WHITE PAPER

IMPROVING THE FUTURE OF SMART AGRICULTURE WITH SPECTROSCOPY

BY AVANTES

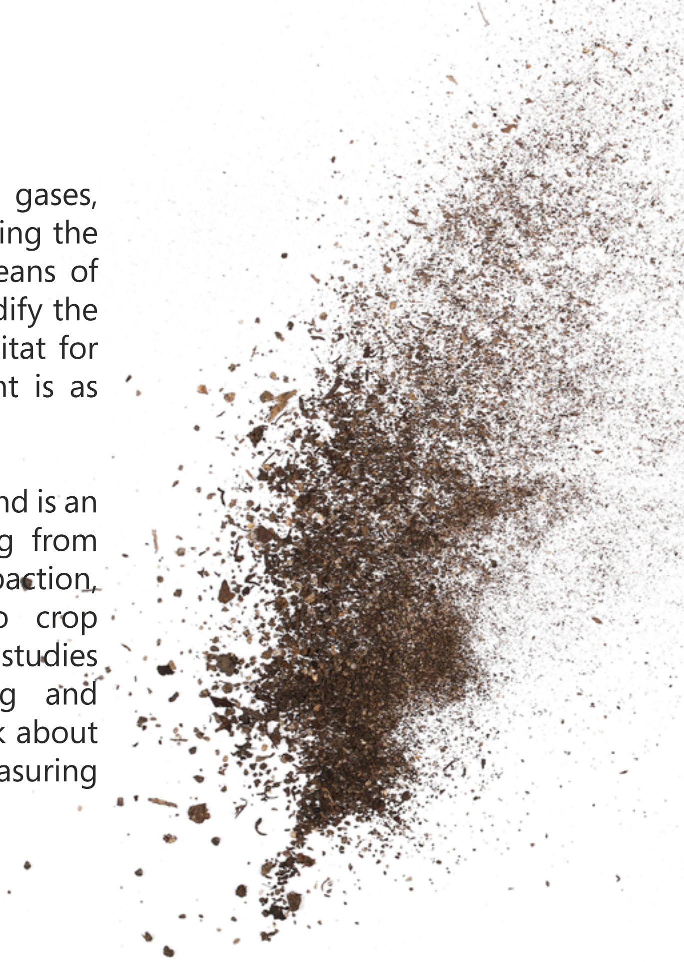
INTRO

IMPROVING THE FUTURE OF AGRICULTURE WITH SPECTROSCOPY

Written by Avantes, Empowering Spectroscopy Solutions

Climate change and population expansion have a direct impact on agriculture. An increasing number of people need to be fed but changing weather patterns can cause complete crops to fail. Inevitably, farms must produce more with less, and frequently under increasingly difficult conditions. Growing seasons are shorter, there are fewer resources such as clean water, and even the soil itself can become depleted. Therefore, more and more players in the agricultural market turn to technology to help them work more efficiently and smarter, like spectroscopy.

The last couple of years, we have seen an increase in applying this enabling technology in smart agriculture. Not only in research but also in agricultural equipment manufacturing, spectroscopy plays a key role. Because of the endless possibilities spectroscopy has to offer, it is applied in numerous applications that improve the future of agriculture. In this white paper, we go over a few applications in which spectroscopy enhances the outcome.



SOIL MANAGEMENT

Soil is a compound mixture of organic matter, minerals, gases, liquids, and even living organisms. In addition to supporting the plant life we need for crops, soil also functions as a means of storing, transporting, and purifying water; it helps to modify the atmosphere we all depend on and even serves as a habitat for organisms large and small. Sustainable soil management is as critical for future food production as it is for life on Earth.

Soil health is elemental to sustainable land management and is an important consideration for farms of all sizes. Anything from erosion to contamination, loss of biodiversity, soil compaction, and everything in between, can be detrimental to crop production and the viability of the farm itself. Numerous studies and technologies are in development for analyzing and managing soil health with the help of spectroscopy. Think about moisture measurement, soilcharacterization, and measuring bulk density and soil compaction.

FERTILIZER AUTOMATION

Not only for the plant but also for the soil the plant is on, it is important not to overapply fertilizer. Yara International ASA uses spectroscopy in a module that attaches to farm tractors used with their fertilizer applicators.They apply spectroscopic diffuse reflection, ideally suited to this application, as it requires limited hardware and performs at a very high speed (e.g., 600 spectra p.s.).

The module measures the solar illumination and correlates this with reflection data from the crops. The reflected light from the crops provides rich information about the chlorophyll content, allowing for the derivation of a health score. This score regulates the fertilizer application level in real-time and also maps this to GPS coordinates for future monitoring.

Yara's module provides an excellent example of spectroscopy's critical role in utilizing resources better and improving agricultural yields.

HEALTH MONITORING & QUALITY ASSESSMENT

Farmers are very concerned about plant health as it directly affects yields and, by extension, profits. Near-Infrared (NIR) spectroscopy is one advancement that has tremendous potential for agricultural applications. It relies on the absorption or reflection of near-infrared light to facilitate qualitative and quantitative analysis of the chemical and physical properties of the test sample. NIR spectroscopy can determine crop parameters, measure the need for fertilizers, check for bruising not visible for the human eye, and detect plant diseases.

DETECT PLANT DISEASES

NIR spectroscopy is proved a cost-effective and accurate method for detecting plant diseases at the leaf and canopy levels. For example, on the detection of Rice Blast Fungus. It is considered a significant threat to food safety and stability due to the severe yield loss that it causes. Until recently, the method for detecting rice blast was a physical inspection on the ground. It was time-consuming and nearly impossible for large-scale operations. With the help of NIR spectroscopy, correlation between rice blast disease index and IR spectra can lead to early detection technologies for large-scale operations. This allows for more efficient use of agrichemicals and a more sustainable method of crop management.

Researchers at the National Rice Research Institute and the Academy of Agricultural Sciences in China employed neural networks to analyze reflectance spectra in the development of their modelling for rice blast detection. Their aim was to detect spectral regions where rice reflectance changed, depending on rice neck blast disease index. But also to select the key wavelength bands and sensitivity to analyze disease severity and validated their neural network-based spectral model for qualifying disease severity[1].

FRUIT QUALITY

Researchers at the Polytechnic University of Valencia, use a spectrometer to develop a mango quality index for prediction modeling. They also use it to create a robotic gripper, capable of simultaneous tactile and NIR measurements to determine the quality and ripeness of the mango[2].

This non-destructive method of assessing fruit quality is based on the mango samples' biochemical and physical properties. Mangoes are typically not ready for consumption at the time of maturity. They require a period for ripening. During this period, many significant chemical and physical changes occur within the fruit. Diffuse reflectance spectroscopy was used with a fiber-optic probe in direct contact with the mango skin to measure the changes in soluble solids, ascorbic acid, water content, and color.

Spectroscopy has a place in every step of the food production cycle, from production to grading and sorting. By measuring plant health and acting accordingly based on the results, farmers can optimize their crop production.

FOOD OF THE FUTURE

Long-term space missions and Mars colonization projects will require producing food in less than optimal environments for plant growth. This has significant ramifications for planning to meet the dietary needs of these future colonies. The Laboratory of Environmental Biology and Life Support Technology, in partnership with the International Joint Research Center of Aerospace Biotechnology & Medical Engineering, is studying the effects of low-intensity light on the growth, photosynthesis, and yield of wheart[3].

The researchers used a spectrometer to control the light intensity of different test groups at the various growth stages. They discovered that low light at early growth stages had little effect on the ultimate yield so long as adequate light was available during the later grain filling stages.

CONCLUSION

Every sector needs to contribute to a better future by working smarter and more efficiently, and spectroscopy enables this in each market, also in agriculture. Whether is it optimizing the soil, measuring plant health, or using the perfect amount of fertilizer, spectroscopy offers endless possibilities. We see an interaction between the two markets; when innovative spectroscopy solutions are developed, innovative applications follow, and vice versa.

Spectroscopy contributes to a better future in agriculture and has become an indispensable technique for our future.

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Avantes Headquarters
Phone: +31 (0) 313 670 170
Email: info@avantes.com
Website: www.avantes.com

Avantes Inc.
Phone: +1 (303) 410 866 8
Email: infousa@avantes.com
Website: www.avantesUSA.com

Avantes China
Phone: +86 (0) 108 457 404 5
Email: info@avantes.com.cn
Website: www.avantes.cn

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