction of foreign plant and animal diseases, the U.S. Trade Representative in trade policy, and the Department of Commerce in general market regulation.

Industrialized Food Cycle



Ilhan (2023), Conrad (2018)

Four Major Categories of Research



Source: Benos, L., Tagarakis, A. C., Dolias, G., Berruto, R., Kateris, D., & Bochtis, D. (2021). Machine learning in agriculture: A comprehensive updated review. *Sensors*, *21*(11), 3758. https://doi.org/10.3390/s21113758

Global Distribution of Research

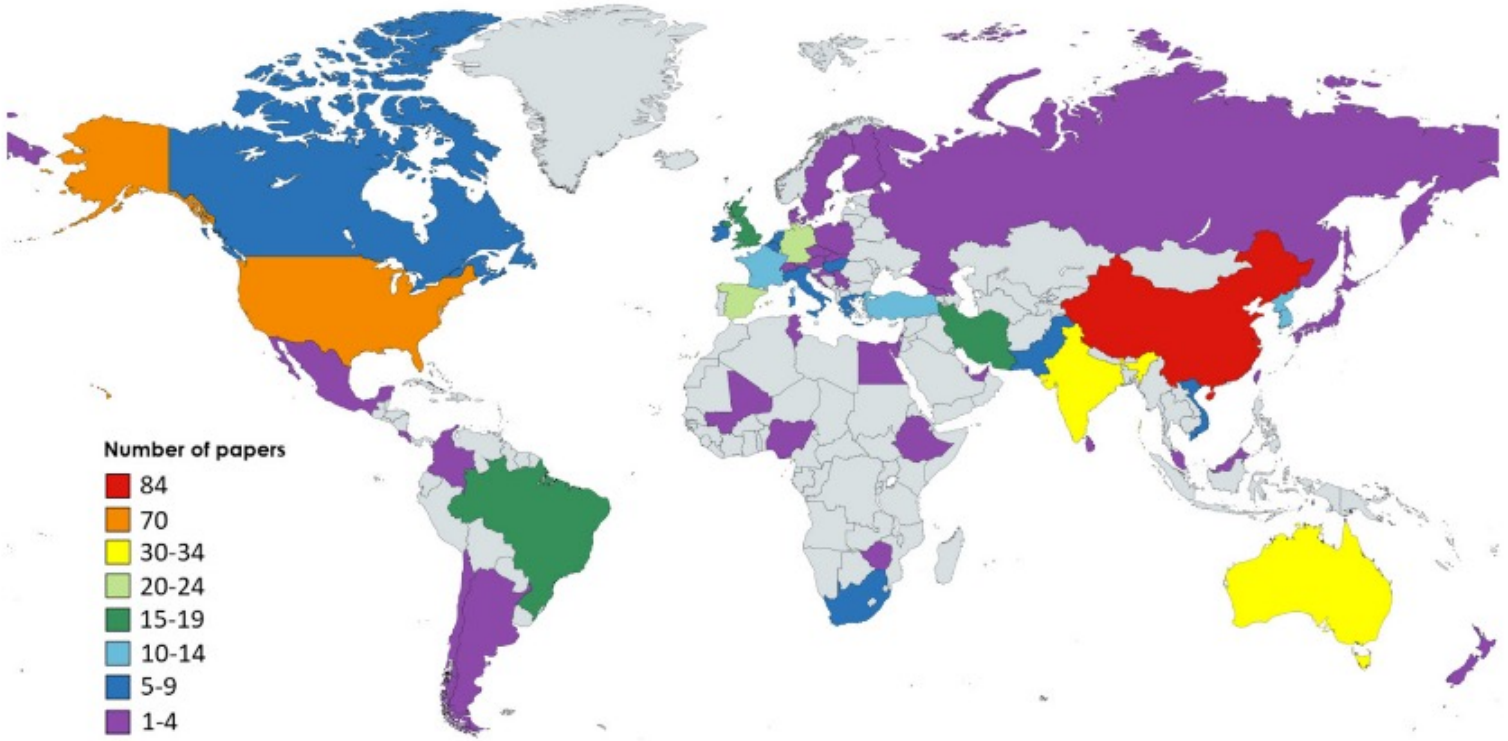


Figure 6. Geographical distribution of the contribution of each country to the research field focusing on machine learning in agriculture.

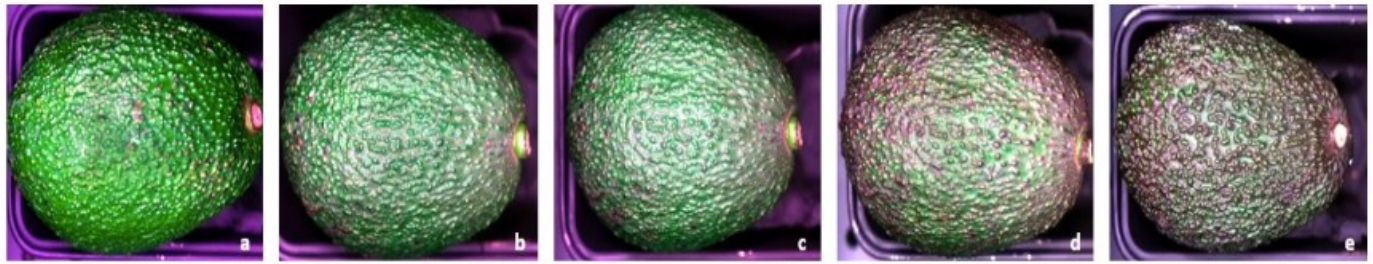
Source: Benos, L., Tagarakis, A. C., Dolias, G., Berruto, R., Kateris, D., & Bochtis, D. (2021). Machine learning in agriculture: A comprehensive updated review. *Sensors*, *21*(11), 3758. https://doi.org/10.3390/s21113758

Innovations

- Detect diseases before symptoms become visible using infrared imaging
- Accurate yield prediction via satellite imagery
- Efficient herbicide dispersal algorithm
- Near-instant livestock out-of-bounds alerts
- Accurately forecast ripeness timeline for picked fruit
- Accurate hourly, weekly, monthly weather forecasting
  - Temperature, wind speeds, solar radiation, humidity too
- Mobile app delivery of predictions

Hyperspectral Imaging of Avocados

Lowest Ripeness



Highest Ripeness

Figure 1. RGB (red, green, blue) images generated through hyperspectral imaging of a single Hass avocado fruit with (**a**) 14 days left to ripen; (**b**) 10 days left to ripen; (**c**) 6 days left to ripen; (**d**) 2 days left to ripen; (**e**) 0 days left to ripen (completely ripe).

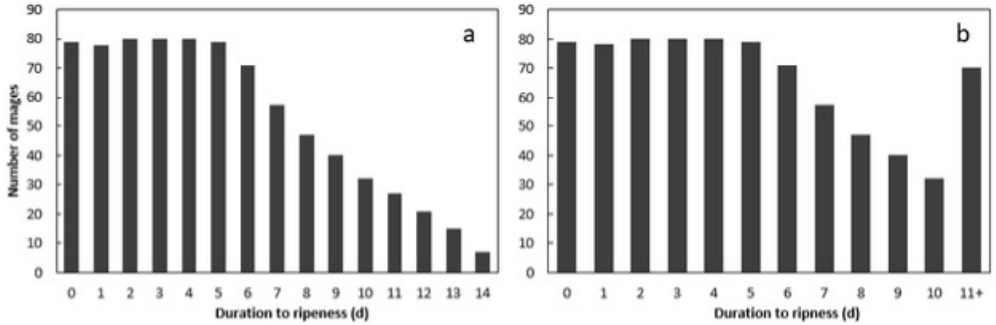


Figure 2. (**a**) Number of original hyperspectral images of Hass avocado fruit in each ripeness-stage category; (**b**) number of hyperspectral images of Hass avocado fruit in each category after combining the categories with 11–14 days to ripeness.

Source: Davur, Y. J., Kämper, W., Khoshelham, K., Trueman, S. J., & Bai, S. H. (2023). Estimating the ripeness of Hass Avocado Fruit using deep learning with hyperspectral imaging. *Horticulturae*, *9*(5), 599. https://doi.org/10.3390/horticulturae9050599

Visualizing a Continuous Target

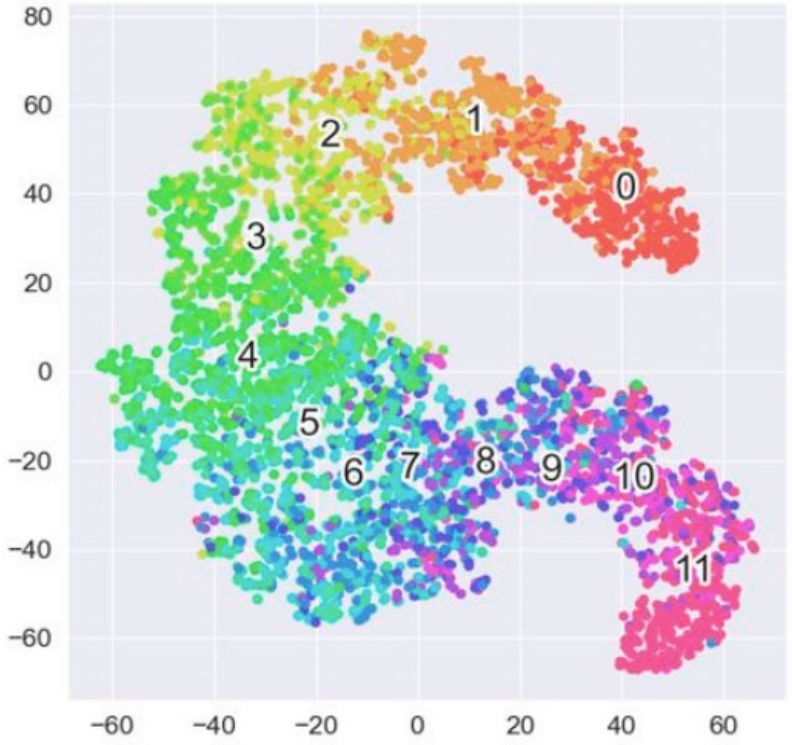


Figure 6. t-SNE visualization of output feature maps for 5000 training samples of the classification model. The numbers in the graphs represent the categories of number of days to ripeness of Hass avocado fruit.

Source: Davur, Y. J., Kämper, W., Khoshelham, K., Trueman, S. J., & Bai, S. H. (2023). Estimating the ripeness of Hass Avocado Fruit using deep learning with hyperspectral imaging. *Horticulturae*, *9*(5), 599. https://doi.org/10.3390/horticulturae9050599

CV Hurdles: Accounting for Orientation

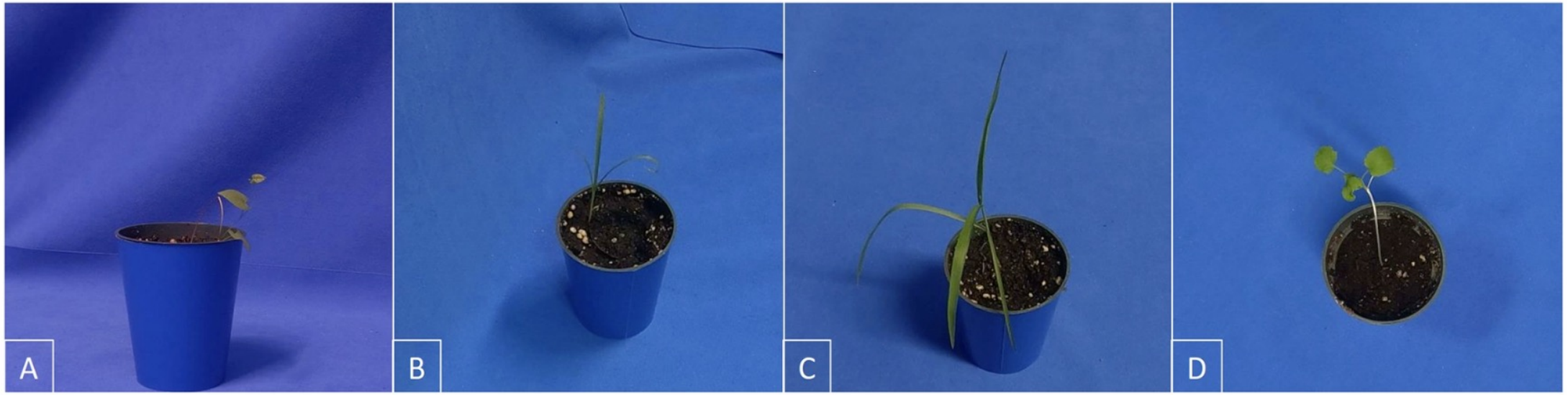


Fig 1. Example images taken by EAGL-I. A: Wild buckwheat in a profile shot. B-C: Yellow foxtail and barnyard grass in oblique angles. D: Canola in an overhead shot. Blue keying fabric is used as background.

https://doi.org/10.1371/journal.pone.0243923.g001

Beck, M. A., Liu, C.-Y., Bidinosti, C. P., Henry, C. J., Godee, C. M., & Ajmani, M. (2020). An embedded system for the automated generation of labeled plant images to enable machine learning applications in agriculture. PLOS ONE, 15(12). https://doi.org/10.1371/journal.pone.0243923

CV Hurdles: Accounting for Background

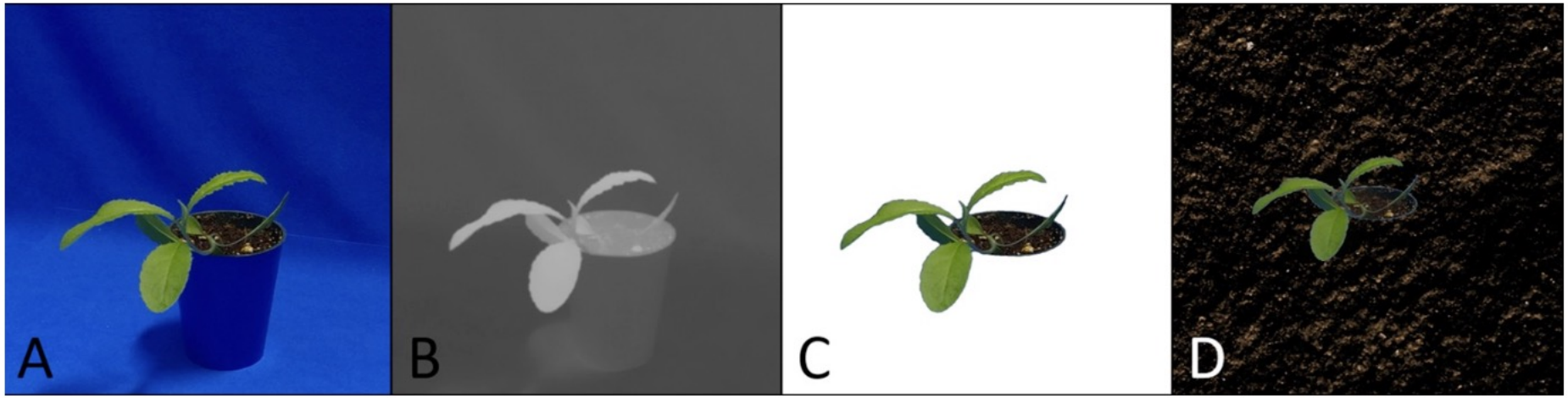


Fig 5. Background removal. A: Original Image captured by EAGL-I. B: The originals blue-yellow channel as a grayscale image. C: Keyed out image. The background is removed by defining a threshold for the blue-yellow values. All pixels below that threshold are masked out. D: The background is replaced by a stock photograph of soil.

https://doi.org/10.1371/journal.pone.0243923.g005

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What I Learned

- Informative effect of research is variable
  - Many studies are “We built a great NN”, no illustrations, no data
- Really smart people are working on these problems
  - AI is well able to meet these challenges
- Your system touches others
- Developed nations have satellite programs
  - Free data
- Hyperspectral Image Processing
- Having more than one work hobby

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agriculture studies

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