15th INTERNATIONAL CONGRESS ON AGRICULTURAL MECHANIZATION AND ENERGY IN AGRICULTURE

October 29-November 1, 2023 - Antalya, Türkiye

Abstract Book

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Preface

It is a great pleasure and honor for us to your participation in the 15th International Congress on Agricultural Mechanization and Energy in Agriculture – AnkAgEng'2023" organized between October 29 – November 1, 2023, in Antalya, Türkiye by Ankara University Faculty of Agriculture Department of Agricultural Machinery and Technologies Engineering. We are also honored to hold the 15th of our congress, the first of which was organized by Ankara University in 1980. Since the first International Congress on Agricultural Mechanization and Energy in Agriculture, we have continued our congress on a regular basis every three years. AnkAgEng'2023 Congress was of great importance for us and the Turkish nation as 2023 is the "100th Anniversary of the Republic of Türkiye" and was held like a feast for the scientific world.

AnkAgEng'2023 offered a magnificent international platform for academics, researchers, engineers, industry participants, and students from all over the world to share their research results in the field of agricultural technology engineering. The main subjects of the Congress are; Machinery and Energy Systems, Agriculture Information Technologies, Digital-Smart Agriculture, Ergonomics, Health & Safety, System Engineering, Postharvest Technologies & Process Engineering, Sustainable Agriculture, Natural Resources & Environmental Systems, Plant, Animal & Facility Systems, Agricultural Engineering Education, and Biosystems Engineering. The congress featured keynote speakers, oral and poster presentations, special sessions, and real-time discussions.

A total of 200 researchers from 30 different countries applied to participate in the congress by submitting abstracts. Participants were from the USA, Canada, Italy, England, Ireland, Spain, Portugal, Denmark, Belgium, Greece, China, Japan, Nigeria, Czechia, Pakistan, India, Iran, Russia, Sweden, Brazil, Bulgaria, Oman, Algeria, Poland, Finland, Malaysia, Romania, Sudan, Tanzania, and Turkiye. At the AnkAgEng'23 congress, 5 invited speakers and 8 online keynote speakers made oral presentations. In addition, 57 oral and 12 poster presentations were presented by researchers.

We would especially like to thank our invited/keynote speakers, session chairs, members of the Scientific Committee, authors, and colleagues for making their valuable contributions. We are thankful to Ankara University, Springer Nature, our main sponsor Türk Traktör, gold sponsor Ziraat Bank, European Society for Agricultural Engineers, American Society of Agricultural and Biological Engineers and International Commission of Agricultural and Biosystems Engineering for their kind support that enabled us to hold this congress.

Sincerely yours
On behalf of the Congress Organizing Committee
Prof. Dr. Ahmet ÇOLAK
Congress Chair

Honorary Chairperson

Necdet Ünüvar, Rector of Ankara University

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Scientific Program

Oct. 29, 2023, Sunday	
14.00	Check-in to the Congress Hotel, Sherwood Exclusive Lara Hotel
15.00	Registration
20.00-23.30	100th Anniversary of the Republic of Türkiye Ball (Gala Dinner)
Oct. 30, 2023, Monday	
08.30 -09.15	Opening Ceremony
Invited Speaker Presentations (1-3) – Hall A	
Chair: Jitendra Paliwal – University of Manitoba	
09.30-10.00	ISP-1: Hyperspectral Imaging Technology: A Novel Nondestructive Tool for Detecting and Evaluating Agricultural and Food Products **Da-Wen Sun – University College Dublin**
10.00-10.30	ISP-2: Building a Sustainable Energy Future **Yunus Çengel – University of Nevada**
10.30-11.00	ISP-3: An Exergy-Based Design of An Agricultural and Horticultural Slow-City Compound with Solar, Wind, and Geothermal Energy with Circular Hydrogen **Birol Kılkış – Fellow ASHRAE, Ostim Technical University**
11.00-11.30	Presentation of Türk Traktör, Main Sponsor
11.30-11.45	Coffee Break
SESSION I – Hall A | Oral Presentations (1-4)	
Chair: David Herák – Czech University of Life Sciences	
11.45-12.00	OP-1: Autonomous Ground Vehicle for Weeding Activities: Preliminary Sustainability Assessments **Giuseppe Todde**
12.00-12.15	OP-2: Evaluation of Hydration State around Glycerol as a Humectant using Microwave Dielectric Spectroscopy **Nao Takeuchi**
12.15-12.30	OP-3: Discharge Coefficients for Adjustable Slot Inlets Used to Ventilate Animal Production Buildings **John P. Chastain**
12.30-12.45	OP-4: Combining Digital Image Processing and Machine Learning is Useful for the Early Detection of Salinity and Drought Stresses in Cucumber **Parvin Mohammadi**
12.45-13.30	Lunch Break

Scientific Program

Oct. 30, 2023, Monday	
SESSION II – Hall A | Oral Presentations (5-8)	
Chair: Poulek Vladislav – Czech University of Life Sciences	
13.30-13.45	OP-5: Enabling Insecticide Spot Application on Boom Sprayer by Developing Machine Vision and Communcation Components **Ahmad Al-Mallahi**
13.45-14.00	OP-6: Optical Techniques for Automated Evaluation of Seed Damage **Mohammad Nadimi**
14.00-14.15	OP-7: Estimation of Vitamin A Concentration in Cattle Blood Based on Fluorescence with/without Blood Cell Separation by Plasma Filter **Mizuki Shibasaki**
14.15-14.30	OP-8: A Network Compaction Strategy to Reduce the Cost of Detection Networks Deployed in Edge-AI Devices: A Case Study for Grading Canola **Chyngyz Erkinbaev**
14.30-14.45	Coffee Break
SESSION II – Hall B | Oral Presentations (9-12)	
Chair: Keyvan Asefpour Vakilian – Gorgan University of Agricultural Sciences and Natural Resources	
13.30-13.45	OP-9: Exploring Transfer Learning for Enhanced Seed Classification: Pre-trained Xception Model **Zeynep Ünal**
13.45-14.00	OP-10: Classification of Pistachio Nut using Convolutional Neural Network **Khaled Idress**
14.00-14.15	OP-11: Deep Learning as a New Technique to Detect Plant Leaf Diseases **Ako Kakarash Omer**
14.15-14.30	OP-12: Definition of Reference Models for Functional Parameters and Price for Mowers and Mowers-Conditioners **Daniele Pinna**
14.30-14.45	Coffee Break
SESSION III – Hall A | Oral Presentations (13-16)	
Chair: Birol Kılkış – Fellow ASHRAE, Ostim Technical University	
14.45-15.00	OP-13: Impact of Building Geometry, Window Types, and Materials on Daylighting Performance of Livestock Buildings **Sheikh Rishad Ahmmad**
15.00-15.15	OP-14: Development of Design of Solar PV Panels within Last 25 Years – Possibilities for Renovation **Martin Libra**

Scientific Program

Oct. 30, 2023, Monday	
15.15-15.30	OP-15: Estimating Tall Fescue and Alfalfa Forage Biomass Using an Unmanned Ground Vehicle **Ali Bülent Koç**
15.30-15.45	OP-16: Tracking Hydraulic Performance of Photovoltaic Pumping System using Solar Radiation Data: An Empirical Model **Assia Harkani**
15.45-16.00	Coffee Break
SESSION III – Hall B | Oral Presentations (17-20)	
Chair: Daniele Pinna – University of Padova	
14.45-15.00	OP-17: Evaluation of Air Conditioning Parameters in Semi-closed Greenhouses According to Turkey's Climate **Mohammed Hassan**
15.00-15.15	OP-18: Effect of Different OLR and Mixture Ratios on Biogas Production using Goat Dung and Maize Silage **Aslı Ayhan Arslan**
15.15-15.30	OP-19: Mapping Biomass Energy Potential from Agricultural Residues in Tanzania **Geofrey Prudence Baitu**
15.30-15.45	OP-20: The Effect of Different Tillage Methods on Plant Emergence Parameters for Wheat **Serkan Özdemir**
15.45-16.00	Coffee Break
ONLINE SESSION I – Hall A | Online Keynote Presentations (1-4)	
Chairs: John P. Chastain – Clemson University	
16.00-16.30	OKP-1: Robotics for Crop-Load Management in Tree Fruit Crops **Manoj Karkee – Washington State University**
16.30-17.00	OKP-2: Precision Agricultural Technology Transition in Fruit/Berry Crops Production Management **Lav Khot – Washington State University**
17.00-17.30	OKP-3: A Greenhouse Plants Heating System Based on Low Temperature Long Wave Radiation Emission **George Papadakis – Agricultural University of Athens**
17.30-18.00	OKP-4: Development of Thermoset Epoxy Resin Film from Soybean Oil **Kasiviswanathan Muthukumarappan – South Dakota State University**

Scientific Program

Oct. 31, 2023, Tuesday	
Invited Speaker Presentations (4-5) – Hall A	
Chair: Martin Libra – Czech University of Life Sciences	
08.45-09.15	ISP-4: Robotics and Perception in Agriculture, Challenges to a Fully Automated Process **Fernando Auat Cheein – Heriot-Watt University**
09.15-09.45	ISP-5: Smart Agriculture and its Connection to the Digital Twin's Ideas **David Herák – Czech University of Life Sciences**
09.45-10.00	Coffee Break
ONLINE SESSION II – Hall A | Online Keynote Presentations (5-8)	
Chairs: Hong Liu – Oregon State University, Serap Görücü – University of Florida	
10.00-10.30	OKP-5: Flying Lora-Drone Gateway for IoT Monitoring in Oil Palm Plantation **Samsuzana Abd Aziz – Universiti Putra**
10.30-11.00	OKP-6: Key Technologies for Fully Intelligent Production of Kiwifruit **Longsheng Fu – Northwest A&F University**
11.00-11.30	OKP-7: Detecting the Basal Stem Rot (BSR) Disease using Vegetation Index, Thermal Imaging, and Machine Learning **Siti Khairunniza Bejo – Universiti Putra**
11.30-12.00	OKP-8: Exploring the Impact of Dust on Photovoltaic Performance: An Overview of Historical Trends, Current Findings, and Future Prospects **Hussein A Kazem – Sohar University**
12.00–13.30	Lunch Break
SESSION IV – Hall B | Oral Presentations (21-27)	
Chair: Yeşim Benal Öztekin – Ondokuz Mayıs University	
10.00-10.15	OP-21: Design and Implementation of a Real-Time Wireless PTO Torque Measurement System for Agricultural Applications **T.Göktürk Seyhan**
10.15-10.30	OP-22: Recent Developments in Agricultural Machinery and Technologies **M. Metin Özgüven**
10.30-10.45	OP-23: Developing Test Method for Automatic Steering Systems **M. Barış Eminoğlu**
10.45-11.00	OP-24: Estimation of Some Soil Loss Characteristics using Machine Learning Algorithms **Sema Kaplan**
11.00-11.15	OP-25: Effect of Different Drying Temperatures on CO2 Emissions in Acorn Drying **Mahmut Kaplan**

Scientific Program

Oct. 31, 2023, Tuesday	
11.15-11.30	OP-26: Microwave Assisted Convective Drying Effect on Drying Time, Energy, Quality and Bioactive Compounds of the Cantaloupe **Mohammad Kaveh**
11.30.11.45	OP-27: Prediction of the Kinetics of Drying Rheum ribes L. by an Infrared-Convective Dryer using Artificial Neural Network and ANFIS **Mohammad Kaveh**
12.00–13.30	Lunch Break
SESSION V – Hall A | Oral Presentations (28-32)	
Chair: Aaron Turner – Clemson University	
13.30-13.45	OP-28: Farm Vehicle and Farm Labor Transportation Crashes in Florida: 2013-2021 **Serap Görücü**
13.45-14.00	OP-29: Implementation and Assessment of an Autonomous Ground Vehicle (AGV) for On-Field Agricultural Operations **Gabriele Sara**
14.00-14.15	OP-30: Criteria of Ecological Pressure on Agricultural Systems **Valentin B. Sapunov**
14.15-14.30	OP-31: Rural Development Policy for Water Management Sustainability in Italy: Opportunities to Achieve Water Framework Directive Objectives **Myriam Ruberto**
14.30-14.45	OP-32: Hazard Identification and Risk Assessment for Cattle Stunning: Case Study **Serap Görücü**
14.45-15.00	Coffee Break
SESSION V – Hall B | Oral Presentations (33-37)	
Chair: Chyngyz Erkinbaev – University of Manitoba	
13.30-13.45	OP-33: Developing a Data-Driven Model for Predicting Water Stress in Pistachio Trees **Azar Alizadeh**
13.45-14.00	OP-34: Water Distribution Uniformity of Nozzles for a Hose Reel Irrigation Machine **Selçuk Arslan**
14.00-14.15	OP-35: Economic Analysis of Subsurface Drainage Systems in North Central Iowa **Kapil Arora**
14.15-14.30	OP-36: Determination of Suitable Shearing Conditions for Effective Pruning of Tree Branches **Saeid Minaei**
14.30-14.45	OP-37: Development of Variable Rate Irrigation System for Linear Moving Irrigation Machine **Bahattin Akdemir**
14.45-15.00	Coffee Break

Scientific Program

Oct. 31, 2023, Tuesday	
SESSION VI – Hall A | Oral Presentations (38-42)	
Chair: Saeid Minaei – Tarbiat Modares University	
15.00-15.15	OP-38: Using Composted Cow Manure to Improve Nutrient Content, Aeration Porosity, and Water Retention of Pine Bark-Based Potting Media **Tom O. Owino**
15.15-15.30	OP-39: Coefficient of Dynamic Wall Friction for Wood Fuel Pellets **Aaron P. Turner**
15.30-15.45	OP-40: Emerging Smart Biosensors for the Specific and Ultrasensitive Detection of Plant Abiotic Stresses **Keyvan Asefpour Vakilian**
15.45-16.00	OP-41: Sexing of Chicken Egg in the Early Incubation Based on the Analysis of Transmission Image **Maho Chihara**
16.00-16.15	OP-42: EASY4DIGIT – European Agriculture System for Digital-Based Technologies **Yeşim Benal Öztekin**
16.15-16.30	Coffee Break
SESSION VI – Hall B | Oral Presentations (43-47)	
Chair: Kapil Arora – Iowa State University	
15.00-15.15	OP-43: Determination of the Effect of Technical Parameters which Affect on the Tractor Energy Efficiency **İbrahim Ergül**
15.15-15.30	OP-44: Determination of PTO Performance Test Method for Electric Tractors **S. Oğuz Yıldız**
15.30-15.45	OP-45: Development of Fertigation System for Hose Reel Irrigation Machine **Turgay Polat**
15.45-16.00	OP-46: Determining the Possibility of Use of the DSSAT Model to Estimate Maize Yield and Water Consumption under Different Irrigation Levels **Sener Özçelik**
16.00-16.15	OP-47: Enhancing System Understanding, Gathering and Structuring Knowledge to Manage Uncertainty in WEF Systems in Gediz Basin **Sinan Aras**
16.15-16.30	Coffee Break

Scientific Program

Oct. 31, 2023, Tuesday	
SESSION VII – Hall A | Oral Presentations (48-52)	
Chair: Giuseppe Todde – University of Sassari	
16.30-16.45	OP-48: Determination of Operating Parameters in Milking Robots with Milk First Cow Traffic **Hasan Kuraloğlu**
16.45-17.00	OP-49: Shear Tests of Grapevine (*Vitis vinifera* L.) Canes **Abdullah Sessiz**
17.00-17.15	OP-50: Comparison and Evaluation of Vegetation Indices for Image Sensing Systems in Precision Agriculture **Ömer Barış Özlüoymak**
17.15-17.30	OP-51: Development of An Autonomous Mobile Robot Prototype for Agricultural Tasks in Greenhouses **Erdem Yıldız**
17.30-17.45	OP-52: Investigation of the Compliance of the Milking Routine and Pulsator's Working Characteristics to the Milking Technique in Some Dairy Cattle Farms in Isparta Province **Mwiinga Micheal Milimo**
SESSION VII – Hall B | Oral Presentations (53-56)	
Chair: Selçuk Arslan – Uludağ University	
16.30-16.45	OP-53: Design Approaches of One-Pass Strip-Till Machines **Serkan Özdemir**
16.45-17.00	OP-54: Examination of the Farm Machinery Tests Based on the Testing Institutes and Machinery Producers in Türkiye **Zeynep Demirel Atasoy**
17.00-17.15	OP-55: Fine-Tuning Growth Conditions: Leaf-Level Vapor Pressure Deficit Control for Optimized Photosynthesis **T. Göktürk Seyhan**
17.15-17.30	OP-56: The Relationship between CO2 Emissions and Soil Moisture Content Under Different Tillage Methods in Cotton Farming **Şener Özçelik**
17.30-17.45	OP-57: Chopper System for In-Line Small Square Balers **Sedat Kahraman**
POSTER SESSION – 17.45-18.30	
18.30	Closing Ceremony
19.00-20.30	Closing Cocktail

Scientific Program

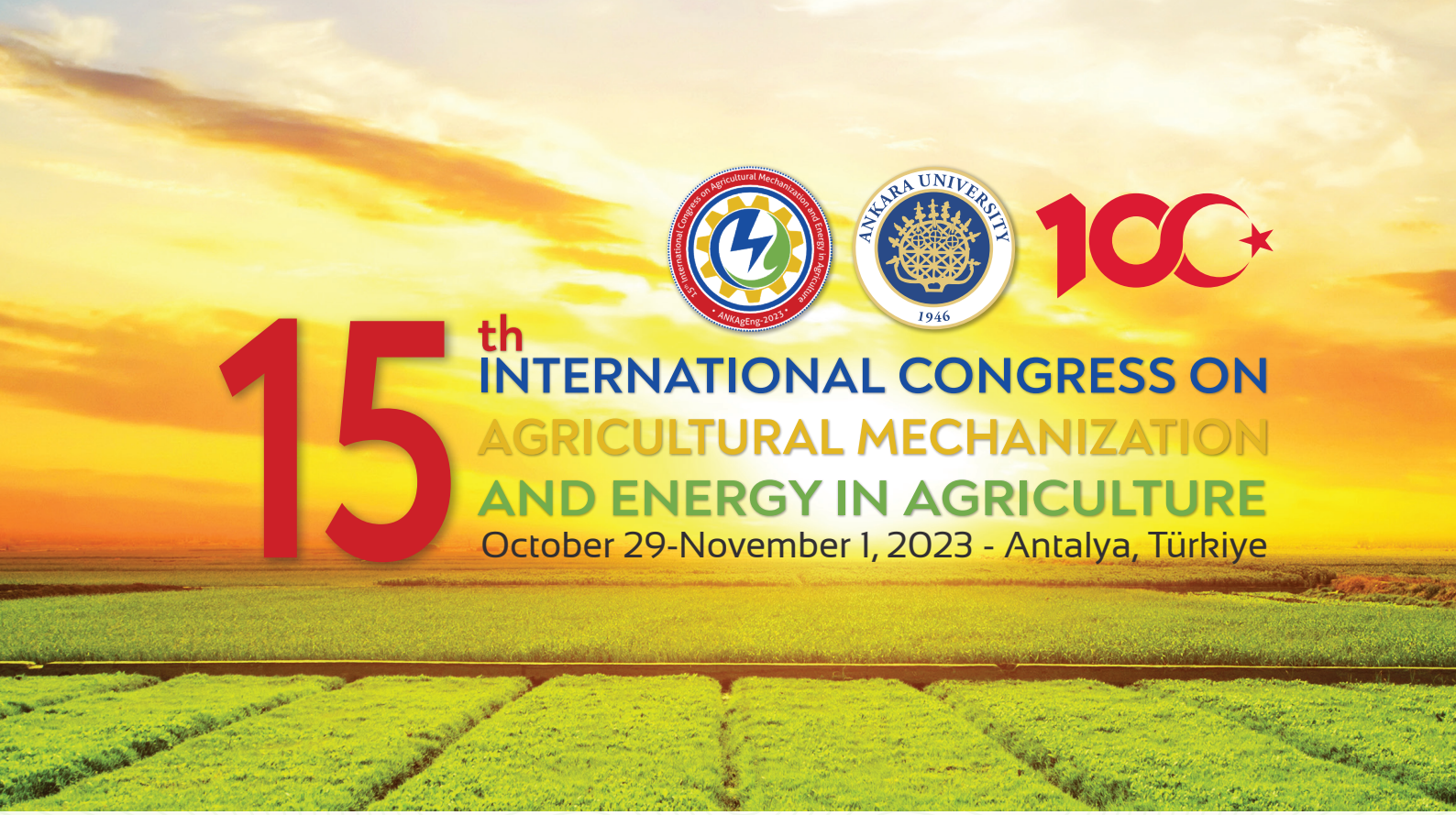
Nov. 01, 2023, Wednesday	
08.30-14.00	Half day tour in Antalya
POSTER SESSION – 17.45-18.30	
PP-1: A method for Multispectral Images Alignment at Different Heights on the Crop **Sabina Laveglia, Giuseppe Altieri**	
PP-2: Novel SERS Framework for Sulphur Quality Analysis of Pulse Protein **Catherine RJ Findlay, Mohammad Nadimi, Alex C-T Ko, Pankaj Bhowmik, Jitendra Paliwal**	
PP-3: Convective Drying of Black Chokeberries (*A. Melanocarpa*) by Different Pretreatments **İsmail Boyar, Hasmet Emre Akman, Nesibe Ebru Yasa Kafkas, Betül Yesil, Sadiye Gözlekçi Kuzu, Can Ertekin**	
PP-4: Studying the Effect of Surface and Geometry Manipulation on Dew Condensation and Rain Collection in Boreal Field Conditions **Soroush Moradi Zavie Kord, Juuso Tuure, Matti Räsanen, Laura Alakukku, Szabol Galambosi**	
PP-5: Analysis of Factors affecting Farmers' Intention to Use Autonomous Ground Vehicles **Jonny Waked, Gabriele Sara, Giuseppe Todde, Daniele Pinna, Georges Hassoun, Maria Caria**	
PP-6: Uncertain Future Menemen Plain Integrated Management of Agriculture and Nature Based Solutions for Sustainable Soil Management **Vural Karagül, Alican Eren, Tuncay Topdemir, Zübeyde Albayram Doğan, Sinan Aras, Nuri Candan, Murat Çağatay Keçeci, Gülay Yılmaz, Gözen Yüceerim, Şener Özçelik**	
PP-7: Investigation of the Performance of a Pneumatic Hazelnut Harvester with Husker Unit Used in Türkiye **Taner Yıldız**	
PP-8: Transmission Raman Spectroscopy for Inner Layers Chemical Analysis of Fresh Produce **Rani Arielly**	
PP-9: Hyperbaric Inactivation – a New Pressure-Based Method to Inactivate *Bacillus subtilis* Endospores at Room Temperature? **Jorge A. Saraiva, Carlos A. Pinto**	
PP-10: Hyperbaric Storage as a New Food Preservation Methodology to Control the Germination and Development of *Clostridium perfringens* Spores **Carlos A. Pinto, Jorge A. Saraiva, Alireza Mousakhani**	
PP-11: Applying Nature-Inspired Optimization and Machine Learning for Strawberry Leaf Scorch Detection and Classification **Mohammad Javidan, Ahmad Banakar, Keyvan Asefpor, Ioannis Ampatzidis, Kamran Rahnama**	
PP-12: The influence of combustion temperature on the emission of pollutants in a low-power wood biomass boiler **Maciej Joński, Adam Ekielski, WULS, Adam Świętochowski, Jan Joński**	

Invited Keynote Presentations

Online Keynote Presentations

Oral Presentations

Poster Presentations



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Invited Speakers Presentations

ISP-01. Hyperspectral Imaging Technology: A Novel Nondestructive Tool for Detecting and Evaluating Agricultural and Food Products

Da-Wen Sun

Food Refrigeration and Computerised Food Technology, Agriculture and Food Science Centre, University College Dublin, National University of Ireland, Belfield, Dublin 4, Ireland

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Hyperspectral imaging is a nondestructive technology that merges the well-established tools of optical sensing—both imaging and spectroscopy. It can not only capture spatial details but can also reveal the spectral signature for each pixel in an image, thus opening up the possibility of food nondestructive detection and evaluation that conventional colour imaging systems cannot perform.

The fusion of spatial and spectral data has propelled hyperspectral imaging to the forefront of technological exploration across various fields. In the food industry, hyperspectral imaging has emerged as a valuable tool, unveiling not just the physical attributes such as colour, size, shape, and texture, but also the intrinsic chemical and molecular compositions like water, fat, and protein in food products.

This presentation focuses on the important role that hyperspectral imaging plays in the food industry in ensuring the safety and quality of food. The fundamental principles and theoretical foundations of hyperspectral imaging will be presented first, followed by a discussion of representative application examples from our own work to those of international researchers. These examples range from the detection and evaluation of the quality and safety of muscle foods such as salmon fillets, chicken fillets, pork, ham, minced lamb, and poultry carcasses, to the detection, analysis, and grading of fruits like banana, lychee, kiwifruit, pear, citrus, strawberry, and cucumber. Additionally, the visualization of kiwi sugar distribution, the tracking of tomato ripening, and the critical detection of melamine contamination in flour will also be explored.

Keywords: hyperspectral imaging; food quality; food safety; nondestructive detection

References

[1] Da-Wen Sun (editor), Computer Vision Technology in the Food and Beverage Industries, Woodhead Publishing Limited, Cambridge, UK, 528 pp., ISBN 978 0 85709 036 2 (2012).

[2] Da-Wen Sun (editor), Hyperspectral Imaging for Food Quality Analysis and Control, Academic Press / Elsevier, San Diego, California, USA, 528pp., ISBN 978-0123747532 (2010).

[3] Da-Wen Sun (editor), Infrared Spectroscopy for Food Quality Analysis and Control, Academic Press / Elsevier, San Diego, California, USA, 424 pp., ISBN 978-0-12-374136-3 (2009).

[4] Da-Wen Sun (editor), Computer Vision Technology for Food Quality Evaluation, Academic Press / Elsevier, San Diego, California, USA, 583 pp., ISBN 978-0-12-373642-0 (2008).34, 276-285.

ISP-02. Building a Sustainable Future in Energy

Yunus A. Çengel

Professor Emeritus of Mechanical Engineering, University of Nevada, Reno, NV, USA

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Fossil fuels, comprised of coal, oil, and natural gas, continue to be the world's primary energy resource. Fossil fuels constituted 82% of the total primary energy consumption and 61% of total electricity consumption in 2022. This represents a modest decline compared to the 2019 values of 84% for the total primary energy consumption and 64% for total electricity consumption. Paris Agreement which entered into force in 2016 aims to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels in order to significantly reduce the risks and impacts of climate change. This goal is to be achieved by developing and utilizing low-carbon technologies, thus reducing the use of fossil fuels.

The World Commission on Environment and Development defines sustainable development as: "*Development that meets the needs of the present without compromising the ability of future generations to meet their own needs*". Sustainability in energy is the branch of sustainability associated with energy. The three legs of sustainability in energy are energy efficiency, renewable energy, and energy storage.

Energy efficiency is defined as '*to reduce energy use to the minimum level, but to do so without reducing the standard of living, the production quality, and profitability*.' Energy efficiency is an expression for the most effective and efficient use of energy, and it results in energy conservation. Energy efficiency is associated with the most efficient use of energy at all stages, from production to end use. Therefore, energy efficiency is a broader term that includes energy conservation.

Energy efficiency continues to be recognized as a major energy resource of high priority to be considered in future energy investment decisions. Energy efficiency is already being touted as the '6th fuel' after coal, oil, natural gas, nuclear energy, and renewable energy. Energy efficiency is also the cheapest resource: The cost of electricity obtained from energy efficiency is usually under 5 US cents per kWh. Further, energy efficiency is local and labor intensive with significant benefits to the environment by displacing pollution and carbon emissions.

The impact and importance of energy efficiency is well-established. As a striking example, if the refrigerators in the U.S. were to consume electric power at the 1974 levels, the U.S. would need about 30,000 MW of additional installed power to meet this extra demand, which is equivalent to 60 coal plants with an average rated power of 500 MW and a construction cost of about $60 billion. Also, the conservation measures that were put in place in 1970s and 1980s in the U.S. became sufficient to meet most power needs of the growing economy, and consequently, a total of 97 nuclear power plants at different stages of construction with a total capacity of 107,000 MW were canceled. A study involving 16 Southern states of the U.S. found that they can meet their electricity needs for the next 20 years by adopting aggressive energy efficiency measures alone. A new binding target which entered into force in all EU countries on 10 October 2023 sets the goal of consuming at least 11.7% less energy by 2030 compared to the projected energy use for 2030 (based on the 2020 reference scenario).

The flagship of sustainability in energy is the accelerating investments in renewable energy, which includes hydroelectric, wind, solar, geothermal, wave, ocean, and bio energies. In 2022, 14.9% of global electricity production came from hydroelectric power plants and 14.4% from other sources such as wind (7.2%) and solar (4.5%). In 2022, electricity production by wind turbines has increased by 13.5% while solar electricity production increased by 24.9%. Also in 2022, electricity generation from the wind and the sun exceeded electricity generation from nuclear power plants which are responsible for 9.2% of global electricity generation.

It should be remembered that untapped renewable energy is wasted renewable energy. Solar energy that is not utilized while the sun is shining, for example, is wasted solar energy.

The intermittent nature of renewable energy such as wind and solar makes it necessary to utilize energy storage. The energy storage technologies include pumped-storage hydropower, compressed air, thermal, battery storage (such as li-ion batteries), chemical (such as hydrogen), and mechanical (such as flywheel). Hydro storage comprises over 90% of energy storage. Li-ion battery storage is replacing the peak power plants. Storage systems are evaluated on the basis of their capacity, electric-to-electric cycle (charging-and-discharging) efficiency, reaction time to changing demands, and charging time. The International Energy Association (IEA) estimated that the global energy storage capacity needs to increase from the 2017 level of 176.5 GW to 266 GW in 2030 in order to keep global warming below 2°C.

Keywords: Sustainability, climate change, energy efficiency, renewable energy, energy storage

ISP-03. Exergy-Based Slow-City/Agriculture Mechanization With Circular Hydrogen And Renewable Energy Systems

Birol Kılkış

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This paper presents a novel concept about an integrated, nearly-zero carbon agricultural and horticultural and animal farm complex, attached to a slow city. A Rational Exergy Management Model-based design concept has been developed to maximize land use effectiveness and minimize carbon dioxide emissions responsibility. The system involves a circular hydrogen approach and comprises the following primary features. 1- Deep wells, 2-Above-the-ground photo-voltaic-thermal solar collectors, 3-Artifical water basin/pool, 4-Water electrolysis system, 5- Hydrogen production and storage facility, 6- Closed water circuit between the pool and fuel cells that generate power and then return water, 7- Hydrogen cogeneration system, 8-Heat pumps and absorption cooling systems, 8-Thermal storage system, 8-Partial coverage of the lake surface with solar photo-voltaic-thermal panels with careful balance between marine life, surface evaporation, and power and heat generation, 9-Wind Turbines, 10-Geothermal energy system, 11-District Energy System, 12-Fishery, Agriculture and animal farm, 13-Light industry, 14- Advanced greenhouse system, 15-Irrigation system, 16-Hydrogen mobility and agricultural mechanization with electric and hydrogen fuel, 17-Food drying and cold warehouse complexes, 18-Dwellings and city infrastructure, 19-Biogas system, 20-Irrigation system, 21-Educational and agricultural research laboratories, 22-Milk industry. Sample calculations show that the net result will be nearly zero carbon complex with 100% renewables, such that nearly-avoidable carbon dioxide emissions responsibility is less than separate photo-voltaic and wind turbine systems by as much as seven times. A novel greenhouse concept and wind turbine- integrated solar photo-voltaic-thermal panel system are also introduced. The paper gives detailed information about this design and proves that a circular hydrogen economy is possible and economical.

Keywords: Circular hydrogen, agriculture, horticulture, renewable energy, slow-city and farm, rational exergy management model

ISP-04. Robotics and Perception in Agriculture, Challenges to a Fully Automated Process

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Agricultural processes are currently attracting the attention of the Industry 4.0 revolution. From a process historically left behind in technologization, agriculture is experiencing strong investment from private and government, aimed at improving efficiency not only in what concerns to resource management, but also in the compensation of the lack of human labor force. The later is a problem faced in most developed countries, but also in third world countries: new generations are not taking the field work left by former generations, since cities or other industrial sectors offer more attractive jobs and salaries. This situation presents is challenging, considering the world ever increasing population. To fully understand the problem, this presentation is aimed at showing the different issues yet to be faced to have a fully automated agricultural process, with special focus on fruit orchards. The presentation covers the most recent developments in agricultural machinery for orchard management, including pruning, harvesting, herbicide handling, among others, aided by the perception techniques which are benefited from machine learning tools, commonly devoted to phenotyping and characterization. The presentation is supported by several case studies covering international agricultural practices. We will be analyzing the automation level of existing farming technologies, with special emphasis on the most important crops worldwide, unveiling the current needs to reach a fully automated process.

Keywords: Agricultural robotics; autonomous robots; robot manipulation; human robot interaction

ISP-05. Smart Agriculture and its Connection to the Digital Twin's Ideas

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This presentation is focused on describing modern methods in agriculture, “Smart Agriculture” utilized in a new era of the fourth industrial revolution known as Agriculture 4.0. At the beginning of the presentation the introduction in to Industry 4.0 and Agriculture 4.0 are deeply discussed. The concept of digital models in relation to the fourth industrial revolution on the example of the oilseed will be presented. In the next section 3D models, image analysis, virtual models and their application in industrial design are listed and verified by experimental studies and visualizations. At the end of this study, the research’s conception, practical application, and cooperation with students are also presented. This study suggests that the utilization of modern methods may be considered an important tool to assess the level of Agriculture 4.0 and can provide valuable information for the design and optimization of agricultural processing technologies.

Keywords: Smart agriculture, Industry 4.0, Agricultural processing technologies

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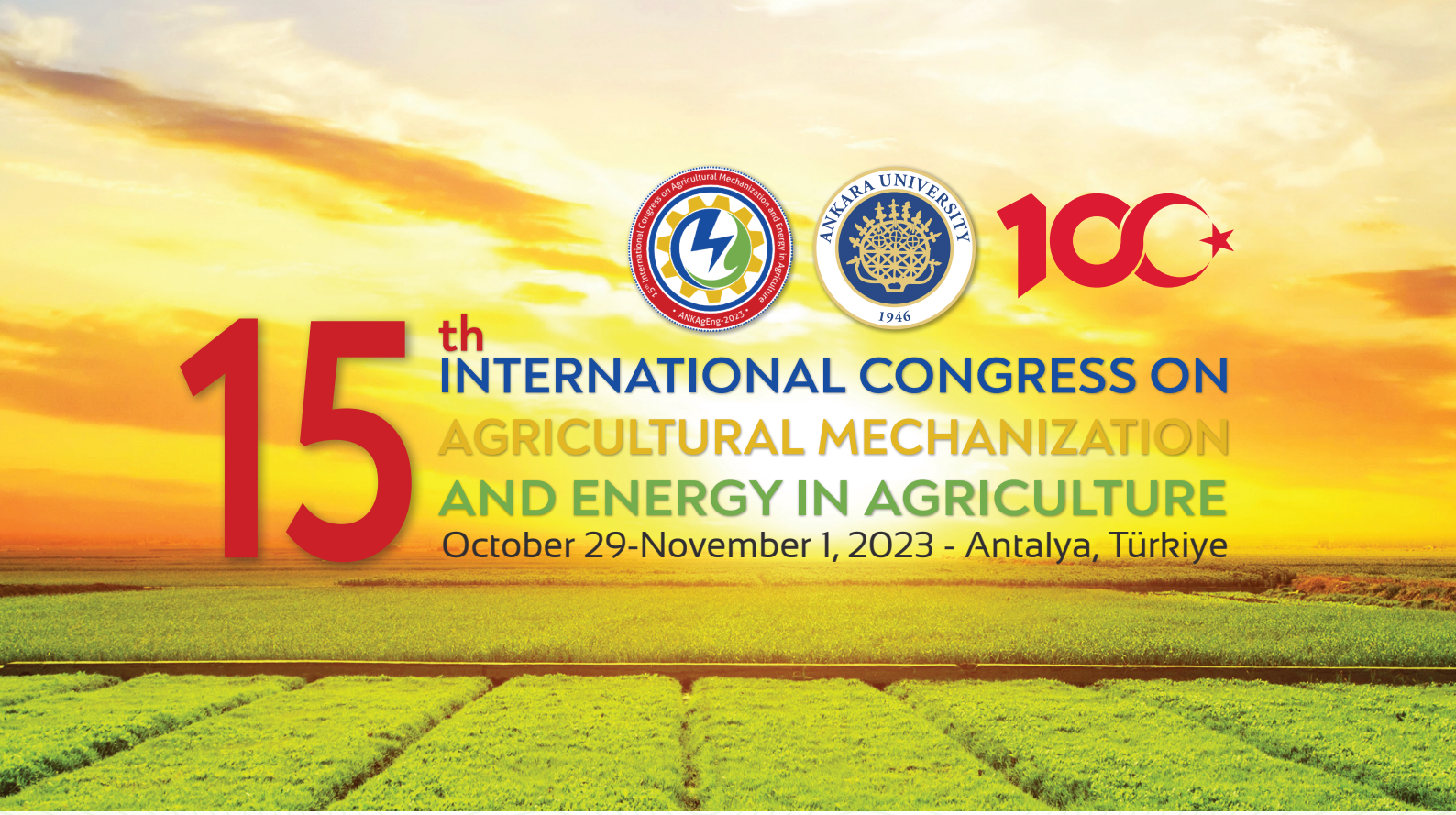

15th INTERNATIONAL CONGRESS ON AGRICULTURAL MECHANIZATION AND ENERGY IN AGRICULTURE

October 29-November 1, 2023 - Antalya, Türkiye

Online Keynote Presentations

OKP-01. Robotics for Crop-load Management in Tree Fruit Crops

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AI and Robotics have been and will continue to play a key role in reducing farming inputs such as labor, water and fertilizer and increasing productivity. Modular sensing, automation, and robotics technologies developed in recent years (including mobile device-based Applications), decreasing cost and increasing capabilities of sensing, control and automation technologies such as UAVs, robust AI tools such as deep learning, and increasing emphasis by governments around the world in advancing AI-empower smart and automated technologies have created a conducive environment to develop and adopt smart, robotic farming systems for the benefit of agricultural industries around the world with a wide range of farming scale and environment. In this presentation, the author will discuss the potential of AI-driven robotic field operations, focusing on crop-load management in tree fruit crops such as apples and cherries. The recent studies at the Washington State University Center for Precision and Automated Agricultural Systems (WSU CPAAS) focused on developing robotic solutions for various crop-load management operations including pruning, flower thinning, pollination, and green fruit thinning. By integrating deep learning-based machine vision systems with robotic platforms, these studies achieved precise object detection and localization, and robotic manipulation thus showing the potential for automating these labor-intensive crop-load management operations. The author will present various robotic prototypes and discuss their performances in the orchard environment. Furthermore, the author will introduce the concept of multi-purpose robotics for thinning, pruning, and pollination incorporating vision systems, manipulators, and motion planning algorithms that would be the same or similar for all operations, while seamlessly switching end-effectors for specific operations. Last but not least, the author will discuss the commercialization efforts through partnerships with startup and technology companies. It is expected that these innovations, when commercially adopted, will reduce labor use, and enhance crop yield and quality, thus increasing the economic and social sustainability of tree fruit industries.

Keywords: AI, Robotic, automation, precision farming

OKP-02. Precision Agricultural Technology Transition in Fruit/Berry Crops Production Management

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Convectional as well as modern orchards need the technological interventions to manage them effectively and economically amidst increasingly dynamic seasonal weather changes and from invasive insects/pests. Besides biotic/abiotic stress and localized crop load management challenges, technology savvy consumers demand of high-quality chemical residue free produce has added extra scrutiny on the way specialty tree fruit and berry crops are produced for the fresh market. Coincidentally, technological landscape is also changing rapidly, allowing development of intervening solutions to address some of the above issues. This talk will thus provide overview of pertinent technological solutions being developed and commercialized for managing today's orchard systems. Synopsis includes discussion on modern orchard systems, advances in ground and aerial remote sensing technologies for monitoring crop physiology, and key biotic/abiotic stressors in the orchard environment as well as the direct translation of such data for precision actuation of the crop protection machines/tools. Discussed will be the landscape of ground (movable and fixed) and aerial crop protection technologies being researched for efficient chemical applications in modern orchard systems.

Keywords: Production management, automation, precision farming

OKP-03. A Greenhouse Plants' Heating System Based on Low Temperature Long Wave Radiation Emission

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The present paper regards an invention for a radiant heating system comprising low temperature radiant heating assemblies suitable to maintain the greenhouse plants (and not the greenhouse air) at a desired optimum temperature. Heat is provided to a screen and subsequently the screen provides the necessary heat to the plants by long wave radiation. The temperature of the heated screen is kept a few degrees Celsius higher than the temperature required by the plants. Calculations and preliminary experimental trials have shown that temperatures of the heated screen such as slightly above the optimum plant temperature up to about 10°C above the required plant temperature, are adequate to maintain the plants at the required temperature at very low air temperatures outside the greenhouse, while achieving high energy saving relative to conventional greenhouse air heating systems.

Keywords*:* Low temperature radiant heating system, Greenhouse plants

OKP-04. Development of Thermoset Epoxy Resin Film from Soybean Oil

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The scientific community has recently focused on developing high-value-added epoxidized soybean oil and green bio-based epoxy resins using sustainable resources because of their cost-effectiveness and eco-friendliness. A part of this work includes the replacement of conventional petroleum-based resins with their green counterparts, that is, bio-based epoxy resins. The aim of this research is to develop low-cost, value-added, and bio-based epoxy resins from conventional soybean oils and commercialize the technology to be scaled up for epoxy resin production for chemical industries. Epoxidized soybean oil (ESO) was developed through the synthesis of conventional soybean oil by applying deep eutectic solvent catalysts, such as choline chloride–oxalic acid (DES-02) and choline chloride–butyric acid (DES-06) followed by three steps of washing neutralization processes. The impact of the catalysts on the epoxidation process was verified using titration methods in combination with infrared and nuclear magnetic resonance spectroscopies. The results showed an optimal carbon–carbon double bond conversion with a high selectivity of 90% when soybean oil was epoxidized with bifunctional DES-02 catalysts. The conventional epoxidized soybean oil synthesis without deep eutectic catalysts yielded relatively low carbon–carbon double bond conversions with 30% selectivity. Various novel bio-based epoxy resins with equal amounts of ESO and acrylic acid as monomers were developed, followed by injection molding. Bio-based epoxidized soybean resin films were characterized by dynamic mechanical and thermomechanical analyses. The results showed that resin films catalyzed by DES-02 and DES-06 improved the storage modulus (ca. 2000 MPa) and loss modulus (ca. 390 MPa).

Keywords: Soybean oil; Epoxidation; Catalyst; Epoxy resin; Bio-based film; polymer

Patent pending. International Publication Number WO 2023/094843 A1, International Publication Date 01 June 2023. Title, A GREENHOUSE PLANTS' HEATING SYSTEM. Inventor PAPADAKIS Georgios.

OKP-05. Flying Lora-Drone Gateway for IoT Monitoring in Oil Plam Plantation

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Low-Power Wide Area Network (LPWAN) technologies like LoRa have become prominent for IoT deployments in large agricultural areas due to their low-power and long-range transmission. However, data transmission in large farms with diverse landscapes suffers from obstructions or occlusions, and wired gateways are still difficult to cover agricultural areas without proper network or power infrastructures. This study integrates LoRa gateways with a flying drone to enhance the connectivity to sensor nodes deployed in an oil palm plantation research plot. The LoRa gateway was mounted on a multi-rotor agricultural drone. The comparison of data transmission employing the flying gateway and fixed gateway on multiple nodes across the plantation was examined and presented.

Improvement with respect to the fixed gateway is notable where the communication recovery was obtained, by using the flying LoRaWAN gateway which was able to move closer to end-devices where data were lost in the previous case. In fact, data were successfully transmitted from all nodes at a maximum data payload of 50dB, with a minimum transmit power of 6dB to the flying LoRaWAN gateway. The result shows the performance benefit of the flying gateway in terms of power consumption reduction at the end-devices which is crucial for smart agriculture applications. This work is important for enabling IoT monitoring in huge agriculture areas, which often lack network coverage and are difficult to access due to canopy occlusion and diverse terrain landscapes.

Keywords: Low-Power Wide Area Network, IoT monitoring, Oil palm

OKP-06. Robotic Operations of Kiwifruit Production in Orchard

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China is the largest country producing kiwifruits worldwide. Bud thinning, flower pollination, and fruit harvesting of kiwifruits in this area mainly depends on manual picking, which is labor-intensive. Therefore, introducing mechanical or robotic operations is highly desired. Kiwifruits are commercially grown on sturdy support structures such as T-bars and pergolas. This presentation will introduce our creative researches and special thoughts to solve problems in bud robotic thinning, flower robotic pollination, and fruit robotic picking of kiwifruit.

Keywords: Robot, kiwi, smart farming

OKP-07. Detecting the Basal Stem Rot (BSR) disease using vegetation index, thermal imaging, and machine learning

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Production of oil palms was severely impacted by the Basal Stem Rot (BSR) disease caused by *ganoderma boninense*. The conventional approach to identifying BSR in oil palm involves manual scouting for sample collections and assessing the physical traits of the trees which is tedious and time-consuming. Hence, the aim of this study is to develop an appropriate model utilizing vegetation index and thermal images obtained from UAVs along with machine learning techniques for detecting BSR disease. The oil palm tree at 10 years old has been categorized into four health classes i.e., healthy (T0), early infected (T1), moderately infected (T2) and severely infected (T3). Based on the result, the Normalized Difference Red Edge Vegetation Index (NDRE) and Green Chlorophyll Index (GCI) indices demonstrated significant differences between healthy and unhealthy classes. Therefore, a combination of NDRE, GCI and thermal reflectance was created as the input variable to develop 23 machine learning models in MATLAB software with different types of kernels. The result indicated that the Coarse Tree model obtained the highest value of micro-F1 score with 92.04 % and 90.89 %, during training and testing, respectively.

Keywords: basal stem rot; multispectral; thermal reflectance; vegetation index; machine learning

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OKP-08. Exploring the Impact of Dust on Photovoltaic Performance: An Overview of Historical Trends, Current Findings, and Future Prospects

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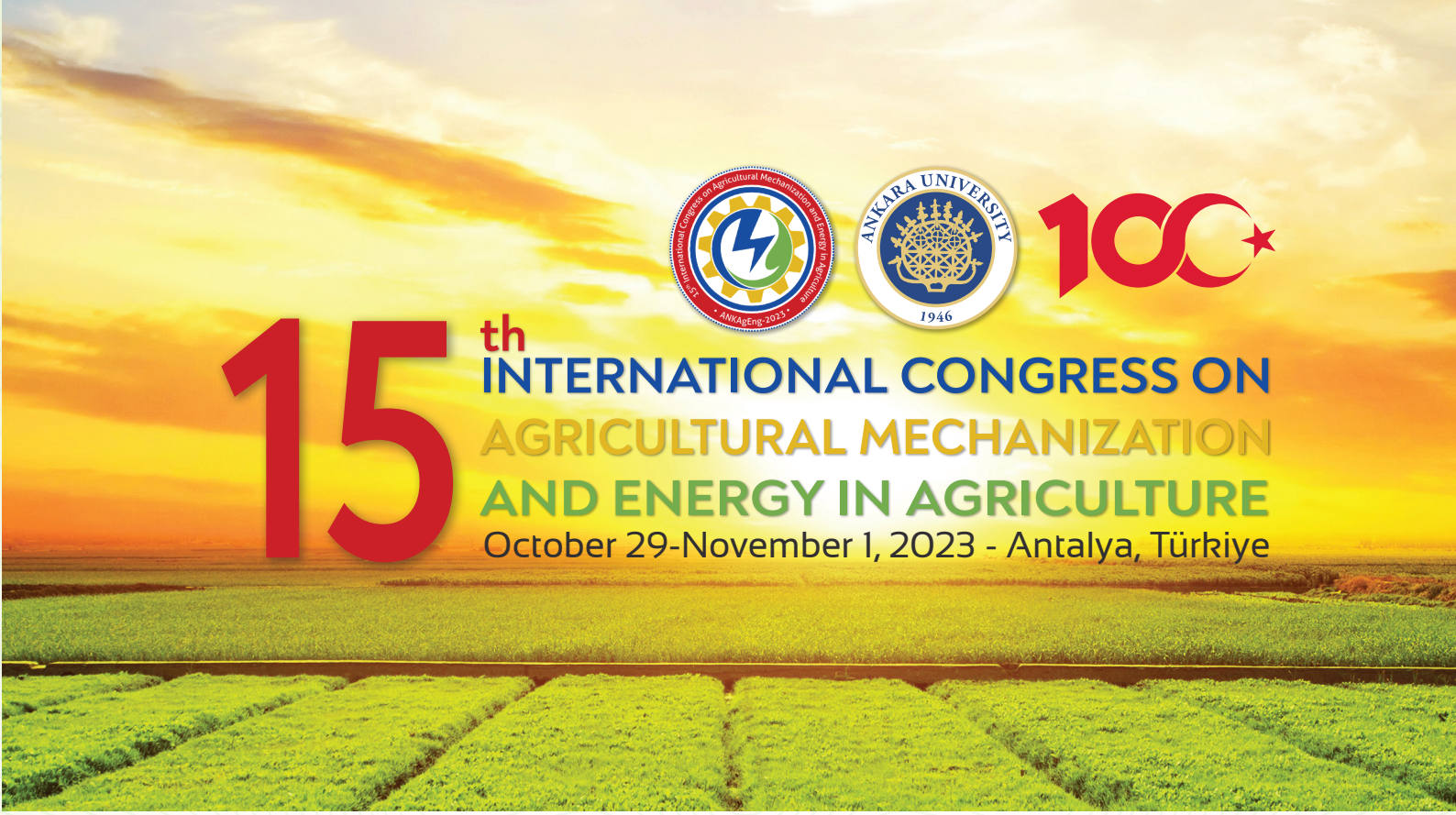
The presence of dust accumulation on the surface of photovoltaic (PV) modules poses significant challenges to their performance. It obstructs the penetration of light into the cells, resulting in decreased power output and system instability. Dust particles not only hinder light transmission, reducing photon absorption and conversion efficiency, but they can also chemically interact with module surfaces, potentially causing etching, scratching, and discoloration, which further compromise module functionality. A comprehensive examination of the physics and chemistry behind dust particles concerning PV modules is essential for a deeper understanding of their behavior and detrimental effects. To combat the adverse impacts of dust, various cleaning and mitigation strategies have been developed. Traditional manual cleaning, while widely practiced in the past, proves labor-intensive and often impractical for large-scale installations. Consequently, automated cleaning systems have emerged as efficient solutions. These systems utilize mechanisms such as brushes, wipers, or high-pressure water jets to remove dust, ensuring optimal module performance. Establishing standardized protocols for assessing dust impact is crucial. These protocols should consider variables like sampling time, cleaning frequency, dust homogeneity, and measurement periods to ensure accurate evaluation and comparison of cleaning strategies. Modeling plays a pivotal role in comprehending the intricate interaction between dust and PV modules. Dust models must incorporate factors like particle size, shape, distribution uniformity, and environmental parameters such as temperature, humidity, and wind speed. A comprehensive dust model encompassing these parameters can aid in predicting and mitigating dust's impact on PV system performance. Integrating such models into PV system design software would enable precise performance assessments, facilitating optimal system sizing and planning. Exploring new prospects in the field of dust impact on PV modules presents exciting opportunities for advancements. Research gaps exist in areas such as developing a comprehensive dust model that considers particle properties, studying the effects of dust on emerging PV technologies, and understanding the long-term performance and durability of modules in dusty environments. Addressing these gaps will enhance our understanding of the challenges associated with dust accumulation and pave the way for improved PV system design, maintenance, and performance in diverse environmental conditions.

Keywords: Photovoltaic module, maintenance, dust particles



15th INTERNATIONAL CONGRESS ON AGRICULTURAL MECHANIZATION AND ENERGY IN AGRICULTURE

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Oral Presentations

OP-01. Autonomous Ground Vehicle for Weeding Activities: Preliminary Sustainability Assessments

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In the last decades, multilateral environmental agreements supported the shift to sustainable patterns of consumption and production. However, the growth of the world population in the near future will boost the requirements of agricultural commodities which must be produced with less resources and emissions. In this context, the use of agricultural machinery for on-field operations appears to be one of the most impactful activities in the food production cycle. The environmental emissions of agricultural machinery have been reduced in recent years, however these efforts are not sufficient to support an ecological shift of agricultural mechanization. Hence, it is mandatory to increase the sustainability of on-field activities. In recent years, several scientific studies have been focusing on the optimization of agricultural inputs, where indirect energy requirements for the production of tractors and self-propelled agricultural machinery represent a non-negligible portion of total impacts. The implementation by farmers of innovative solutions for improving farm efficiency and sustainability has been addressed in many ways. One of these solutions deals whit the implementation of autonomous ground vehicles (AGVs) to carry out agricultural tasks. In the last few years, the number of agricultural AGVs available in the market is increasingly growing, most of them are powered by electric motors and are equipped with different types of implements. Even though the environmental burdens of agricultural machinery have been deeply investigated by several studies, at present the impacts associated whit agricultural AGVs are still limited. Thus, this study aims to analyze the energy and environmental burdens of using an AGV coupled with a mower to accomplish on-field weeding activities. The life cycle assessment (LCA) methodology was adopted to analyze direct and indirect energy requirements and the associated environmental emissions. The cumulative energy demand (CED) and climate change (CC) impact categories were selected. The fully electric AGV is equipped with two rubber tracks powered by 2000 W motors, while the autonomy is ensured by two 220 Ah lead-acid batteries. The self-propelled rotary flail mower is powered by a 9 kW engine, weighs 230 kg and has a working width of 120 cm. The implement was coupled to the AGV through a standard tow hitch. The results of the analysis showed that the embodied primary energy of both AGV plus Implement (AGV+I) accounted for 145 MJ kg^{-1}, while related emissions were found to be 13.27 kg CO_2e kg^{-1}. The mower accounts for the largest impact shares, having about 52% of the embodied primary energy when referred to the implement's mass. Moreover, analyzing the inputs of the AGV+I system, the battery pack and the iron materials accounted for the main portion of the total impacts, respectively for 34% and 24%. In conclusion, the outcomes of this study will strongly help to pursue the objectives and targets foreseen by the main strategic plans related to the reduction of environmental impacts, improvement of agricultural production efficiency, and increasing the digitization and innovation of the agricultural sector. Moreover, the growing interest in the no-tillage technique might boost the diffusion of these technologies in the agricultural sector, increasing the sustainability of the food production process.

Keywords: life cycle assessment; agricultural automation; on-field mechanization; terrestrial drone; carbon footprint.

OP-02. Evaluation of Hydration State Around Glycerol as a Humectant Using Microwave Dielectric Spectroscopy

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Water in agricultural products can be broadly divided into bound water, which is strongly bound to components such as proteins and starch, and free water, which can easily move or evaporate due to changes in the surrounding environmental conditions. Free water is essential for the growth of micro-organisms that can cause spoilage of agricultural products. Drying is therefore a processing method that reduces the free water in agricultural products and improves their storability. Salting and candling are also treatments that inhibit the growth of micro-organisms by binding the free water in the food with salt or sugar. In food engineering, water activity is an important indicator for the growth of micro-organisms by evaluating the proportion of free water in food. It is an empirical value defined approximately 70 years ago by the vapour pressure in the food. Generally, the higher the water activity, the more microbial growth occurs, and it is widely used in the food industry and food science. Glycerol, a highly hygroscopic moisturiser, is used as an additive to suppress water activity by reducing the free water content in processed foods. Traditionally, hydration has been considered to be related to the hygroscopicity of hygroscopic moisturisers. Based on this, it is expected that the more hygroscopic the hygroscopic moisturiser, the stronger the hydration effect. Therefore, it has been considered that highly hygroscopic substances are more likely to hydrate to form stable hydrogen bonds with water, thereby reducing the proportion of free water in foodstuffs. Indeed, there have been many studies that have modelled and explained these phenomena on the basis of these phenomena. In recent years, several technologies have emerged to assess detailed water dynamics. Our research group used these techniques to evaluate the hydration state around glycerol, which is known as a highly hygroscopic moisturiser, and suggested that hygroscopic moisturisers may not show strong hydration. This result challenges the conventional interpretation that hydration plays an important role in the hygroscopicity of moisturisers. We have investigated the observation of the hydration state of water molecules surrounding glycerol. Microwave-band dielectric spectroscopy, which has not previously been used to study hydration water in moisturisers, was performed. Microwave dielectric spectroscopy allows us to observe the oriented polarisation of water under an alternating electric field. With this technique, water with a delayed orientation of water molecules compared to pure water due to hydrogen bonding with solutes can be distinguished from normal water (bulk water) as hydration water. On the basis of this knowledge, we are now developing a fundamental understanding of the mechanism of this phenomenon on the basis of more detailed chemical structures and characteristics. If the differences in hydration activity can be newly defined as water activity at the molecular level, it may be possible to more precisely determine the growth environment of micro-organisms in processed foods. It is expected to become a new indicator for food safety and security. In this presentation, the results of an investigation into the evaluation of the state of water around moisturisers from two aspects will be presented. First, we focused on the dielectric relaxation spectra of moisturisers in the microwave band. In order to understand the characteristics of hygroscopic moisturisers, diols were used as samples in addition to diglycerin and glycerin, which are considered to be particularly hygroscopic, and diols, which are moisturisers but have poor hygroscopic properties. Hydration water and bulk water were separated by dielectric spectroscopy. Based on this, a quantitative evaluation of the amount of hydration water around the humectants was carried out. Differential scanning calorimetry was used as a thermodynamic approach to evaluate the temperature dependence of the molecular dynamics.

Keywords: Water activity, Humectants, Glycerol, Polyol, Hydration water

OP-03. Discharge Coefficients for Adjustable Slot Inlets Used to Ventilate Animal Production Buildings

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A well-designed ventilation system for an animal production production building requires energy efficient fans to provide the required ventilation rates and and properly sized inlets to provide the desired velocity for each stage of ventilation. Field experience has shown that the fluid mechanics of ventilation inlets is often the least understood part of the system resulting in compromised environments for animals and excess energy use by fans. The objective of this study was to empirically determine discharge coefficients (C_d) for inlets with an adjustable baffle. Two types of baffled inlet were included in the study. One was built so as to direct the air jet across the ceiling, and the other was oriented to direct the air jet down the wall. The experiments were conducted in a test apparatus that contained the two inlets and several fans to vary the airflow rate. The inlet velocity was measured with a hot wire anemometer and the pressure drop across the inlet was measured using a manometer. Discharge coefficients were calculated from the data for a range of slot depths (d) and widths (W). It was found that the discharge coefficients for the baffled inlets were not a function of jet orientation as has been accepted for many years. However, the value of the discharge coefficient of the baffled inlets varied with the aspect ratio (d/W). The average discharge coefficient for the baffled inlets was 0.50 for aspect ratios of 0.018 or less and was in excellent agreement with the literature. For aspect ratios between 0.018 to 0.030 the value of C_d increased linearly from 0.50 to 0.63.

In most applications, the aspect ratio for long adjustable baffled inlets (W = 5 m or more) will be less than 0.018 and a C_d of 0.50 will be sufficent for inlet opening sizing for all stages of ventilation. However, many modern ventilation systems use manufactured adjustable baffle inlets that are installed as box inlets in an insulated ceiling or along sidewalls. The slot widths (W) on maufactured inlets can range from 0.3 to 1.0 m and the inlet will open to a value of d that can cause the aspect ratio to exceed 0.018. A common method of controlling ventilation inlets is to adjust the inlet opening area (dxW) until the static pressure drop across the building envelop is at specified value of 30 Pa which corresponds to an inlet velocity of 3.5 m/s if the discharge coefficient is 0.50. However, if the aspect ratio is greater than 0.018, the actual C_d will be greater than 0.50, and the inlet velocity will be larger than desired resulting in over ventilation of the building which can result in an increase in the energy required for ventilation. The heating costs will also be increased if supplemental heating is required to maintain optimal air temperature for the animals during winter. The results of this study indicated that precise design and control of ventilation inlets, along with selection of energy efficient fans, is needed to provide energy efficient ventilation for agricultural buildings.

Keywords: mechanical ventilation, inlets, air velocity, animal environment, energy

OP-04. Combining Digital Image Processing and Machine Learning is Useful for the Early Detection of Salinity and Drought Stresses in Cucumber

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Timely detection of plant abiotic stresses and their type and severity can be beneficial in order to prevent the loss of yield in crop production systems. This study introduces a new method to detect the type and severity of salinity and drought stress, as crucial abiotic stresses, in cucumber plants. Plants were cultivated in a greenhouse environment. Tap water was supplied daily for irrigation to maintain soil water potential close to the field capacity. However, drought-treated plants were stressed by withholding water, at three levels: 80, 60, and 40% of field capacity. Further, salinity-treated plants were irrigated with water containing three levels of salt concentration: 20, 40, and 60 mM.

Plant morphological features were measured five times at three-day intervals beginning with applying the abiotic stresses by transferring three leave randomly selected from each pot to a chamber with artificial lighting equipped with a camera for image acquisition. Images captured from plant leaves at different growth periods after the application of stresses were gathered to create a database. Digital image processing was used to extract the gray-level cooccurrence matrix of the images followed by the calculation of various image textural features including entropy, energy, and local homogeneity. These features were considered plant morphological features which are extracted from leaves during the experiment.

A program developed in the MATLAB programming environment was used for machine learning based on the image textural features of the leaves as inputs and stress type and severity as output. The program included the artificial neural network (ANN) regression model for the prediction of model output having the three input features. The number of hidden (learner) layers (between 1 and 3) and the number of neurons in each layer (between 5 and 20), and their weight and bias parameters were optimized using sophisticated optimization algorithms to achieve the most efficient machine. As a robust evolutionary method, the genetic algorithm (GA) was used to optimize the architecture of the ANNs. GA works by creating an initial set of random populations as possible solutions. Each individual is a chromosome, describing a solution for the problem. GA selects individuals with higher eligibility, being more likely to survive and crossover. After an iterative procedure called generations, the parent chromosomes produce better offspring by removing weak solutions based on the objective function.

The results revealed that the image textural features could predict the type and severity of the plant abiotic stresses with MSE values of 1.47 (at severe stress conditions) and 0.85 (at mild stress conditions). This shows that the machine was capable of detecting the stress at severe salinity and drought conditions, which is helpful for farmers since the highest loss in agricultural production occurs when severe abiotic stresses are applied to the plants during cultivation. The highest prediction performance of the ANN machine when both stresses were applied to the plants was 0.79 which was achieved for a network with three hidden layers. Moreover, GA, as a metaheuristic optimization method, could improve the performance of the machine in predicting the plant stresses since the MSE values of prediction were more than 2.00 when not using GA to optimize the network architecture. So, the optimized machine learning method developed in this study was efficient to consider variables extracted from image processing useful for the prediction of severe plant abiotic stresses in cucumber plants.

Keywords: Artificial neural networks, severe stress conditions, image textural features

OP-05. Enabling Insecticide Spot Application on Boom Sprayer by Developing Machine Vision and Communcation Components

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Despite its effectiveness in improving yield, uniform spraying has negative impacts on the environment and the use of resources. In this research project, we plan to contribute to the adaption of spot spraying by developing electronic and mechanical components that allow boom sprayers of different size scales to adopt this technology. In this paper, we demonstrate the development of machine vision system that uses artificial intelligence to detect Colorado potato beetles based on YOLO v5 models, and the development of a communication to scheme to integrate the machine vision system with an open-source spraying mechanism via Controller Area Network. Using field images taken on-the-go from a camera mounted on a sprayer, the accuracy of detecting beetles reached 64%, which reveals a promising result given the possibility of enhancing image quality and the computation techniques moving forward. Also, the machine vision node, developed to integrate a machine vision system that consist of two neighbouring cameras, was able to flawlessly translate the detection results to a spraying system mounted on boom sprayer to control 6 nozzles individually. These results allow for scaling up the detection and spraying mechanisms to cover full booms which can reach to widths of 36 m. Beside building on the current developments on the detection and communication components, our next steps will include allowing for real-time spraying by introducing modifications on the pumping and nozzle components.

Keywords: Machine vision, ISOBUS, Nozzle control, Real-time spraying, Pest control

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OP-06. Optical Techniques for Automated Evaluation of Seed Damage

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Cereal grains and oilseeds, fundamental components of global diets, face significant vulnerability to mechanical damage during various stages, including harvesting, transportation, and storage. Beyond immediate physical degradation, the repercussions of such damage extend to seed viability and consequent economic implications. Traditional assessment techniques, predominantly reliant on external visual inspections, face challenges of subjectivity and inefficiency, restricting evaluations to superficial seed alterations. To circumvent these shortcomings, this study presents a fusion of optical techniques, namely two-dimensional (2D) X-ray imaging and hyperspectral imaging (HSI) – all underpinned by machine learning and deep learning frameworks – targeting an automated, holistic assessment of flaxseed damages. Leveraging an expansive dataset of 3,600 flaxseed samples spanning varied moisture contents and impact energies, the findings underscore the amplified susceptibility of seeds to damage under heightened impact stress at minimal moisture levels. Remarkably, through the integrated approach, the study achieved classification accuracies surpassing 87% for all techniques. While X-ray imaging presented throughput limitations, Vis-NIR HSI can be considered an effective alternative. In summation, the study accentuates the profound potential harboured by optical techniques in seed damage assessments, advocating their capacity to replace conventional methods. By seamlessly integrating advanced imaging with computational intelligence, the study not only streamlines damage detection but also amplifies the possibility of curbing damage, promising heightened yields and minimized economic setbacks. Future endeavors should channel this foundational research towards broader crop varieties to ensure universal applicability and validation.

Keywords: Optical techniques, flaxseeds, X-ray imaging, mechanical damage.

OP-07. Estimation of Vitamin A Concentration in Cattle Blood Based on Fluorescence With/Without Blood Cell Separation by Plasma Filter

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Japan has an endemic breed of meat cattle called the Japanese Black Cattle. In terms of fat content in loins meat, the Japanese Black Cattle has a higher value of 39.6% compared to 3.6% for the Angus breed. Meat with high Beef Marbling Standard (BMS) is produced by lowering blood Vitamin A (VA) levels during the middle part of the fattening period. VA control is based on farmers' experience and intuition, and therefore cases of VA deficiency have been reported. The parts of the meat altered by VA deficiency are discarded as inedible parts, leading to economic losses. Excessive VA control is also a problem from an animal welfare viewpoint, because it causes pain and discomfort even while the animal is alive.

Despite the existence of these problems, daily testing is not performed because the HPLC method is the main method for measuring blood VA levels, which is expensive and time-consuming. In this study, a simple technique for measuring the amount of VA in blood is proposed, which is based on the fluorescence properties of retinol, the main component of VA in blood. The excitation-emission matrix (EEM) of whole blood, plasma and plasma absorbed by a glass filter using a blood cell separation filter were measured.

A total of 160 blood samples were obtained from Tajima Cattle fattened at Hyogo Prefectural Tajima Agricultural High School. EEM of glass filters was measured by a spectrophotometer (FP-8300, Japan Spectroscopy) using the front face method. And EEM of whole blood and plasma were also measured by the same spectrometer with a single drop of 7 μL of each sample dropped into a single drop measuring unit (SAF-851, Japan Spectroscopy). HPLC measurements of retinol concentrations were conducted by an outsource laboratory. Usually, blood retinol binds to a protein and forms a complex with excitation and fluorescence peaks at 330 nm and around 470 nm. Therefore, we measured the excitation and fluorescence at 300-400 nm and 320-550 nm, respectively. The PLS analysis was performed with 10-fold cross-validation, using the fluorescence intensities as explanatory variables and the measured values of retinol by HPLC as objective variables.

From EEM of all samples, The excitation peak 300 nm and the fluorescence peak between 320 and 400 nm are thought as amino acid peaks. And retinol fluorescence peaks were clearly visible in plasma, but no clear fluorescence peaks could be seen in whole blood and plasma-absorbed glass filters. In whole blood, this may be due to absorption and scattering of light by the presence of blood cells. Whereas in the plasma-absorbed glass filter, its white scattering is a factor. PLS regression analysis was performed using the excitation range of 300-400 nm and the fluorescence range of 400-550 nm to avoid the influence of the amino acid fluorescence peak and three latent variables were used. As a result of the PLS regression analysis with each sample, R2Pred, RMSEP, and RPD are as follows. Whole blood results were 0.91, 9.12, and 3.36, plasma results were 0.95, 7.11, 4.45 and plasma with glass filter results were 0.92, 9.29. 3.44. All RPD value shows these measurement methods have the possibility to estimate retinol levels in blood with considerable accuracy in practical use.

The results suggest that in the future development of techniques for measuring blood VA levels, a variety of test methods may be selected depending on the required measurement accuracy and the complexity of the pre-treatment.

Keywords: Japanese Black Cattle, Retinol, Fluorescence

OP-08. A Network Compaction Strategy to Reduce the Cost of Detection Networks Deployed in Edge-AI Devices: A Case Study for Grading Canola

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The increased computational complexity or 'cost' of modern detection networks can hinder their full potential to be used towards achieving Agriculture 5.0. Unlike areas like autonomous driving where the advancement in hardware supports the rapid development of detection networks, the agri-food industry still relies on using CPU-based or low-power GPU-based hardware as a platform for these faster and more accurate computer vision models. To achieve true democratization of these vision algorithms that will one day manifest the dream of a truly autonomous farm and food processing facility, these models need to be made leaner and lighter while retaining the improvements in inference speed and accuracy. One key area where this technique is used in the domain is quality control and grading of produce. Canada exports the highest amount of canola in the world, but the lack of automation in its grading process makes the whole task laborious, time-consuming, and prone to sampling errors. The aim of this study was therefore to use canola grading as a case study to develop a lightweight yet capable model for detecting damages to canola kernels that can be readily deployed in embedded devices. The one-stage detector, YOLOv7 was chosen to be the baseline model, which was trained to identify the defects. The foundational convolutional layers present in it were systematically replaced with ghost convolutional layers as a strategy to compress the model. This approach reduced the floating-point operations per second (FLOPS) and model size as several filters were discarded to generate the same amount of feature maps as in the case of standard convolutional layers using a cheap linear operation. Based on a comparative experiment involving eight options for replacement, the option involving the substitution of all the ELAN modules and the SPPCSPC module present in the baseline model were carried out with ghost layers. Compared to the original model, the newer condensed model was 37.64% smaller in size, the cost reduced from 105.1 GFLOPs to 75.8 GFLOPs, and the mAP@0.5 increased by 1.63%. The inference speed was also within the constraints of 24 FPS required for running in real-time. These results indicated that this network compaction strategy can make state-of-the-art object detection models compatible with edge AI devices without affecting their performance.

Keywords: Canola; Object Detection; Network Compaction; Computer Vision; Grading

OP-09. Exploring Transfer Learning for Enhanced Seed Classification: Pre-trained Xception Model

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Seed classification plays a crucial role in various agricultural and industrial applications, such as crop breeding, seed quality assessment, and plant disease identification. This study presents a novel deep-learning model for seed classification. In this study, a dataset of 31 seeds containing 7000 RGB images was created with the goal of developing an accurate and efficient deep learning-based model capable of classifying seeds with high precision. In this study, a deep learning model based on YOLOv5 called TL-YOLO is proposed. The YOLOv5 is modified by removing the classification layer and replaced with five different layers to enhance the accuracy of the proposed model. In this study, we have also incorporated transfer learning, which further improves the TL-YOLO's accuracy. The results show that TL-YOLO has achieved 99.97% accuracy. Furthermore, the TL-YOLO has been compared with state-of-art models such as AlexNet, MobileNetv3, VGG19, YOLOv5, and InceptionV3. From the results, it is stated that TL-YOLO has outperformed the state-of-art models in terms of accuracy, precision, and recall. The results underscore the significance of utilizing deep learning techniques for seed classification tasks, offering a valuable tool for researchers, agricultural professionals, and seed industry stakeholders. Overall, this study contributes to the advancement of seed classification techniques by leveraging deep learning models, enabling accurate and efficient seed identification and classification across a wide range of seed types. The findings open new avenues for automated seed analysis and quality assessment, enhancing productivity and sustainability in the agricultural sector.

Keywords: Seed classification, disease identification, deep learning, AlexNet, MobileNetv3, VGG19, YOLOv5

OP-10. Classification of Pistachio Nut Using Convolutional Neural Network

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Pistachio (*Pistacia vera* L.) is an agricultural product native to the Middle East and Central Asia. The world's major pistachio producers, Iran, the USA, Turkey, and Syria, contribute close to 90% of the total production worldwide. In Turkey, there are eight main domestic pistachio varieties such as Uzun, Kırmızı, Halebi, Siirt, Beyazben, Sultani, Değirmi, and Keten Gömleği. Also, there are five foreign varieties named Ohadi, Bilgen, Vahidi, Sefidi, and Mümtaz. Among these domestic and foreign pistachio varieties, the most preferred ones are Kırmızı, Siirt, and Halebi. Each produced kind has its unique market and pricing point for consumers to purchase. For instance, the varieties of Kırmızı and Siirt, due to their dark green color, distinctive flavor, and aroma, Kırmızı is frequently utilized in the confectionery and sweet pastry sectors. In contrast, Siirt is well-liked as a snack due to its high cracking rate and round shape. However, the process used to separate pistachio nuts is still carried out with basic knowledge. Because of this, there is a high potential for mistakes to be made in the classification process because each variety of pistachio nut has a virtually identical form. Innovations are needed to recognize the type of pistachio nuts so that the packaging process for sales can be right on target. By implementing innovative technologies in the pistachio industry, we can maximize yield productivity and ensure the well-being of farmers. For instance, advanced agricultural machinery equipped with artificial intelligence (AI) algorithms can aid in identifying and sorting different pistachio nut varieties based on their size, shape, and color. This automated categorization process saves time and labor and ensures consistent quality control throughout the production chain. This paper aims to classify pistachio variety of Kırmızı, Siirt, and Uzun based on Convolutional Neural Network (CNN) models Inception V3, VGG16, and the proposed CNN model.

Keywords: Artificial Neural Network, Deep Learning, Convolutional Neural Network, Pistachio

OP-11. Deep Learning as a New Technique to Detect Plant Leaf Diseases

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Today with the new growth of the economy, the agriculture sector is transforming and progressing from the traditional to a modern cycle, farms and greenhouses, as crucial support for modern agriculture, are widely used.

Deep Learning (DL) has proven to be very capable in both pattern recognition and Machine Learning (ML). By sequentially focusing attention on pertinent portions of the available data, this form of the network can actively learn to identify patterns (Schmidhuber, 2015). In this study, which we will do in the early diagnosis of plant diseases, a new model is developed using one of the DL algorithms and artificial neural networks. One of the most widely consumed vegetable crops worldwide is tomato. Around 340 billion pounds (170 million tons) of fresh and processed tomatoes were produced globally in 2014, according to data from the Food and Agriculture Organization (FAO) (FAO 2017). The production of industrial tomatoes differs regionally as well; typically, these production activities take place in the Aegean and Marmara areas (Keskin et al., 2005). The Ministry of Agriculture and Rural Affairs (MARA) has certified seeds for 60 industrial tomato varieties and 400 table tomato varieties. Therefore, to reduce tomato diseases a number of modern plans and techniques are required to overcome the excessive use of pesticides. This work is an original study that explores smart applications to identify and classify plant diseases and insects in tomato farms and then send computer-centered data and images to access automated-systemic plant protection methods to avoid potential problems.

Keywords: Greenhouse, Deep learning, plant disease, artificial neural network

OP-12. Definition of Reference Models for Functional Parameters and Price for Mowers and Mowers-Conditioners

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At present, the management of different operations in agricultural production is rapidly evolving as an effect of increasing attention to the issues of sustainable development and intensification. The key components of sustainable agriculture are increased agricultural machinery productivity and efficiency. The old agricultural machinery management procedure must be revised in order to fully utilize and apply engineering advancements. Different factors must be taken into account when defining the farm fleet (tractors and implements), as well as when planning and managing the machinery. Among them, the cost is important, but also their size, weight, working area, required power etc. The totality of this information have an important influence on productivity, on the environment and on the return of the investment. The objective of the current work is to determine the most important factors that affect the costs and effectiveness of mowing implements, such as working width, number of working elements (blades), required power, weight, and price. To identify dependencies and extract reference models, the various parameters are analyzed in a correlation matrix. The study's methodology is based on linear and multiple linear regression analysis performed on approximately 250 mowers, among which both drum and disc apparatus were considered, and 240 mowers-conditioners, for a total amount of roughly 490 machines.

We were able to analyze the key significant parameters, calculate their impact, and develop forecasting models for price, power, mass, and working width thanks to the investigation that has been done. The range of important features as weight and price was very wide: for mowers, weight went from 190 to 1350kg, with an average of 782kg while mowers-conditioners were significantly heavier ranging from 680 to 4020kg, with an average of 1648kg. In addition, the price ranges showed similar differences: mowers costed between 2500 and 39000€ with an average of 12977€ while mowers-conditioners were more expensive costing between 8950 and 90500€ with an average of 27751€.

The significant relevance of the technical parameters and adjustment issues were outlined both for mowers and for mowers-conditioners and the dependencies among factors were highlighted. Relevant correlations were found between price and weight, between weight and working width, required power and working width. As an example, the relation between weight and price of the machine were strongly positive both for mowers (R^2>0.8) and mowers-conditioners (R^2>0.8). Independently from the price factor, also technical features such as required power and working width showed a positive correlation, R^2 was 0.73 for mowers and 0.86 for mowers-conditioners. According to these correlations, models have been proposed, which can be implemented in order to support the decision-making phases of the market stakeholders.

Keywords: Mowers, Mowers-conditioners, Price, Weight, Working-width, Required Power.

OP-13. Impact of Building Geometry, Window Types, and Materials on Daylighting Performance of Livestock Buildings

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The availability and quality of natural light in livestock buildings affect the welfare and productivity of animals and their caretakers, while affecting the energy performance of the buildings. This study investigated the impact of different building properties on daylight conditions of livestock buildings. The study was conducted via parametric daylight simulations in Climatestudio. Firstly, building geometries with different facade orientations, width-to-length ratios, and roof pitches were simulated. Secondly, different glazing types, sizes, and locations were considered for their respective daylight performance. Finally, the use of different materials for the facade, floor and roof of the buildings were simulated and comparatively analysed. The study analysed the simulation results to assess daylight availability in relation to different building properties. The results provided insight that can help determine building geometry, window properties, and material selection during the design process. Overall, the study highlighted the importance of further research and development of design guidelines and standards that incorporate these factors to improve the daylighting performance of these buildings, while ensuring animal welfare and productivity.

Keywords: Daylighting performance, Livestock buildings, Cattle, Parametric study, Lighting, Simulations.

OP-14. Development of Design of Solar PV Panels within Last 25 years – Possibilities for Renovation

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Encapsulation of solar cells is most important for PV panel durability and reliability. Because of extreme market competition both quality and "quantity" of components of new PV panels is reduced compared to older design. Results in reduced reliability/durability of new PV panels compared to old ones. For instance, Solarex and/or Kyocera were producing PV panels for more than 30 years and they provided workmanship warranty 5 years. Manufacturers of new PV panels last typically about 10 years but they offer workmanship warranties in the range 12-25 years. The PV panel with warranty 25 years is in production 1-2 years only. The article compares in detail technical parameters of encapsulation between older and new PV panels. New PV panel renovation method was developed and tested for more than 5 years in real field conditions.

Keywords: Photovoltaics, Reliability, Renovation

OP-15. Estimating Tall Fescue and Alfalfa Forage Biomass Using an Unmanned Ground Vehicle

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Improving the efficiency and utilization of forage crops is important for enhancing productivity. Precise assessments of biomass levels play a vital role in assisting producers of hay, silage, and grazers in determining the optimal harvest timing and achieving an efficient stocking rate. This study aimed to develop a pre-harvest biomass estimation method by utilizing crop height measurements obtained through a ski-shaped plate mounted on an unmanned ground vehicle (UGV). The research primarily focused on evaluating the performance of the proposed method on tall fescue (*Schedonorus phoenix*) and alfalfa (*Medicago sativa*) trial plots which underwent measurements and harvested at 10, 20, and 30-day intervals. The ski-shaped plate, referred to as the "compression ski," was constructed and attached to a ground vehicle. Continuous height measurements of tall fescue and alfalfa were captured using an ultrasonic sensor and a microcontroller. Geotagged measurement locations were acquired through an RTK-GPS receiver mounted on the UGV. Plot boundaries were determined using aerial images processed in Agisoft Metashape and ArcGIS Pro. The compressed height indicators obtained were correlated with wet yield measurements, leading to the development of estimation models. Independent methods for estimating the dry matter fraction (DMF) were established to complement the wet yield estimation models. The wet yield estimation model was combined with a DMF estimation to create a prediction model for dry matter yield (kg DM/ha). The best-performing compression ski-based model achieved a standard error of 291 kg DM/ha for tall fescue and 491 kg DM/ha for alfalfa. The proposed pre-harvest biomass estimation method utilizing compressed height measurements with a UGV, and a ski-shaped plate offers a promising approach to optimize efficiency and utilization in grassland management. This method holds potential for enhancing productivity and resource utilization in the aforementioned areas of forage production systems.

Keywords: Biomass yield, tall fescue, alfalfa, sensing, unmanned ground vehicle.

OP-16. Tracking Hydraulic Performance of Photovoltaic Pumping System Using Solar Radiation Data: An Empirical Model

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Use of photovoltaic pumping systems for drip irrigation is becoming popular to promote sustainable irrigated farming based on benefits of renewable energy and water saving. As use of standalone photovoltaic water pumping system directly coupled to a drip irrigation network requires constant and stable operating pressure and flow rate to satisfy condition of an optimal water uniformity distribution, it is of great importance to maintain hydraulic performance during an irrigation operation according to potential fluctuations of daily solar irradiance. To address this problem, an empirical model for estimating optimal performance outputs of a photovoltaic pumping system is developed to find correlation with variability of the occurring irradiance within the day. This model was based on polynomial equations calibrated using experimental data and links electrical upstream data related to the photovoltaic generator with hydraulic downstream data of the pumping system (water pressure and flow rate). The model can be considered a decision tool for tracking the power point resulting from optimal electrical and hydraulic performances of the pumping system in response to changes in daily irradiance. The tracking method is based on switching an optimal number of engaged orifices within a hydraulic network to maintain a constant operating pressure and yield. The performance of the model was evaluated using the Root Mean Squared Error (RMSE) and the Mean Absolute Percentage Error (MAPE) methods, and the results showed that the model outputs converge with experimental data outputs to predict flow rate, pressure, and hydraulic performance with an RMSE of less than 10%.

Keywords: Drip irrigation, Standalone, Photovoltaic Pumping System, Hydraulic Performance, Irradiance.

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OP-17. Evaluation of Air Conditioning Parameters in Semi-closed Greenhouses According to Turkey's Climate

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Due to climate change and increasing energy prices worldwide, it has become necessary to use greenhouses more efficiently and to spread production throughout the year. The aim of this study is to investigate the possibilities of using semi-enclosed or fully enclosed greenhouse technologies that can replace traditional modern greenhouses. In line with this goal, greenhouse technologies that could provide a solution between traditional greenhouses and semi-closed greenhouse concepts are being explored in Turkey. Given that Turkey's climatic conditions are much more favorable compared to many other countries, controlling traditional modern greenhouses using semi-closed techniques is seen as a viable solution under desired conditions. This technique, especially applicable to plastic greenhouses, could extend the production process in greenhouses to 345 days. In addition to designing greenhouses with a semi-enclosed technology during the installation phase, it is also important to adapt existing greenhouses to meet this concept. Data related to the creation of necessary parameters and the determination of transition phases to formulate control algorithms for domestically developed systems with multi-climate or poly-climate techniques in Turkey are being evaluated within the scope of this study. The effects of energy efficiency and product quality of the greenhouse operating with the Multi climate technique, which was installed in the province of Mersin (covering an area of 5000 m2), have been evaluated under both classical greenhouse and semi-closed greenhouse conditions. The establishment of an appropriate climate for plant growth and development in greenhouses is achieved by controlling variables such as temperature, relative humidity, and sunlight within the greenhouse. In traditional greenhouses, the climate is constantly changing due to external factors like sunlight, temperature, humidity, rain, and more. Excess energy accumulation is managed to a limited extent through strategic activation of ventilation or cooling systems. Semi-closed greenhouses exhibit significant differences in control methods and operational techniques. Particularly, the positive pressure within the greenhouse is the most distinctive feature that alters the control approach. Positive pressure inside the greenhouse is achieved using electronically controlled fans. Additionally, heating-cooling coils coupled with these fans allow for climate control within the greenhouse. Another key distinction of semi-closed greenhouses is that they require a smaller area for roof ventilation windows compared to traditional greenhouses. These significant differences also offer important advantages in greenhouse control techniques. Controlled air exchange between the interior of the greenhouse and the climate corridor also facilitates energy savings. Controlled air inlet and outlet allow for homogeneous profiles of horizontal and vertical temperature, humidity, and CO2 concentration to be obtained.

Keywords: Semi-closed Greenhouse, Climate control, coolers, chiller, AHU

OP-18. Effect of Different OLR and Mixture Ratios on Biogas Production using Goat Dung and Maize Silage

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The aim of this study is to determine the effect of the use of goat excrement, which has not been used much in biogas research, and the use of maize silage, which is generally used in biogas production, on biogas production. The maize silage used does not contain cobs and maize kernels. It was studied under mesophilic conditions in a batch fermentation system with a hydraulic retention time (HRT) of 40 days. In the experiments, anaerobic fermenters with a total volume of 3 liters each, with heating and automatic mixing system were used. The amount of biogas produced was measured using the water displacement principle and the biogas content was measured with a biogas analyzer. Trials were carried out using two different mixing ratios at the same (0.5 grVS/l day) organic loading rate (OLR) and using the same mixing ratio at two different OLR values. The highest biogas production (approximately 40 liters) was measured at an OLR value of 0.8 gVS/l d using 65% goat manure and 35% silage in the mixture. Also, the highest methane content was obtained in this application. Although increasing the amount of silage with a constant OLR resulted in a small increase in the biogas generation, the methane content decreased.

Keywords: biogas, goat dung, maize silage, OLR, mixture ratio

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OP-19. Mapping Biomass Energy Potential from Agricultural Residues in Tanzania

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Tanzania, like many countries in sub-Saharan Africa, faces significant challenges in meeting its growing energy demands while simultaneously promoting sustainable development. Biomass energy, derived from agricultural residues, has emerged as a promising alternative to fossil fuels, offering a range of economic, social, and environmental benefits. This paper presents a comprehensive assessment of the biomass energy potential from agricultural residues in Tanzania. The study utilizes geographic information systems (GIS) and remote sensing techniques to map the spatial distribution of potential biomass resources across the country. The analysis incorporates data on crop production, residue generation, and energy demand to estimate the potential contribution of agricultural residues to the national energy mix. The data were obtained from multiple sources, including national surveys, satellite imagery, and existing literature. The results of the study indicate that Tanzania has significant untapped potential for biomass energy from agricultural residues. The highest potential is located in the northern and southern regions of the country, which are characterized by a favourable combination of crop production, residue generation, and energy demand. Maize, rice, and sugarcane residues were identified as the most significant biomass energy sources, with a total potential of over 40 million tons per year. The study concludes with policy recommendations for promoting the sustainable utilization of agricultural residues for energy production. These include the development of appropriate technologies for small-scale farmers, the establishment of incentives for biomass production, and the promotion of public-private partnerships for the development of biomass energy projects. The research contributes to the growing body of literature on renewable energy in Africa and provides valuable insights for policymakers, researchers, and practitioners working in the energy and agricultural sectors.

Keywords: Biomass energy, agricultural residues, GIS, renewable energy, sustainable development.

OP-20. The Effect of Different Tillage Methods on Plant Emergence Parameters for Wheat

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Conventional tillage; it is an application where most of the plant residues are buried or burned under the ground, and the plant residues on the soil surface are less than 15% after planting. With the environmental awareness that developed after the 1970s, alternative methods have been developed that minimize the field traffic and soil tillage without overturning it. In this method, which is defined as conservation tillage, the main criterion is that the field surface is covered with at least 30% plant residue. Reduced tillage forms the subgroup of conservation tillage. In this system, chisel or disc tools are generally used for primary tillage, harrow disc or cultivators are used for secondary tillage and seedbed preparation. In tillage application, no-tillage is done before planting after the previous crop harvest. Sowing is done directly on the previous crop stubble without seedbed preparation. In this research; no-tillage, reduced tillage and conventional tillage methods were tested in terms of plant distribution and plant emergence uniformity. The mean emergence date, emergence rate index and percentage of emergence values were calculated for that. In the research, the best mean emergence time value was determined in the reduced tillage method with 15.18 days, the highest emergence rate index and percentage of emergence value were determined in the conventional tillage method with 20.7 plants/day m^2 and 70.4%, respectively.

Keywords: Conventional tillage, Conservation tillage, Sustainable agriculture, No-tillage

OP-21. Design and Implementation of a Real-Time Wireless PTO Torque Measurement System for Agricultural Applications

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Power Take-Off (PTO) torque measurement plays a crucial role in various applications. Traditional wired torque measurement systems present limitations such as cable restrictions, susceptibility to electromagnetic interference and limited mobility. In this paper, we propose a novel wireless PTO torque measurement system that addresses these challenges and offers numerous advantages. The system utilizes wireless sensor networks and advanced signal processing techniques to enable real-time and accurate torque measurements in dynamic environments. The design and implementation of the wireless PTO torque measurement system was presented, emphasizing the integration of sensor nodes, data acquisition, transmission protocols, and signal analysis algorithms. The experimental results demonstrate the system's capability to provide reliable torque measurements while offering flexibility and freedom of movement. The developed system offered 0.8 mV/V per kN·m sensitivity and 99.14% accuracy and good linearity during static calibration and 105 m signal range in open field. Experiments were conducted using 2.75 m rotary tiller. Furthermore, potential applications and benefits of the wireless PTO torque measurement system in industrial settings, such as improved efficiency, remote monitoring and enhanced safety were discussed. Overall, this research contributes to the advancement of wireless sensing technologies in the field of torque measurement, promoting for smarter and more efficient agricultural systems.

Keywords: Power take-off, power transmission, torque measurement, rotary tiller, strain gauge

OP-22. Recent Developments in Agricultural Machinery and Technologies

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Due to global warming and climate change, various problems are encountered in the agricultural sector such as irregular rainfall, drought, flood, water shortage, and increase in diseases and pests. These problems cause low efficiency and low quality in agricultural production and increase concerns about access to food. In addition, it has been reported by FAO that the amount of global food production should be increased by approximately 70% by 2050 to meet the food needs of the increasing world population. Increasing productivity is possible by developing high-yield and more resistant plant varieties and using agricultural mechanization practices that save labor, time, and production costs. Agricultural mechanization enables agricultural operations such as soil tillage, sowing-planting, fertilization, spraying, harvesting and product processing to be carried out using machinery and energy, thus enabling faster and larger production capacity.

In addition to the technological methods, models and tools that manage the processes of obtaining, processing, storing, transferring, and using information, the development of portable computers and hardware with high processing and calculation power and their easy availability have enabled agricultural machineries to transform into smart agricultural machineries. Two important features of smart agricultural machineries are the ability to develop "Smart" behavior and "Autonomous" operation. The feature of being smart includes the machinery being aware of its surroundings during its operation, making its own decisions on changes such as changing its movement style or speed according to predetermined situations, and applying the decision itself. The autonomous feature allows the machinery to operate without human intervention and provides machineries with capabilities such as detection, evaluation, decision-making, control, and fault detection for safe operation. A smart agricultural machinery can be designed originally or can be made autonomous thanks to hardware and software such as automatic steering system, sensors and cameras that are added later to an existing agricultural machinery. However, environmental conditions such as humidity, temperature and corrosive factors in agricultural areas and technical difficulties such as communication problems experienced over long distances are some of the obstacles to smart agricultural machineries.

By using the diagnostic test system, especially in smart agricultural machines such as tractors and combine harvesters, fault codes and error messages received from the electronic brain control unit can be responded to the problem immediately and directly. In this way, there are no situations such as wasted time for service, unnecessary trips to the service, not being able to find the problem or replacing the wrong part. During these operations, there is no loss of operation due to malfunctions or problems in the smart agricultural machineries. When these smart agricultural machineries malfunction while working in the field, the malfunction can be detected via remote connection. If the detected malfunction is caused by software problems, it is resolved by updating the program via remote connection. If the malfunction is caused by defective equipment, the relevant service and maintenance will provide a new part of the defective part or repair operations will be carried out without delay.

In this study, the developments in the field of agricultural machinery and technologies today are discussed and the equipment and methods used are explained in the light of developments. In addition, the impact of these developments on human life and the environment in agricultural, technological, and economic terms is discussed.

Keywords: agricultural machinery, tractor, digital agriculture, climate change, food safety

OP-23. Developing Test Method for Automatic Steering Systems

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Precision agriculture means planning and managing the processes from tillage to harvest using modern technology and techniques in order to increase the productivity of the grown agricultural crops. One of the most important components of precision agriculture equipment is the location determination and verification unit for automatic steering systems. Automatic steering systems enable agricultural tractors to reach the targeted locations with the least deviation from the determined route in agricultural operations. In this study, a simple equipment that can be connected to the tractor with a three-point leakage system was developed for pass-to-pass verification tests of the automatic steering systems. With the help of this equipment and tape measures, three replicate trials were carried out at 3m and 18m working widths. At the same time, the position information during the trial hours was compared with the records in the log files in the software part of the automatic steering system. As a result of the evaluations, statistically significant difference wasn't found between the values obtained from the field trials with developed equipment and the results obtained from the log files of the automatic steering system. The results show that this developed equipment can be used practically in pass-to-pass tests in the field.

Keywords: automatic steering systems, pass to pass test, developing method

OP-24. Estimation of Some Soil Loss Characteristics using Machine Learning Algorithms

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The assessment of soil erosion is crucial for long-term soil conservation plans. Although traditional and direct measurements are the most accurate method for determining precise soil losses, this procedure is costly and time-consuming when applied over a large area. This study was conducted to determine wind erosion risks for wind cases experienced over wheat-planted and fallow lands under semi-arid arid conditions. BEST® sediment traps were used to determine the severity of wind erosion with direct measurements in the field. The efficiency of some artificial intelligence algorithms was also tested to determine the factors affecting soil losses (sediment transport rate, plant height, plant cover, and soil roughness) and to estimate soil loss ratios. Multilayer Perceptron-MLP, Gaussian Processes-GP, and Random Forest-RF machine learning algorithms were applied for estimation. The most successful r results in estimating sediment transport rate, plant height, plant cover, and soil roughness were obtained in the MLP algorithm, and these values were determined as -0.7533 (fallow plots), 0.9768 (wheat cultivated plots), 0.9777 (wheat cultivated plots), and 0.9613 (wheat cultivated plots), respectively. Promising outcomes were achieved for the estimation of wind erosion-induced soil losses with the use of artificial intelligence algorithms.

Keywords: Machine learning, sediment transport rate, plant height, plant cover, soil roughness.

OP-25. Effect of Different Drying Temperatures on CO_2 Emissions in Acorn Drying

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Since the harvest period of acorns comes to rainy periods, it has a very high initial moisture content. For this reason, its nutrient content decreases during storage, and deterioration occurs. In order to prevent losses, it is necessary to ensure the preservation of the products with the drying process immediately after the harvest. The aim of present study is to determine and compare the effects of gradually increasing drying temperatures on CO_2 emissions related to specific energy consumption in acorn drying. Drying processes were performed in a convective dryer at 40, 60, 80, 100 and 120°C. The CO_2 emissions of these temperatures were calculated for wind, solar, hydroelectric, and geothermal power plants. As a result, while the lowest CO_2 emissions were obtained from the wind power plant, the greatest CO_2 emissions were obtained from the geothermal power plant. In addition, it was observed that as the drying temperature and drying time increased, the amount of CO_2 emissions also increased.

Keywords: Acorn, CO_2 emission, air-convective drying, energy.

OP-26. Microwave Assisted Convective Drying Effect on Drying Time, Energy, Quality and Bioactive Compounds of the Cantaloupe

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Drying is a common technology that provides a long post-harvest storage period for products such as cantaloupe. This work aimed to investigate the drying behavior of cantaloupe during combined convective-microwave drying system. Three drying air temperatures (40, 55 and 70 °C), microwave powers (180, 360 and 540 W) and air velocities (0.5, 1 and 1.5 m/s) were investigated on drying time, specific energy consumption, shrinkage, rehydration ratio, changes in total color, phenol and antioxidant content of cantaloupe during drying. Nine mathematical models were selected to fit the experimental data for drying kinetics, and the results revealed that the Midilli model exhibited, in all cases, the best performance in fitting the experimental data (R^2 varying from 0.99959 to 0.99997; χ^2 from 0.00002 to 0.00203 and RMSE from 0.01857 to 0.54241). Calculated values of moisture diffusivity for dried cantaloupe varied from a minimum of 2.42×10^{-11} to a maximum of 9.79×10^{-9} m^2/s under the tested drying conditions. Drying time and specific energy consumption values decreased as air temperature, microwave power and air velocity was increased. Shrinkage, rehydration ratio, changes in total color values were calculated and found to vary in the range from 27.85 to 50.07%, 3.44 to 5.57 and 27.11 to 35.74, respectively. The range of antioxidant activity and total phenolic content of the dried cantaloupe was 42.57–79.11% and 18.15–34.36 mg GA/100g dw, respectively.

Keywords: Drying, cantaloupe, energy, antioxidant activity, phenolic content

OP-27. Prediction of the Kinetics of Drying *Rheum ribes* L. by an Infrared-Convective Dryer Using Artificial Neural Network and ANFIS

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In this research, nonlinear models including artificial neural network (ANN) and adaptive-network-based fuzzy inference system (ANFIS) were employed to evaluate the moisture ratio and drying rate of the *Rheum ribes* L. dried by infrared/convective dryer. The drying process was carried out in three temperatures (50, 60 and 70 °C), infrared powers (250, 500 and 750 W), the distances between the product and the infrared source (10, 15 and 20 cm), and thicknesses (3, 5 and 7 mm). These four parameters along with the drying time (0-1000 min) were considered as the network input in the ANN and ANFIS to assess the moisture ratio and drying rate. The best nonlinear model was selected based on the determination coefficient (R^2), mean square error (MSE), and mean absolute error (MAE). The rise in the temperature and IR power and a decline in the thickness and the distance between the product and the infrared source can shorten the drying time. The R^2 value of ANN and ANFIS models was 0.9988 and 0.9996, and MSE values was 0.0037 and 0.0021, respectively. Based on the considered statistical criteria (R^2, MSE, and MAE), the best model for the prediction of melon moisture content was the ANFIS model. These results indicated the high performance of the ANFIS model in the evaluation of the moisture content compared to ANN methods.

Keywords: *Rheum ribes* L., Infrared-convective dryer, ANN, ANFIS, drying rate

OP-28. Farm Vehicle and Farm Labor Transportation Crashes in Florida: 2013-2021

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The agriculture industry continues to be one of the most dangerous and fatal industries in the United States. In the state of Florida, little work has been done to quantify the amount of injury and fatality related to the agriculture industry. Particularly, there is no literature on agricultural vehicles involved in crashes in Florida. The goal of this study is to determine if there are spatial relationships among the agricultural crashes that occur in the state. Additionally, this study will implement multivariate spatiotemporal models. The aim of these multivariate spatiotemporal models is to estimate the number of agricultural crashes in each county in the state of Florida.

Agricultural vehicles on roadways can pose additional safety hazards. This is because often these vehicles are moving slowly, and drivers of the other vehicle are careless when driving near these vehicles. The significance of this study is that by estimating the amount of these crashes per county, we can suggest that additional safety measures be implemented in areas where the expected number of crashes expect to be higher. The importance of understanding spatial data is that future crashes can be forecasted based on the current spatial data of the crashes.

The data for this study comes from the Florida Department of Highway Safety and Motor Vehicles (FDHSMV) for the years 2013-2021. The data is recorded by the Florida Highway Patrol when a vehicular crash has occurred. The data is coded to allow the selection of farm and agricultural-related vehicles. Specifically, this study focuses on farm labor transport vehicles and farm vehicles (e.g., farm tractors). A farm labor transport vehicle is defined as any vehicle equipped and used for the transportation of nine or more migrant or seasonal farm workers (in addition to the driver), by the Florida Statutes. The data coming from FDHSMV will contain information on the county in which the crashes occurred, the number of individuals involved in the crash, the year in which the crash occurred, and the number of injuries/injury severity of the crash. Additionally, data from the United States Department of Agriculture was used. This added demographic information included the market value of agricultural products sold per county, the number of agricultural workers per county, the amount of land used for agriculture (in acres) per county, the number of farms per county, the estimated value of the land and buildings, and finally the estimated value of all machinery and equipment. The final data set includes 953 crashes. These crashes include 469 injuries.

Keywords: agricultural vehicles, farm labor transportation, roadway crash, spatio-temporal models

OP-29. Implementation and Assessment of an Autonomous Ground Vehicle (AGV) for On-Field Agricultural Operations

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The agricultural sector has been faced with many challenges related to the environmental impacts of anthropogenic and farming practices. Nowadays, the agricultural sector has the potential and responsibility to mitigate the negative environmental effects through sustainable actions. This goal could be pursued with conservative strategies while improving yields and soil management. The combination of precision agriculture practices, digital farming technologies, and robotic solutions provides answers to these challenges. In the last years, many studies have been focused on the development and implementation of autonomous ground vehicles (AGV) and teleoperated mobile robotic platforms capable of carrying out agricultural tasks (soil preparation, crop treatments, weed control, harvest, etc.) with limited or no human intervention. Despite AGVs have been studied and tested in the agricultural context, equipped with sensors, or implements, ready-to-market AGVs for farming applications are still rare. Furthermore, AGVs are emerging technologies where the availability of scientific findings that clearly state the overall benefits deriving from their implementation in the agricultural sector are still limited. Thus, this study aims to customize a commercial AGV for specific use in agriculture and test its operating capabilities on-field to perform agricultural tasks coupled with different implements.

The electric-tracked AGV used in this study was 1.30 m wide and 1.05 m long, with tracks of 33 cm each, and powered by lead acid batteries. Moreover, the AGV was coupled with a rotary mower and a rotary tiller. Both implements were self-powered by an endothermic engine of 11 kW and 4.8 kW respectively. The performances of the AGV coupled with the implements were evaluated considering different field conditions. Considering the performance of AGV coupled with implements, cutting efficiency (%), soil clumping, and bulk density (g cm^{-3}) were evaluated in relation to the towed load. Furthermore, the energy consumption (fuel and electricity) performing the on-field tasks was measured.

The driving performance tests allowed monitor the forward speeds where the maximum speed value corresponded to 0.77 m s^{-1}. Moreover, the forward speed was significantly influenced by towed load but not by the time of usage. The cutting efficiency of the mower was on average 57.55% with homogeneous and heterogeneous covering crops. The overall rotary tiller operations improved soil characteristics, both clumping and bulk density. In addition, the tests carried out on soil tillage and mowing, showed no significant difference. The results of this study contribute to the future implementation and usage of AGV in agriculture to perform specific on-field tasks. In fact, the study provides an overview of the use of an electric autonomous ground vehicle coupled with specific implements for soil tillage and weed control, to support farmers in the management of the field in safer conditions and with low environmental emissions.

Keywords: unmanned ground vehicle, robot, weed control, soil tillage, sustainable agriculture

OP-30. Criteria of Ecological Pressure on Agricultural Systems

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The current global environmental situation is characterized by: 1. The growth of anthropogenic pressure. 2. The growth of climate instability due to unknown reasons. This leads to significant environmental disturbances in agricultural systems. Quantitative and qualitative assessment of the state of agrocenosis is necessary to ensure efficient agricultural production and ensure environmental cleanliness of products. There is a need for effective and inexpensive methods of regular monitoring of agricultural systems. Such methods can be based on the achievements of fundamental science, especially ecology. These methods were developed for a number of years by the ecological scientific schools of Russia. The methods of assessing the state and forecasting are static and dynamic. Dynamic methods are based on the assessment of trends in the development of the system using methods of applied mathematics. In static approaches, the method of phenogenetic indication based on the measured parameters of the population, such as sex ratio, sexual dimorphism, quantitative and qualitative variability, is important. At the same time, the types of indicators of the quality of the ecological situation are determined, the populations of which are subject to assessment and survey. The corresponding approaches have been worked out on the assessment of agricultural systems in the North-Western region of Russia and can be applied to other regions of the globe, in particular, to the Mediterranean Sea region. The most significant projected trends are the growth of specific agricultural production in conditions of population stabilization and increased instability of the ecological situation.

Keywords: ecological control, phenogenic indication

OP-31. Rural Development Policy for Water Management Sustainability in Italy: Opportunities to Achieve Water Framework Directive Objectives

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The Common Agriculture Policy (CAP), in particular its second pillar (Rural Development Policy), offers funding opportunities for measures aimed at achieving the Water Framework Directive (WFD) objectives programmed in the River Basin Management Plans (RBMPs), i.e., the masterplans on the water governance in its sense of protection and management.

The new CAP programming (2023-2027), defined for the first time in a National CAP Strategic Plan (CSP), identified specific needs for water resources to be met through different type of intervention (investment, environmental and climate commitments and other management commitments). An important requirement of the new CAP Regulation - Reg. (EU) 2021/2115, is the integration between the CAP and the WFD, therefore the consistency between the CSP and the RBMPs. In December 2021, the RBMPs for the 2021-2027 programming cycle were approved, containing the Programme of Measures (PoMs) aimed at achieving / maintaining the good status of water bodies, identified basing on the analysis of the pressures of water uses and economic analysis. To verify the consistency between the two planning tools, correspondences between interventions planned in the CSP and the measures of the POMs was analyzed in various step along programming process, considering the difference between their logics and regulations. A survey of River Basin District Authorities (RBDA) has been conducted to identify any correspondence between the CSP interventions and the specific POMs measures of which they could potentially ensure financial coverage. Matches have been verified considering macro interventions of CSP and Key type of measures (KTM) of RBMP's. Furthermore, through an analysis at RBD level, the potential contribution of EAFRD to covering the cost of the RBMPs measures has been analyzed. Monitoring this correspondence will mean optimally finalizing water resource management policy in Italy.

Keywords: water framework directive, river basin district management plans, water management, common agricultural policy, rural development policy.

OP-32. Hazard Identification and Risk Assessment for Cattle Stunning: Case Study

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Workers in the animal slaughtering and processing industry experience a higher risk of work-related injuries than in other industries. The rate of nonfatal occupational injuries in the animal slaughtering and processing industry is nearly three times higher than the national average in the U.S. To understand the specific risks and hazards associated with stunning activities in a slaughterhouse, we conducted a case study at the University of Florida Meat Processing Laboratory. The aims of this study were to identify hazards and quantify the risks during stunning activities.

Two sources were used to identify the hazards: video-based observations and interviews with the workers. A camera was installed to record the facility during the process of the cattle at the stunning box. Each video file was watched, and an Excel file was created to mark specific hazards. After identifying the hazards, the duration of hazards present on the scene was recorded. For each video, the stunning process was divided into three sections based on the activity: guiding, stunning, and hanging.

Additionally, semi-structured interviews were conducted with the meat processing laboratory employees to understand their perceptions of the safety situation. This information was included in the risk assessment process. The existing stunning box, used since the 1980s, was modified by adding engineering controls to enhance worker safety and improve animal restraint during stunning.

Video surveillance data obtained before and after the installation of engineering controls demonstrated significant reductions in worker exposure to risks when stunning cattle. The main benefit of installing the cattle head catch gate was a reduction in the time required to stun cattle. The average duration of the cattle stunning activity was 188 seconds before installing the cattle head catch gate. After installation of the head catch gate, stunning took an average of 44 seconds a reduction of more than 39%. This presentation will discuss our research results and suggestions to improve safety and health conditions in small facilities.

Keywords: cattle stunning, occupational health and safety, risk assessment, stunning box

OP-33. Developing A Data-Driven Model for Predicting Water Stress in Pistachio Trees

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Drought and water shortage are major concerns in California and many parts of the world, and efficient water use is critical for growers. Water stress refers to the condition where the water demand exceeds the available water for a plant. The immediate goal of this research was to enhance existing water stress monitoring systems and develop a better irrigation scheduling system for pistachio trees in California. Currently, existing strategies for detecting water stress are either model-based or sensor-based, and each approach has its limitations. In this project, we developed a data-driven model that combines both model-based and sensor-based approaches, as well as a system that takes advantage of both techniques.

The test site was a pistachio orchard in Central California. During the growing season, extensive amounts of data were collected. Local environmental data such as ambient temperature, relative humidities, pressure, and rainfall were collected using two Aerable Sensors. Besides these, other collected data included Multi-spectral aerial images, thermal images, sap flow, stem water potential data, and local. Aerial images were used to construct several vegetative indexes. A feature selection method was used to determine the most relevant input data. All selected data were fed into different AI models. This paper discusses the results and shows the best approach for water stress detection in a pistachio orchard.

Keywords: Sensor, Irrigation scheduling, AI model

OP-34. Water Distribution Uniformity of Nozzles for a Hose Reel Irrigation Machine

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A hose-reel irrigation machine is being modified to a hose-reel fertigation machine (HFM) to apply irrigation water and liquid fertilizer through the same irrigation pipe with section control. Water distribution uniformity has the utmost importance, especially when irrigation needs to be done at a site-specific variable rate (VR) using an HFM. The aim of this study is to determine the application accuracy and distribution uniformity in the boom sections. An experimental setup is being used under indoor conditions to simulate the water spray of the HFM using flood-type nozzles with a spacing of 1600 mm, at a spray height of 1450 mm, with three different nozzle sizes (4, 5, and 6 mm holes) at four different flowrates (0.8, 1.0, 1.2, and 1.4 L/min), corresponding to the irrigation application rates of 15, 22, 27, and 35 t/ha at a constant ground speed of 60 m/h. Collection pans were used to determine the volumes of water across the spray width. Due to the large hole sizes on the nozzles, the pressure needed at the inlet of the spraying pipe was negligible. Increasing the flow rate did not cause a noticeable pressure to deliver the flow rates needed for the simulation of flowrate through the boom section. This observation confirms the observations in real field operating conditions. It was found that the amount of sprayed water did not decrease from the center to the edges continuously, the greatest volume was usually at the tip of the spray beam. At all flow rates tested, the maximum volumes at the tips were 2 to 4 times greater than the rest of the width of the beam. This could be explained by the large holes in the nozzles operating at very low pressures that cannot pulverize the water efficiently. As the flow rate increased from 0.8 to 1.4 L/min, the spray width varied from 0.95 m to 5.35 m, corresponding to the spray angles from about 35 to 120°. At a constant spray height, if the need for irrigation rate changes, requiring increased or decreased flow rates through sections of the irrigation machines, the spray width and the overlap distance will change significantly, changing the flow rate distribution. It was concluded that it is unlikely to accomplish a uniform water distribution since the coverage, overlap, and spray angle will change based on the application rate and height changes due to crop growth requirements. In light of the initial indoor tests, it was concluded that different nozzle spacing and boom heights should also be tested with water and liquid fertilizer injected into the irrigation water.

Keywords: Hose Reel Irrigation, nozzle test, spray distribution, fertigation

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OP-35. Economic Analysis of Subsurface Drainage Systems in North Central Iowa

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In the corn belt of United States and several areas around the world, subsurface drainage plays a critical role in making crop productivity profitable leading to better farm management. Subsurface drainage causes the excess soil water to leave the plant root zone resulting in better crop yields as the plant roots are not waterlogged for long time durations. In Iowa, subsurface drainage is fundamental to its agricultural economy. Farm operations of cultivation, planting, and pesticide applications on several farms are only feasible due to removal of excess soil water with subsurface drainage. According to USDA-NASS, approximately 35% of Iowa's row-crop farmland (over 5.1 million ha or over 12.6 million acres) is considered artificially drained with subsurface drains.

The economics of payback on a drainage system typically depends on drainage intensity (spacing and depth), drainage capacity (size and grade), water quality and quantity management (controlled drainage, shallow drainage, bioreactors, wetlands, etc.). Spacing and depth of subsurface drains are two key factors directly impacting the time it takes for excess soil water removal after intense rainfall events. Soil types, i.e. saturated hydraulic conductivity of the soil, also impacts how quickly the water will move through the soil to the subsurface drains. These three factors can be modelled for their impact on the soil water table and subsequently crop yields using a computer simulation model called DRAINMOD. This model simulates the hydrology of poorly drained soils using climate data and predicts the effects of subsurface water management practices (drain spacing and depth) on water table depths and crop yields.

Two drain depths of 0.9 m (3 ft) and 1.2 m (4 ft) were studied in this analysis using four drain spacings of 6.1 m (20 ft), 12.2 m (40 ft), 18.3 m (60 ft), and 24.4 m (80 ft). Different patterns of subsurface drains exist on the farmland which consist of parallel, herringbone, double main, and random. In this analysis, only the parallel subsurface drainage pattern was studied using DRAINMOD. Three different poorly drained North Central Iowa soil types (Okoboji, Canisteo, and Clarion) with saturated hydraulic conductivities of 3.3, 10.1, and 33.3 mm/hr, respectively, were used in DRANMOD computer simulations to predict crop yields.

An economic analysis was then preformed using the cost of the subsurface system, its installation and maintenance costs, and increased revenue from improved crop yields on the return on investment. Over half of the land in North Central Iowa is leased, so a comparison was also performed between the return to a landowner versus the return to a land tenant, depending upon who paid for the drainage improvements. A landowner would expect to have a higher land rental rate from the tenant to justify their investment in the drainage system.

Three different corn and soybean market prices were used in the analysis to calculate increased revenues under continuous corn and corn-soybean crop rotations common to North Central Iowa.

DRAINMOD software simulations and economic analysis are still being performed. Results will compare the return on investment for narrower and shallower drains with wider and deeper drains. This can help landowners and land tenants to make better farm management decisions if it is beneficial to invest in subsurface drainage and help decide the optimal drain spacings based on two different crop rotations and multiple pricing outcomes.

Keywords: Subsurface, drainage, design, yield, economic, analysis.

OP-36. Determination of Suitable Shearing Conditions for Effective Pruning of Tree Branches

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Pruning shears used for tree canopy management are manufactured in various sizes and blade curvatures. This paper reports on the selection of suitable blade curvature of manually-operated pruners for tree branch pruning. Various shears available on the market were examined and three with the highest, lowest and medium curvature radii were selected. These were mounted on a material testing machine and used for shearing tree branches (Morus alba) in a randomized complete block design experiment. Effects of blade curvature radius at three levels (42, 45 and 50.5 mm), cutting speed (200, 400 and 600 mm/min) and Mulberry branch diameter at three levels (thin, medium and thick) on the required cutting force and energy were studied. Analysis of covariance was used to remove the effect of branch moisture content. Statistical analysis of the data showed that the effect of blade-curvature on the required cutting force and energy was significant at the 1% level. Cutting force and energy, which are important in manual pruning due to the strain they place on the worker, significantly increased with blade curvature radius. The best cutting conditions for various branch diameters were found to be: blade-curvature radius of 45 mm for large branches and 42 mm for thin and medium branches all at cutting speed of 400 mm/min.

Keywords: Shears, Pruning Process, Cutting Force, Energy consumption.

OP-37. Development of Variable Rate Irrigation System for Linear Moving Irrigation Machine

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In this research, a variable rate controller was developed for linear move irrigation systems. Materials were linear move travelling irrigator, stepper motor, battery, electronic control unit, 2 wireless communication points, flowmeter, GPS module and variable rate application map software. Linear move travelling irrigator machine manufactured in Turkey. Total irrigation length was 300 m, hose diameter 90 mm, nozzle diameter 8 mm and number of the nozzles was 40. Boom length was 40 m. Irrigation width was 50 m. Stepper motor had 1.80° stepper angle and 4.5 Nm torque. a GNSS GPS used to determine geographical positions. Correction signals for GPS was established via CORS-TR system. Electromagnetic flowmeter was used. Flowmeter worked with DC24 V. Working pressure and measurement range were 4.0 MPa and 100 m^3/h, respectively. A software developed before for variable rate fertilization was used to apply the desired variable rate irrigation by detecting location of the machine and changing the irrigation speed established by changing hose collection speed. The first part of the flow measurement system (irrigation part), the position and velocity values were taken, and the wireless transmission system that provides the transmission of these data. The second part of the control system in the irrigation machine where the operating speed of the irrigation machine was adjusted by processing the transmitted data.

The variable rate irrigation system was tested on the flat concrete surface and the field. A special laboratory test software was developed to determine accuracy of the system in the laboratory tests before attached to the linear irrigation machine. Working situation, reactions of the stepper motor and electronic control unit were checked. Data acquisition and exchange between access points and computer were checked and saved. The variable rate irrigation system was tested on the flat concrete surface to determine system performance for different forwards speeds varied from 6.3 m/h to 7.0 m/h with 0.1 m/h steps. Variable rate irrigation maps were created to test the developed system. In these tests, water application amounts were measured by using catch cans. The measured data were compared with calculated water amount. Required water application rate were determined from 1.6 m^3/h to 2.0 m^3/h. Descriptive statistics such as total, mean, minimum, maximum, standard deviation (SD), coefficient of variation (CV%) were used to evaluate data.

The total water application amounts as flow rate (m^3/h) were measured and saved with GPS positions data includes time. The measured data and theoretically planned data were compared. According to the flat concrete test results; flow rate was changed from 1.94 m3/h to 1.59 m3/h by changing irrigation speed from 5.29 m/h to 8.18 m/h. Standard deviations of the flow rate measurements varied from 0.01 m3/h to 0.06 m3/h. Coefficient of variation of the distribution were calculated 0.75% as minimum and 3.02% as maximum. Coefficient of variation values of tests were in the acceptable limits (CV <7%).

The planned and measured total wate applications per geographical positions were close to each other. Regression equation was determined as y=1.0018x and R2=1. Differences between the planned and measured data was changed between 6.56 m3/h and 7.90 m3/h. The variable rate irrigation map data and applied data in the field were too close to each other in the acceptable limits. Differences as percentage of the planned flow rate were varied from 0.03% to 0.77%. The developed variable rate controller was worked successfully in the laboratory, and the field tests. Future work will be to determine effect of variable rate irrigation on irrigation efficiency, yield and quality of the field crops.

Keywords: linear move irrigation, precision farming, variable rate irrigation, field crops

OP-38. Using Composted Cow Manure to Improve Nutrient Content, Aeration Porosity, and Water Retention of Pine Bark-Based Potting Media

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A commercially available composted cow manure (CCM) was used as a potting media amendment. A common base mix of 8 parts pine bark and 1part sand was compared with 3 other mixes that contained 20%, 30%, and 40% compost (v/v). The remaining fraction of these three mixes was the base mix (bark and sand). The plant nutrient concentrations of the base mix and the three CCM-base mix blends were compared with common plant nutrient concentrations provided by fertilizing the base mix with a common granular fertilizer.

The chemical characteristics of the three compost-based potting media mixes were calculated on a mass basis. The aeration porosity, total porosity, volumetric water holding capacity and bulk density of the four mixes were measured. The results indicated that increasing the percentage of compost in potting media caused the desired decrease in aeration porosity, and total porosily.

The data of water retention curve was obtained using the dew point method. The results indicated that the 40% compost potting media mix had the largest range of readily available water. Including compost in potting media created a substantial increase in valuable plant nutrients (P_2O_5, K_2O) and minerals. The study delivers a template how to prepare and analyze soil-like substrates regarding their WRCs using the dew point method. It was concluded that adding 40% of the CCM to a screened bark base and sand mix would provide most of the improvements in fertilizer value, physical properties, and mass of water in a container for a growing plant.

Keywords: Compost, Potting Media, Water Retention Curve, Dew Point, Porosity.

OP-39. Coefficient of Dynamic Wall Friction for Hardwood Fuel Pellets

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The design of storage and handling systems for bulk materials requires an understanding of their frictional properties. While these properties are well-studied for many agricultural commodities, they need to be better defined for pelletized biomass, which present unique challenges due to their particle sizes and nontypical aspect ratios. This study evaluated the coefficient of dynamic wall friction for hardwood fuel pellets against two common handling surfaces (ultra-high molecular weight polyethylene (UHMW-PE) and galvanized steel). Effects of confining pressure and shear displacement were investigated using a direct shear wall friction tester, which allowed for up to 20 cm of displacement. Three confining pressures (5 kPa, 10 kPa, and 15 kPa), and two loading methods were evaluated. Fuel pellets against UHMW were most impacted by displacement, with friction decreasing up to 9.5% over the length of the test. Additionally, sequentially increasing the confining pressure over the length of a single test resulted in shear stress differences of up to 14.2%, compared to independent tests. The lowest confining pressure was most affected by these trends and showed higher friction values, relative to the higher confining stresses. Linear functions for stress-dependent friction were estimated, and the overall wall friction angle across methods was 13.2° for UHMW and 11° for steel. Overall, this study explored several factors that influence wall friction test methods, and the results can help improve the design of pellet storage and handling systems.

Keywords: Coefficient of friction, Wood fuel pellets, Physical properties, Direct shear testing

OP-40. Emerging Smart Biosensors for the Specific and Ultrasensitive Detection of Plant Abiotic Stresses

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Today, the effective role of miRNAs and their target genes in plant stress response is rather revealed to humans due to the extensive work carried out in the last decade. Plant stresses result in simultaneous tissue-specific up/down-regulation of miRNAs. Besides various methods, such as PCR, microarrays, northern blotting, and biosensors, are available to measure either the regulation or concentration of miRNAs in plant tissues.

Biosensors, having a living unit as a receptor in their structure, have been introduced as an efficient analytical method for fast and sensitive determination of miRNA concentration in biological samples. Today, the use of low-cost colorimetric biosensors based on nanoparticle aggregation for specific and ultrasensitive determination of miRNAs is increasing in the field of plant science. Utilizing metal nanoparticles, especially gold and silver nanoparticles and nanostars improves the performance of the sensor because of their high extinction coefficient and strong distance- and size-dependent optical properties. These biosensors work based on a change in the color of the solution containing the nanoparticles and the target miRNA because of the nanoparticle aggregation.

In this study, an optical biosensor has been used to measure the concentration of various miRNAs that involve plant stress response in tomatoes after applying drought stress to the plant. To carry out the experiments, plants were cultivated in a greenhouse environment and tap water was supplied daily for irrigation to maintain soil water potential close to the field capacity. Drought-treated plants were stressed by withholding water, at three levels: 80, 60, and 40% of field capacity. The concentration of several plant miRNAs, including miRNA-167, miRNA-172, miRNA-393, and miRNA-396, in plant leaf samples was measured using the biosensor at five-day intervals beginning with applying the drought to the plants.

After creating a database in which the plant miRNA concentrations were the inputs while the plant stress level was the model output, the artificial neural network (ANN) was used to learn the patterns between the model inputs and output. Using this machine learning unit to create a possibility of predicting the level of stress severity based on the results of the biosensor is the reason for calling our biosensor a smart device in this work. The network was developed using a computer code written in the MATLAB programming environment. ANN is a multi-layered network that includes various hidden artificial neurons to learn the relationships in the database in the form of mathematical equations stored in the neurons.

The results indicated that the machine learning model could predict the severity of the plant drought with the MSE value of 1.77. This shows that combining an optical biosensor and machine learning technique based on ANN architecture could detect the stress level in drought conditions, which can be useful for farmers and agricultural engineers in tomato fields. In conclusion, the machine learning method developed in this study was efficient to use variables extracted from biosensors as the model input in detecting drought stress in tomato plants.

Keywords: Machine learning, miRNA sensor, tomato plants

OP-41. Sexing of Chicken Egg in the Early Incubation Based on the Analysis of Transmission Image

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All male chicks are killed immediately after hatching in conventional hen-laying hen production because male chicks cannot lay eggs. The number is estimated to be more than 7 billion birds per year worldwide, which is problematic from the viewpoint of animal welfare and the energy or labor required during the egg incubation period. Many researchers have been studying non-destructive or minimally invasive methods to determine the sex of embryos before hatching. Our research group has already found a significant difference between male and female embryos around day three based on time series spectroscopic spectra. This difference was found at a wavelength related to the absorption of hemoglobin, which is included in the blood. Therefore, we assumed that there might be a difference in vascular growth in the initial period of incubation. It is also preferable to be able to identify the sex of the embryo as soon as possible, considering that the chick embryo may be capable of pain transmission from day 7 of incubation and that a lot of costs are involved. As one of the methods to observe the process of angiogenesis from multiple angles, an imaging system was constructed to visualize blood vessels in the early stages of egg incubation. A green illumination around 550 nm selected based on the spectroscopic properties of chicken eggs was used to acquire the transmission images, and we succeeded in the precise observation of embryos and blood vessel growth during the early incubation period. It was also possible to confirm the drastic changes in the distribution of blood vessels, which was consistent with a previous biological study. Application of noise removal using Gaussian and Laplacian filters and Otsu binarization to the images enabled the extraction of the areas where embryos and blood vessels were captured. On the basis of these findings, more than 100 eggs were incubated, and their transmission spectra at 450 to 900 nm and images were obtained. The spectra were measured with the eggs placed in a vertical position, and images were taken in a horizontal position. Since the amount of light transmitted decreased day by day because of the embryo growth, the exposure time was increased as the incubation progressed. Two days after hatching, their sex was determined by the feather. Linear support vector machine was used to create a classifier and full cross-validation was performed. When the absorbance at 500 to 625 nm on incubation day four and the area of the embryo and blood vessel shadow region at the same time were used as variables, the percentage of the correct sex determination was found to be approximately 5% higher than when only the absorbance information was used. This suggests that transmission image data may also be helpful for sex identification before hatching, and we hope to utilize more features from the images to achieve more accuracy. In this presentation, we will introduce the result of a larger-scale incubation experiment, focusing on the image data. Transmission images of over 300 fertilized white eggs (Julia lite) were captured from just before the start to the seventh day of incubation. Morphological features of embryos and blood vessels, which include area, shape, and perimeter, were extracted by image analysis. We examined how these characteristic values change with growth and the relationship between features and sex. The possibility of sex determination of early embryos was also investigated using a deep learning system.

Keywords: sexing of chicken embryo, blood vessels, transmission image, machine vision, deep learning

OP-42. EASY4DIGIT - European Agriculture System for Digital-Based Technologies

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Digital agriculture, also known as precision agriculture, is the use of advanced technologies and data analysis techniques to optimize and improve agricultural production. This includes the use of sensors, drones, GPS mapping, satellite imagery, and other technologies to collect data on soil moisture, nutrient levels, weather patterns, crop growth, and other factors that impact agriculture. Digital agriculture enables farmers to make more informed decisions about how and when to plant, irrigate, fertilize, and harvest crops. By analyzing data in real-time, farmers can identify problems early on and take corrective action before crops are affected. This can lead to higher yields, better crop quality, and reduced waste. Digital farming has the potential to revolutionize agriculture and bring significant benefits for farmers and the society overall, as we need new ways to grow more food more sustainably, but there are bottlenecks limiting in terms of time, investments and effectiveness the take-off of the new digital technologies in agriculture. Concretely, it means applying new technologies and innovative solutions, such as data science, advanced sensors in the field and flying drones, digital communication channels, and on field automation starting from an in-depth and well developed decision system supporting right, practical and sustainable planning and management. The mission of the EASY4DIGIT VET Erasmus+ KA220 is mainly focused on reducing the existing gap of specific competences in digital education supporting Decision Support Systems and tackling lack of knowledge and information dedicated to young as well as adult farmers as final users and trainers as intermediary category. EASY4DIGIT intends to address the challenges by developing awareness and competences of farmers towards an advanced digital knowledge focused on smart and resilient farming. EASY4DIGIT will raise the skills capacity and in-house functional knowledge and best practices in order to improve the overall competitiveness of the agriculture industry and succeed in an increasingly digital, green and knowledge driven economy.

Keywords: Digital agriculture, Decision support systems, Erasmus+

OP-43. Determination of the Effect of Technical Parameters which Affect on the Tractor Energy Efficiency

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In this study, parameters which affect tractor energy efficiencies, such as wheel drive types, fuel injection systems, and transmission types were studied. There are much more data which are relating to tractor energy efficiency in OECD Code 2 tractor test reports. While the calculation of the total efficiency, specific fuel consumption, hourly fuel consumption and power data were measured on OECD Code 2 PTO and drawbar test. Results have been evaluated according to tractor technical specification separately and the effect of those specifications have been determined. As well as tractor energy efficiency depends on the engine, wheel drive system, soil type and characteristics, tyres, working pressures, tractor weight, compatibility between tractor and equipment and driving efficiency; the first two parameters affect 60-70 %. According to the results, while the average total efficiency of 293 tractors was 28.2%, only the average total efficiency of 4WD tractors was lowest at 27.7%, and the average total efficiency of tractors with CVT and CR systems became highest at 30.8 %. While the effect of the CR injection system on the total efficiency of tractors has become 9.3%, it has become 1.8% for tractors only CVT gearboxes. Both the effect of CR injection system and CVT on the total efficiency of tractors have become 11.2 %. While the effect of both the CR injection system and CVT on the specific fuel consumption of tractors has become 6.4 %, it has been calculated as 5.1 % for tractors only with the CR injection system.

Keywords: tractor, energy efficiency, specific fuel consumption, tractor efficiency, tractor testing

OP-44. Determination of PTO Performance Test Method for Electric Tractors

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In this study, the PTO performance test method determined on the basis of OECD Code 2 standards was defined as a result of the tests performed on the electric tractor at the Directorate of Agricultural Equipment and Machinery Test Center. PTO performance test for diesel tractors according to OECD Code2 is carried out in four stages; The one-hour test, normal loads, partial loads, and an additional five-point test. Fuel temperature, oil temperature, engine temperature, ambient temperature, engine air intake temperature, pressure and fuel consumption values are measured at each test stage. In the electric tractor test method developed in practice, battery and engine temperatures were measured instead of fuel, oil, air inlet temperatures measured in diesel tractors, and energy consumption was measured instead of fuel consumption. The Electric tractor test was carried out in three stages: one-hour maximum power test, 540 min-1 standard PTO loading test, 750 min-1 PTO loading test and battery discharge test. The battery discharge test was carried out at full load at maximum power, at 85% of maximum torque, at 75% of 85% of torque, at 50% of 85% of torque, at 25% of 85% of torque. During the battery capacity measurement tests, temperature measurements were made for each battery pack and the tests were completed within the allowable limit.

Keywords: Electric tractor, OECD Code 2, Tractor test method

OP-45. Development of Fertigation System for Hose Reel Irrigation Machines

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Hose reel irrigation machines irrigate with linear motion and sprinkler method. In this study, an integrated fertigation system was developed for a 110 mm x 400 m hose reel irrigation machine manufactured by SEZERMAC. In the developed system, together with an hose reel irrigation machine, a volumetric dosing pump with a microprocessor, a fertilizer tank manufactured in special dimensions, a pair of symmetrical consoles for the fertilizer tank and solar system components were used. In order to determine the working performance of the developed system, pH, EC, TDS values were measured in irrigation water mixed with liquid chemical fertilizer. At the same time, necessary analyzes were made to determine the total nitrogen and total phosphorus values. The Christiansen uniformity coefficient (CUC) was calculated to determine the working performance of the system developed using the values obtained as a result of measurement and analysis. CUC values calculated for pH, EC and TDS parameters were determined to be between 95.0% and 99.9%. The CUC values calculated for the total nitrogen and total phosphorus amounts were found to be between 83.79% and 96.42%. The developed fertigation system could be used successfully with hose reel irrigation machines.

Keywords: Dosing pump, Fertigation, Hose reel irrigation machine, Solar system components

OP-46. Determining the Possibility of Use of the DSSAT Model to Estimate Maize Yield and Water Consumption under Different Irrigation Levels

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The Mediterranean climate zone is at serious risk in terms of agricultural production due to the detrimental effects of climate change. It is required to set up new production strategies against the difficulties in supplying irrigation water faced in our region for recent years. In this context, plant growth models stand out as an important tool. The maize production having a large area in Aegean Region shrinks because of an increase in temperature and drought in recent years. In this context, with this study, it is aimed to predict the effects of different irrigation levels on evapotranspiration (ET), leaf area index (LAI), biomass and grain yield of maize to maximize maize yield capacity and water use efficiency under drought stress in Menemen condition. In this study, 5 different deficit water treatments that are 4 different percentages (%120, %90, %60, %30) of weekly evaporation amount taken from Class A pan and rainfed are considered. In accordance with the simulation outcomes through DSSAT model, RMSE values are found 0.97 t/ha, 2.55 t/ha, 0.49 and 40 mm respectively for yield, biomass, LAI and ET. Difference between values measured and predicted by model is found higher in upper water deficit treatments while it is found lower or equal in absence or lower water deficit treatment conditions. In conclusion, the risk condition can be mapped in agricultural areas for maize production by applying DSSAT model within different drought stress levels. Additionally, the strategies for increased water use efficiency can be developed at the level of big production areas in catchment and plain in compliance with deficit water resources.

Keywords: Menemen, deficit irrigation, soil moisture, irrigation schedule, evapotranspiration (ET)

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OP-47. Enhancing System Understanding, Gathering and Structuring Knowledge to Manage Uncertainty in WEF Systems in Gediz Basin

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Economic uses of the primary resources in agricultural production such as soil and water have been limited by the pressures of reasons such as drought caused by climate change, migration and population growth. Conflicts over water use and sharing between the urban, industrial and agricultural sectors; it can damage the social structure as well as negatively affect the economic development. The Water-Ecosystem-Food (WEF) approach needs to be well defined and developed for fair sharing of soil and water resources, thus sustainable economic development and a solution to inter-sectoral conflicts. With this study, learning and action alliances were formed by bringing together the stakeholders of the Menemen Plain. The study carried out in the Menemen pilot area with 13 partners from six countries. By supporting the functionalization of the Nexus paradigm through a collective learning process with a resilience-focused approach. The project aims to contribute to improved water allocation and enhanced food security while protecting ecosystems and helping to adapt to climate change. Throughout this project, relevant stakeholders and all relevant actors were involved in the process in order to find solutions to existing problems in certain areas with different climatic conditions and socio-economic characteristics in the Mediterranean region. The Water-Ecosystem-Food relationship approach was defined and developed for the pilot region. In this study, meetings and surveys were held with stakeholders in the pilot area to develop LAA (Learning and Action Alliances). It has been observed that the interaction between institutions is not sufficient and they do not have much information about each other. According to the surveys the main agricultural problems were determined as water scarcity, water quality problems, soil salinity and yield reduction. In this context, samples were taken from the irrigation network during the irrigation season. Soil and ground water samples were taken by gridding in agricultural production areas. According to these samples, it has been observed that salinity and alkalinity problems have increased in agricultural production areas, water supply has decreased by 85% in the last five years, and the product pattern has changed due to water scarcity. In the future, water-based production model for the continuation of the agricultural ecosystem and remedial practices against salinity problems are seen as nature-based solutions.

Keywords: Lenses, Menemen, irrigation, salinity, WEF

OP-48. Determination of Operating Parameters in Milking Robots with Milk First Cow Traffic

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Smart farming practices take their place in dairy farms as well as in other areas of agriculture. Giving individual attention to animals raised in groups, gaining momentum with identification products, feeding animals, diagnosis and follow-up of health problems, detection of heat, milking and barn cleaning can be done with robotic devices and equipment. The most important development among technological products has been the realization of milking processes with robotic systems. The main purpose is to reduce the labour, increase animal welfare and improve the quality of life of farmers with the use of robotic systems. Milking robots, which have been used for 30 years in developed countries, entered Turkey about 10 years ago. Robotic milking technology, which has become popular in our country in a short time, will be the most common technological development of dairy cattle enterprises in the future. In addition to the fact that all of the commercially patented robot units are imported and high-cost products, the wrong and inefficient use of these products can cause losses in the economy of the farmers.

In this study, it was aimed to determine the parameters and milking values for increasing the efficiency of robotic milking systems, which were acquired with high investment costs, by monitoring the operation in a commercial farm. The farm where the research was carried out was planned according to "milk-first cow traffic" and there are a total of 500 Holstein Friesian breed dairy cows in the farm. The main building, where the milking cows are located, consists of four independent barns under the same roof and there are 8 robotic milking units in total, 2 in each barn section. In the study, two-year performances of all robotic milking systems in the farm were examined. Some of the main parameters examined are; number of cows milked per robot, daily milking frequency per cow, daily milking distribution, hourly milking distribution of robots, daily milk yield, milking yield, milk flow, cow's milking time interval, rejection number and duration, robot's daily milking number, robot's milking loading rates in washing, idle and non-milking processes, etc...

In the two-year trials comparing 8 robots in four barns, the average number of milkings per cow was found to be close to each other across the herd (2.66, 2.70 units/cow, day). In the first year of the trials, the average daily milk yield, yield per milking and time spent on the robot were 32.6 kg, 12.1 kg and 7.41 minutes, respectively, while in the second year these values were 37.2 kg, 13.9 kg and 7.63 minutes. minutes are set. Grouping of animals according to their yield in the second year can be shown as a reason for this change. While the average daily milking number of the robots in the farm was 148.5 times in the first year, this number decreased to 138.3 in the second year, while the daily milking intervals of the cows increased from 8.56 h to 8.72 h. On the other hand, while the loading rate of robots was 76.2% in the first year, this rate decreased to 73.4% in the second year. In the second year trials, the placement of cows whose teats are not fully suitable for the robotic system in Barn 1, medium milk yield group in Barn 2, high milk yield group in Barn 3, and cows that will dry up in Barn 4 and pregnant heifers that are about to be born, contributed to this difference. thought to be the cause. Because manual interventions such as hand attach-grab and fetch in Barn 1 and Barn 4 were effective in this change.

Keywords: milk cows, robotic milking, milking frequency, robot load, milk yield.

OP-49. Shear Tests of Grapevine (*Vitis Vinifera L.*) Canes

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In this study, shearing properties such as shearing force, shearing energy, shearing strength and specific shearing energy values of the branches of local grape (*Vitis vinifera* L.) varieties such as Öküzgözü, Boğazkere and Şire were determined and compared with each other in terms of these properties. The shear tests were carried out with three different knife shapes, two of them are serrated type (serrated 1 -knife-edge thick, serrated 2 -knife-edge thin) and flat (knife-edge flat) with five knife edge angles (50°, 60°, 70°, 80° and 90°). Shearing properties were measured by the materials testing machine. According to test results, maximum shearing force, shearing strength and energy values were obtained at knife of serrated 1 (knife-edge thick) type, the lowest average value was observed at Serrated 2 type knife as 382.77 N. The shearing force slowly decreased with increasing knife-cutting angle from 0° to 40°. The maximum shearing force was observed at 0° knife cutting angle as 426.90 N. The lowest values were obtained at 30° and 40° cutting angle. The cutting force and strength decreased with increasing knife-cutting angle from 0° to 40°. The highest shearing force requirement was obtained Öküzgözü variety, followed by Boğazkere and Şire variety.

Keywords: Grapevine cane, Shear test, Shearing force, Shearing energy, Shearing strength

OP-50. Comparison and Evaluation of Vegetation Indices for Image Sensing Systems in Precision Agriculture

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In precision agriculture, remote estimation processes such as the determination of the canopy area, the yield and plant volume are useful for the camera-based observations. Especially, using accurate vegetation index for identifying the plants is very important in the remote image sensing systems. As known, vegetation indices are frequently used for providing the data for agricultural analysis. They are practical indicators of the imaging information for agricultural crop monitoring. There are various vegetation indices used for automated crop imaging applications in the literature. Vegetation indices are used for discriminating the plant canopy from the soil or another background in the automated image sensing and machine vision systems. In this study, four frequently used Red Green Blue (RGB) vegetation indices were compared to the manually extracted plant region images of interest obtained in the ImageJ software by using Otsu thresholding method. Excess Green (ExG), Excess Green minus Excess Red (ExG-ExR), Green Percentage (G%) and Triangular Greenness Index (TGI) indices were used with digital colour images of single artificial plants. A novel image processing algorithm was developed in LabVIEW software for determining the green area of artificial plants. An industrial digital camera was also used to capture the artificial plant images for image processing. Performances of mentioned RGB vegetation indices were also evaluated and compared with each other. One-way ANOVA statistical analysis method was used to evaluate the differences between the vegetation indices for artificial plant samples. Vegetative index groups were determined and compared statistically. The objective of this study is to compare four RGB vegetation indices with each other and with a well-accepted thresholding method (Otsu) to determine the proximity performance of these indices using image processing algorithms. The comparison of mentioned vegetation indices showed that the highest congruence ranking had been statistically obtained for the ExG and TGI indices at the estimations of the canopy areas according to the vegetative index. While both the ExG and TGI indices presented more proximities to the reference point (mean pixel values obtained by using ImageJ software), ExG-ExR and G% indices showed worse proximity performances to the referred mean pixel values obtained by using ImageJ software. According to the results, both ExG and TGI indices showed reliable separability and can be preferred for green canopy area estimation in image sensing systems.

Keywords: canopy area, image processing, precision agriculture, vegetative index

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OP-51. Development of an Autonomous Mobile Robot Prototype for Agricultural Tasks in Greenhouses

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Robots can work more effectively and flawlessly than humans. Also, working with them are reducing the occupational health and safety hazards in all areas. Because of these advantages robotic technology is gaining more popularity in all areas. One of these areas is the usage of robots for agricultural operations. Robotic Application in Agricultural Tasks is an interdisciplinary research area, relating robotics, electronics, software and agriculture. In this study, an autonomous mobile robot prototype was developed that can perform for some agricultural tasks in modern greenhouses. It was designed to drive both on hot water piping rails and concrete floor. Mobile robot prototype has a total of 8 wheels. Four of them are mecanum, and the others are pipe wheels. The mecanum wheels enable the mobile robot to move on the concrete floor. Besides, the pipe wheels enable the mobile robot to move on the hot water pipe lines installed between rows. Mobile robot can work both autonomously or user-controlled. Mecanum wheels advantage is to move in any direction in any angle. With the advantage of the wheels' omnidirectional motion, 10 main controlling moves have been developed for mobile robot platform. These are left, left-front, front, right-front, right, right-rear, rear, left-rear, clockwise turn and counter clockwise turn. The mobile robot platform can be controlled both by wireless keyboard or bluetooth mouse. Mobile robot system has 4 Brushed DC motors and 2 DC motor drivers. Each motor can be controlled independently. DC motors are powered by 2 series-connected 12V 72AH batteries. This robot has 2 controllers, the main controller is a PC and the other is an Arduino UNO. Mobile robot has 4 IR distance sensors and 2 limit switches to detect obstacles. Sensors are connected to Arduino UNO and Arduino UNO sends sensors data to the PC. Both PC and Arduino UNO can receive and send data. Also an IMU (Inertial Measurement Unit) sensor has been used to determine the orientation of the mobile robot. An algorithm has been developed to rotate to a saved orientation position. A GUI (Graphical User Interface) has been developed to monitor the sensors' and mobile robot's situation. This GUI is developed in Visual C# programming language. Autonomous or manual control can be selected from the GUI. In autonomous mode user can determine the row number. An ULV (Ultra-Low-Volume) sprayer powered by an electric motor can be equipped to the mobile robot. ULV spraying unit has 1200W AC motor so an 2000W inverter has been used to power the ULV from battery. Also, a platform made from sheet iron hat has 52 cm x 74 cm (width x length) can be mounted on the chasis for different operations. This platform can carry some loads such as plastic fruit crates with harvested produce inside. In the trials the ULV sprayer was worked, and four plastic fruit crates that has loaded with 40 kg has been successfully carried with mobile robot.

Keywords: Greenhouse Robot, Modern Greenhouse, Mecanum Wheels, ULV Sprayers

OP-52. Investigation of the Compliance of the Milking Routine and Pulsator's Working Characteristics to the Milking Technique in Some Dairy Cattle Farms in Isparta Province

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The number of dairy cows in Turkey increased from approximately 5 million to 7 million, while annual raw milk production rose from 8.7 million tons to 21.8 million tons between 2000 and 2020. However, despite these improvements, the average milk yield per cow still falls below the optimal levels. Improving the milking routine and ensuring that milking machines meet standardised technical parameters can further enhance the average lactation yield. Enhancing the milking routine and aligning the technical parameters of milking systems with standards can increase the average yield per cow from the current 3500-4000 liters per year to 5000-6000 kg per year, representing a 25-30% increase in efficiency. The study was carried out in the Isparta province, involving 20 carefully selected dairy farms using purposive stratified sampling. The evaluation of the milking system components was based on pulsatron tests conducted on pulsation devices. Additionally, the adherence of milkers to milking routine regulations in machine milking was determined through the stopwatch method, relying on the work and time study technique. The objective of this study was to assess the adherence of milking machine settings and milking routine to internationally established standards (ISO standards), with the shared aim of improving udder health, milk yield, and quality. In this study, the evaluation of milking machine settings and milking routine was conducted based on internationally recognized ISO standards, specifically ISO 5707, ISO 6690 and ISO 3918, which specifically pertain to milking machines. The findings of this study demonstrate that the use of properly adjusted milking machines in conjunction with appropriate milking routines significantly increases the quantity and quality of milk that can be obtained per cow. This research aims to provide dairy farm owners with insights into the conformity of milking facilities and equipment with defined international standards, as well as to inform them about the correct and comprehensive implementation of milking machine settings and milking routines required to achieve optimal milk yield and quality.

Keywords: Milking machines, milking routine, udder health, milk yield, milk quality.

OP-53. Design Approaches of One-Pass Strip-Till Machines

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All over the world and in our country, the increasing awareness on the conservation of soil and water resources, together with the demands of reducing production costs, made it necessary for researchers to turn to alternative production ways in agriculture. As a result of these searches, it has been revealed that conservation tillage methods should become widespread as an alternative to traditional tillage method, where field traffic and fuel consumption are high, and environmental effects such as carbon emissions, soil degradation and air pollution are the most negative. Despite years of research and government support, no-tillage, which is one of the sustainable agricultural practices and applied on an area of approximately 200 million hectares in the world, has unfortunately not been adopted in Türkiye. Strip-tillage, which creates a soil environment that enhances seed germination, is a new alternative to no-tillage in areas where poorly drained soils are dominant. In this context, the strip tillage and sowing method, which is one of the conservation tillage methods, is a combination of traditional and no-tillage methods and will provide both environmental and economic benefits by saving time, labour and fuel as an alternative to the traditional method. Where soil moisture conditions are suitable, strip-tillage creates narrow-width tilled strips, traditionally in the fall, to increase early spring soil evaporation and soil temperature in the top 5 cm of the soil. When the previous studies on sowing with strip tillage are examined, it is seen that it is frequently applied in countries where agriculture is developed in the world, but there is not enough research and application area in Türkiye. In countries where agriculture is developed, it is seen that the strip tillage and sowing method is applied as a combination of two separate machines in a one-pass (tillage and sowing). In the studies carried out in Türkiye (strip tillage and sowing), it is applied separately in two stages. Both sowing application and strip-tillage can be performed in one pass. The basic requirements for strip-tillage to be effective are accuracy in matching tillage equipment on the tool bar with the planter and placement of seeds in the tilled zones. In this study, an in-row of pneumatic precision planter, mounted on a single chassis that will reduce the field traffic to a one-pass, is designed and simulated.

Keywords: Strip tillage, Conservation tillage, Sustainable agriculture

OP-54. Examination of the Farm Machinery Tests Based on The Testing Institutes and Machinery Producers in Türkiye

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Agricultural machinery tests are arranged within the framework of regulations as the 182 machine tests by the Ministry of Agriculture and Forestry in Türkiye. *Machine tests are optional; and authorization of testing institutes, machinery tests, and reporting processes are carried out by the Ministry. Agricultural machinery tests are carried out in a total of 19 test institutions, 5 of which are in the Ministry Institutions and 14 of which are in the Agricultural Machinery/Biosystem Engineering Departments of Agricultural Faculties. Within the scope of this research, the data in the machinery test report files and the authorized test institution files on the official website of the Ministry were examined. Analyzed data belongs to the last 5 years.* In this context, test reports of the farm machinery were evaluated concerning province and firms, category of agricultural activities, and expertise area of the test institutions. *Database analysis methods, scatter charts, and geographical concentration visuals were used to interpret the data. According to the results obtained; a total of test institutions issued 7588 test reports. The institution that issued the highest number of test reports was TAMTEST, an affiliate of the Ministry, with a total of 2171. As a testing organization affiliated with the Ministry of Agriculture; the total number of test reports prepared by TAMTEST, Söke Agricultural Extension, and Training Center, and 3 Agricultural Research Institutes (Adana Eastern Mediterranean, Konya Soil-Water and Desertification, Tekirdağ Viticulture) is 2862. 62.3% of the remaining experiments were conducted by 14 universities authorized by the Ministry.*

Keywords: *Agricultural Machinery Tests, Test Reports, Test Institutions, Manufacturers*

OP-55. Fine-Tuning Growth Conditions: Leaf-Level Vapor Pressure Deficit Control for Optimized Photosynthesis

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The optimization of plant growth conditions plays a crucial role in enhancing photosynthetic efficiency, which ultimately impacts crop productivity and resource utilization. Among various environmental factors, vapor pressure deficit (VPD) has gained considerable attention due to its significant influence on stomatal conductance and water loss in plants. This paper presents a comprehensive study on the fine-tuning of growth conditions through precise control of leaf-level VPD to optimize photosynthesis. To investigate the difference between constant relative humidity condition and constant leaf-level VPD, a series of controlled experiments were conducted. Humidifier, air conditioning and exhaust fan were used to control relative humidity, thus VPD. For the first experiment, temperature and relative humidity were set to 21 ± 1°C and 65 ± 5%, respectively. For the second experiment, temperature and VPD were set to 21 ± 1°C and 1.2 ± 0.2 kPa. Relative humidity was changed according to calculated VPD value.

Under controlled leaf-level VPD conditions, a distinct optimization of photosynthesis, with a notable increase in biomass production and overall plant quality were observed, highlighting the significance of precise control over this environmental parameter. Experiments indicated that VPD control affects stomatal regulation, leading to improved water-use efficiency and reduced water loss. These findings emphasize the potential of optimizing growth conditions through VPD control to achieve sustainable water management and resource conservation in agricultural systems. Based on the obtained results, we propose practical strategies for implementing leaf-level VPD control in controlled environment agricultural practices. By fine-tuning growth conditions to maintain an optimal VPD range, farmers and researchers can optimize photosynthetic efficiency, reduce water consumption, and enhance crop productivity. This approach has the potential to address the challenges posed by climate change and limited water resources while ensuring sustainable and efficient agricultural production.

In conclusion, this paper highlights the importance of leaf-level VPD control for optimizing photosynthesis and improving resource utilization in plant growth. The findings contribute to the understanding of plant-environment interactions and offer valuable insights for agricultural practices aimed at achieving sustainable and efficient crop production.

Keywords: Vapor Pressure Deficit, Photosynthesis, Stomatal Conductance, Transpiration, Environmental Control, Water-use Efficiency, Agricultural Productivity.

OP-56. The Relationship Between CO_2 Emissions and Soil Moisture Content Under Different Tillage Methods in Cotton Farming

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In this study, soil moisture was instantaneously detected using the LICOR 8100 - 202 Model Soil Moisture Sensor under field conditions. Soil moisture measurements with the sensor were conducted in the 0-20 cm top layer of the soil. The moisture measurements were carried out simultaneously with CO_2 emission measurements. Soil moisture measurements were performed using the gravimetric method on soil samples taken from the same depth. In a study investigating irrigation and different soil tillage methods, it was noted that CO_2 emissions increased in all cases after irrigation compared to before irrigation. This was attributed to the increased soil moisture and the consequent increase in physical and biological activities in the soil. Similarly, in this study, changes in soil moisture also affected the amounts of CO_2 emissions. The changes in soil moisture had an impact on the amounts of CO_2 emissions in the conducted study, and this interaction generally occurred in an inverse relationship. CO_2 measurements taken one day after irrigation showed a decrease in emission levels, followed by a rapid increase in subsequent periods. It is estimated that the reason for this is the cream layer formed at the measurement point by irrigation. The results obtained from previous studies are consistent with the findings of this study. In order to determine the effects of different soil tillage methods on CO_2 emissions, all measurements were repeated immediately after agricultural practices during cultivation. As a result, it was determined that the emission levels increased on days when soil tillage was performed. However, a different situation emerged in irrigation. After irrigation conducted on May 31, 2016, and August 1, 2016, there was a sudden increase in CO_2 emission levels. Conversely, a sudden decrease was observed in measurements immediately after irrigation starting from August 25, 2016. This situation is thought to be a result of the impermeable layer formed at the measurement point due to irrigation, as indicated in the literature.

Keywords: Soil tillage, CO_2 emission, soil moisture, irrigation, soil properties.

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OP-57. Chopper System for In-line Small Square Balers

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A small square baler is a piece of machinery used to compact, compress, and cut hay and other materials into square-shaped bales. These machines are usually pulled from the side of the tractor by the tractor and driven from the tractor PTO. These machines, which move next to the tractor, occupy a larger area in the field. In this project, a chopper system will be designed for in-line small square balers that will work center of the tractor track width.

Chopper is a shredding system used to cut stem part of the grass into smaller pieces that has been harvested and spread on the field. The farmers prefer the bale system with chopper, stating that the small grass is eaten more easily by the animal. In-line small square balers with chopper system is used to produce bales with small grain sizes, while reducing time and labor costs during the feed preparation stage.

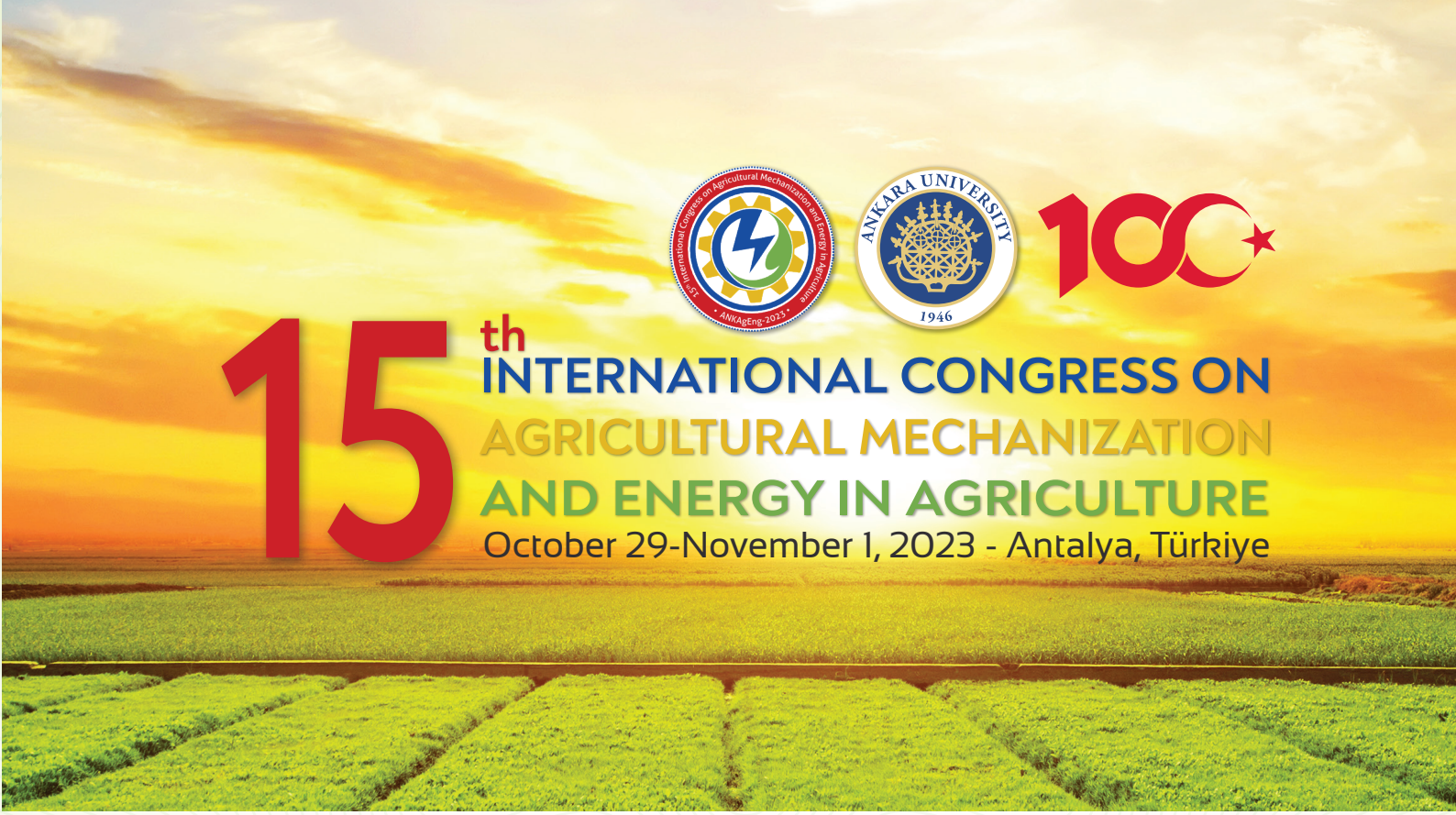
At regular small square balers, prong system which sends the grass to the bale chamber, carries the grass to the bale chamber by dragging it from the side, the gearbox works slower (output speed = 92 rpm), at in-line small square balers, the fork system will work faster (102 rpm) as it will work together with the rotor. This will reduce unit costs by producing approximately 10% more products at the same power value.

In the developed in-line small square baler, there is a movable counter under the rotor that can be opened and closed with hydraulic drive when necessary, enabling working with or without knives, and movable knives that can be removed and mounted inside the movable counter. The use of the machine with or without cutting blades is ensured by the up or down position of the blades in the moving contra. When this system is overloaded and clogged, the system is protected by a safety clutch to prevent any damage to the system.

In the system we have developed, the chopper system can be disassembled from the machine with the retracting of the pick-up system, the machine can also be used without chopper system.

With this study, in-line small square baler with chopper system design will be developed and prototype production will be made after design verification studies. In-line small square baler with chopper system is not available in the national or international market. This machine, which will be developed by Paksan Makina R&D Center, is an innovation for our country and the world.

Keywords: Square Baler, Chopper



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Poster Presentations

PP-01. A Method for Multispectral Images Alignment at Different Heights on the Crop

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Image recording is the geometric alignment of two or more images of the same scene taken at different times, from different points of view, and/or different sensors. In precision agriculture at short distances, automatic image recording is required for applications involving real-time monitoring and/or quick system response; it is usually conducted by using either area-based methods (comparing and matching the images to a reference image without detecting features) or feature-based methods (where the image recording process relies on detecting the same control points in the images and in the reference image). The result is a hyperspectral image hypercube where the pixels are precisely aligned as required in order to calculate some crop status indices in applications related to precision agriculture. The automatic image recording capability of a system using multispectral images is extremely important in order to ensure the accuracy of the collected data; moreover, due to the different arrangements occurring in precision agriculture remote sensing, usually using images taken from far distances, the image misalignment is minimal and not taken into consideration. However, an approach allowing to align images is required when images are taken at short distances, but it is currently lacking in the literature even if it is required in order to obtain accurate crop health status indices.

This research focuses on the preliminary development of a practical method for the automatic image recording to be used in precision agriculture, using a system of near-crop multispectral images aiming at plant health monitoring in the framework of precision agriculture and smart technologies for the application of agrochemicals and the use of smart technologies towards a sustainable "zero pollution" in agriculture. High-resolution multispectral cameras suffer from height-related image misalignment and/or distortion and, for this reason, the purpose of the work is the development of an approach allowing for high-precision image recording in working conditions, that necessarily must also consider the measure of the variable height between the multispectral sensor and the measured target object due to the images misalignment. Hence, preliminary, a low-cost distance sensor has been developed, tested and validated, using a diode distance sensor managed by an Arduino-Nano board that afterwards could allow for the development of an IoT sensor. The image recording method is implemented by creating a transformation matrix in order to fully minimise the error in the alignment of images captured close to the target object. The validation at different heights allows for the construction of a table that is then suitable to be used on a low calculation speed system (e.g. a Raspberry) in order to align the images retrieved from the multispectral system. This allows for the on-fly calculation of the common indices evaluating the crop status from the images taken in real-time, thereby speeding up the overall system response and performance. The image recording process has been carried out using Matlab®, with the aid of the Image Processing Toolbox and the Hyperspectral Imaging Library, through a multiscale 2D feature detection algorithm from a scale space constructed using nonlinear diffusion algorithms by non-rigid transformations. The results of the experiment have shown that the proposed methodology is performant with regard to the problem of short-distance multispectral image registration; therefore, it could be used in practical applications related to precision agriculture monitoring of crop health status.

Keywords: Image alignment, Multispectral image, Image processing, Precision agriculture, Crop health status, Variable height.

PP-02. Novel SERS Framework for Sulphur Quality Analysis of Pulse Protein

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An inherent shortage of sulphur-containing amino acids is one obstacle to increasing the incorporation of pulses, which are otherwise nutritionally rich, into food products. Worldwide depletion of sulphur in agricultural soil and the limited availability of sulphur-containing fertilizers reduce the presence of sulphur amino acids in pulses. In addition, efforts to decrease emissions from burning fossil fuels have the paradoxical effect of reducing sulphur nutrition to pulses available from the fixation of atmospheric H_2S, and SO_2 gases. Given the difference in sulphur amino acids between plant and animal proteins, there are nutritional implications to the broad adoption of plant-based meat products. Conventional analysis methods that detect sulphur amino acids in pulses, such as high-performance liquid chromatography (HPLC) and mass spectroscopy (MS) are time-consuming, expensive, and lack portability. Moreover, these methods require hydrolysis, which can be insensitive to pre-existing cysteine oxidation in the samples. This can be problematic as proteins are highly susceptible to oxidative reactions, which have dire consequences such as a loss of essential nutrients. Furthermore, legacy analysis techniques lack specificity and cannot unambiguously identify sulphur amino acids. As a result, there is a need for feasible, rapid, and reliable testing platforms to improve the detection of sulphur amino acids in pulses. This study proposes a novel approach to analyzing macro- and micro-nutritional components of pulse proteins, specifically addressing sulphur amino acids, by utilizing Surface-Enhanced Raman Scattering (SERS). The method overcomes the limitations of conventional methods and is extended to alkaline extracts of pea (*Pisum sativum*) and microfluidics, creating new methods to analyze pulse proteins, based on the attraction and affinity of cysteine for the noble metals comprising SERS substrates. Simulated physiologically-relevant low levels of sulphur amino acids and actual pulse protein extract from 10 genetic lineages of peas were introduced to printed paper SERS substrates (P-SERS) and to a colloidal solution (Metrohm AG, Herisau, Switzerland). A microfluidic chip was designed to accommodate the SERS substrate and ensure efficient utilization of small aliquots of the pea protein isolate and colloid solution. A Raman system with a 786 nm laser was used to acquire data. SERS spectral signatures specific to cysteine were detectable at concentrations as low as 10 ppm (mixed with high concentrations of amino acids that do not contain sulphur). Samples without cysteine or cysteine residues in proteins were distinguishable. Disulphide bridges blocked the binding of amino acids or proteins to the noble metal substrate. A reducing reagent, Tris(2-carboxyethyl) phosphine hydrochloride (TCEP) was used to disrupt disulphide bonds and restore binding to gold and silver nanoparticles (~100 nm size).

This study proposes a novel approach to analyzing pulse protein components, specifically sulphur amino acids, using Surface-Enhanced Raman Scattering (SERS). The method overcomes the limitations of conventional methods and is extended to alkaline extracts of pea (*Pisum sativum*) and microfluidics, creating new methods to analyze pulse protein quality. The outcomes of this research have the potential to benefit the pulse protein industry by facilitating rapid screening methods for selecting pulse cultivars with improved protein quality, promoting sustainable protein production, and bridging the gap between breeding programs and end-use quality. The proposed method would allow for the rapid determination of levels of sulphur amino acids in peas, which could aid traditional breeding methods by enabling quick testing of phenotype and genetic selection of pulse varieties with higher sulphur amino acid levels for further propagation. Further research on the application of SERS in analyzing other macro- and micro- nutritional components of pulse protein could lead to more effective methods for improving the quality and nutritional value of pulses.

Keywords: SERS, pulse proteins, pea, sulphur amino acids

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PP-03. Convective Drying of Black Chokeberries (*A. Melanocarpa*) by Different Pretreatments

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Aronia is named as a super fruit due to its high quantum of antioxidants, it's one of the fruits with the loftiest Oxygen Radical Absorbance Capacity (ORAC) value and has come popular among berry fruits in recent times. Research continues its use in numerous different fields and forms. In this study, the drying curves, color changes and bioactive composites parcels of aronia were delved at three different drying temperatures (60, 70 and 80°C) and1.5m.s^{-1} constant air velocity by applying ten different pretreatments. All pretreatment drying was completed in the longest time at 60°C and the shortest time at 80°C, lasting 1125 and 405 min, independently. In drying carried out at 80°C, the "PH" (potassium hydroxide) pretreatment operation was the most effective in syncopating the drying time. In the color measures made, the C* value gave the loftiest values in the "PSB" (pure sodium bicarbonate) pre-treatment operation at 80°C, and the h and ΔE values at 60°C in the "NP" (non-pretreatment) pretreatment operation. While anthocyanin and total phenol values dropped in all samples dried by applying different pretreatment, the "PPC" (pure potassium carbonate) – "PH" (Potassium hydroxide) values were the highest and the "SC" (sodium carbonate) – "SH" (sodium hydroxide) – "HW" (hot water) – "CSB" (marketable sodium bicarbonate) – "PSB" (pure sodium bicarbonate) boluses increased in terms of antioxidant exertion compared to the fresh samples.

Keywords: Aronia, conventional drying, pre-treatment

PP-4. Studying the Effect of Surface and Geometry Manipulation on Dew Condensation and Rain Collection in Boreal Field Conditions

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Ongoing global warming and climate change have led to changes in all components of water cycles resulting in a negative effect on both the scale and frequency of climate-related risks and human systems (negative impacts on food production and human wellbeing). Dew formation can be economically viable for the purpose of small scale agricultural in some water-stressed areas, such as the coastal regions of northern and east Africa and the Arabian Peninsula (yearly dew yield of 100 l/m^2). However, due to the low water collection capabilities of Passive Dew Collectors (PDC), they have been less studied. Improving the dew collections capabilities of PDC can bring these low-cost solutions to arid/semi-arid areas to revert and manage the negative impacts of agricultural and ecological droughts trends on a local scale. Examining the effect of surface and geometry manipulation on dew harvesting and rain collection capabilities of PDC in field conditions. Four PDCs (Standard, Sandblasted, Wire and Ridge) with white polyvinyl chloride (PVC) film, an area of 0.97 m^2 were placed alongside each other in the open field facing west on the Viikki campus, the University of Helsinki, Finland (60°13'36'' N, 25° 1'8'' E, 5 m.a.s.l) between Jun-Oct of 2021 and 2022. All panels of PVC films were insulated with 25 mm thick polystyrene and inclined 30° from horizontal; untreated PVC film (Standard panel) was used as a reference PDC. Other panels experimented with surface manipulation in form of increasing the surface roughness through sandblasting (Sandblasted panel), geometry manipulation in the form of bending the film into ridge and valley to form sharp edges (Ridge panel) and adding cotton wire to untreated PVC film surface to assist the droplet transportation through capillary action (Wire panel). A detailed comparison between the PDC's dew and rain collection capabilities was made through studying the measured parameters of relative humidity, surface and air temperature, air velocity, and dew deposition. The process of droplet formation and depositions of each panel was studied through time-lapse photographing a 10 cm x 10 cm area of the panels during a dew night event. Cumulative dew yield of the four tested PDCs indicates that sand blasting is the most promising method in increasing the yield of dew collection capabilities of the PDCs in field conditions. In addition, the image analysis of the dew event confirms that the rough surface, changes the droplets formation size and intensity (compared to untreated PVC foil surface). Wire panel was the most efficient in collecting rainwater; image analysis of Wire panel indicates a change in droplet intensity and size surrounding the cotton wire during a dew event, however this change did not result in cumulative dew yield increase (compared to Standard panel), however during a precipitation event, cotton wires increased the panel rainwater collection significantly. Dew harvesting capabilities of passive collectors in field condition can be altered through surface manipulation in forms of sandblasting and increasing the surface roughness; this improvement is achieved through changes in droplets formation, size and intensity on rough surface that leads to faster droplet recovery compared to standard surface. Rainwater collection can also be improved through use of cotton wires and capillary action.

Keywords: Passive Dew collection, Rain collector, Dew

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PP-05. Analysis of Factors Affecting Farmers' Intention to Use Autonomous Ground Vehicles

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In recent years, many efforts have been made to increase the automation of farming production systems, i.e., tilling, sowing, and weeding. New autonomous ground vehicles (AGV) for the agricultural context have been developed to support farmers and automate farming processes. Manufacturers of agricultural machines are developing a wide range of AGV with different functions and dimensions moving towards the use of electric engines and high-efficient machines. In fact, AGV are promising technologies that could mark a new agriculture characterized by automatic and autonomous systems. Although there has been a high advancement of AGV, this technology is not yet widespread on farms. Several factors affect farmers' willingness to adopt an autonomous ground vehicle. Thus, this study aims to investigate factors influencing farmers' intentions to use AGV in agricultural activities.

Based on previous studies that examine technology acceptance in the farming context a model was developed. Starting from the original technology acceptance model (TAM) an extended version of the TAM was used. The TAM main factors such as perceived usefulness, perceived ease of use, and attitude toward the use of technology were modeled and extended including the attitude of confidence, personal innovativeness, job relevance, and perceived net benefit. The data were collected with an online survey submitted to Italian and Lebanese farmers. Survey answers were analyzed using partial least square-structural equation modeling (PLS-SEM). The PLS-SEM multivariate statistical analysis allows to verify the reliability and validity of the measurement model and explore the relationship between the factors of the model.

The results of the measurement model indicated that all variables were valid except for the attitude of confidence. The results of the structural analysis showed that personal innovativeness had a positive effect on perceived ease of use, whereas job relevance and perceived ease of use had a positive effect on perceived usefulness that positively influenced attitude toward the use of AGV and perceived net benefit. It was also determined that attitude and perceived net benefit had a positive effect on the farmers' intention to use AGV for on-field activities. Finally, the model outcomes underlined that neither farm size nor farmers' education level had an influence on their intention to use AGV in agriculture. This study provides further information on which factors influence the diffusion of autonomous machines, such as AGV, that can support the farmers' activities and reduce the environmental impact of the agricultural sector.

Keywords: technology acceptance model, partial-least-squares, SEM, farmers intention, unmanned operation

PP-06. Uncertain Future Menemen Plain Integrated Management of Agriculture and Nature Based Solutions for Sustainable Soil Management

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Agricultural production is under the influence of many components. Economic factors, climate, ecology, state of natural resources and socio-economic structure are among these components. For sustainable agriculture, the NEXUS between water, ecosystem and food needs to be well defined and improved. In this study, learning and joint action alliances were formed by bringing together the agricultural components of the Menemen Plain. During the project, cooperation between agricultural stakeholders was developed and all actors of agriculture were included in the process. In the study, it was observed that the interaction between institutions was very weak and they did not have much information about other institutions. In the survey conducted with stakeholders to analyze the agricultural activities the region, water scarcity emerged as the biggest problem. In a separate survey conducted with agricultural producers, it was seen that the producers were not satisfied with the new irrigation planning and irrigation union activities implemented due to drought.

This project focused on water allocation and adaptation to climate change, which are the main problems in the region. In the project, the physical and chemical properties of the soil were determined by dividing the Menemen plain into 1x1 km grids and soil sampling from 3 different depths. The risky areas that will be most affected by climate change were determined and planning and solutions were presented for these areas. By preparing the productivity maps of the Menemen plain, preliminary information about soil fertility was produced for the producers and a plant nutrition program was proposed. Land suitability maps were prepared with GIS software and evaluations were made for plants of importance in the region. In this evaluation, it is seen that 90% of the areas are suitable for agricultural activities, but it is predicted that there will be problems in agricultural production in the future due to other limiting factors.

Moreover, in order to improve the agricultural activities and natural resources in the plain, nature-based solutions were developed and training and field days were organized in order to disseminate these activities in the region with exemplary practices. Dissemination of microbial fertilizers, reduction of chemical fertilizers, inclusion of winter legumes in the planting system and intermediate agriculture are among the main ones. Although regenerative agriculture does not stand out in terms of productivity in agricultural production, it is an important alternative for the improvement of risky areas. Due to the increase in population in recent years, the pressure on agricultural areas is increasing. It has been observed that agricultural enterprises and warehousing activities have a significant share in this, followed by small structures built for the gardening. It is predicted that there will be significant decreases in agricultural production of the Menemen Plain, with the decrease in agricultural areas, especially water scarcity due to climate change. With the project, it is aimed to raise awareness of agricultural stakeholders in the Menemen Plain, to protect agricultural lands, to guide decision makers correctly, and to reveal urgent new action plans for sustainability. The protection of the plains, which is the main and biggest source of agricultural production, has strategic importance for our country in terms of food security.

Keywords: NEXUS, Menemen Plain, Soil fertility, Sustainability

PP-07. Investigation of the Performance of a Pneumatic Hazelnut Harvester with Husker Unit Used in Türkiye

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Türkiye is the leader country in the World in hazelnut production. The most important cost factors in hazelnut cultivation are cultural and harvesting-husking operations. If it is done with human labor, harvesting costs constitute approximately half of the income. Mechanization applications are almost scarce in harvesting processes in Türkiye. Considering the difficulties in recruiting workers in recent years, the mechanization issue becomes even more important. Increase in demand for human labor necessitated the increase in the rate of mechanization in order to reduce the harvesting costs. In addition to the scientific studies that have been going on for the last 30-35 years; along with imported hazelnut harvesting machines and machines with mechanical and pneumatic collecting units manufactured by local manufacturers, machines that perform harvesting and husking processes at the same time have started to be used especially in flat and near-flat areas.

In this study, it was aimed to determine the performance of a combined hazelnut harvester-husker with a pneumatic collection unit in two different garden conditions (flat and slope) with linear planting system. According to the results, work efficiency, harvesting efficiency, filled-nut husking efficiency and husk-separation efficiency values were found higher in flat garden conditions than sloping garden conditions. Kernel losses, damaged-nut ratio and values increased with the moist of the garden in sloping garden conditions, uneven fruit distribution and feeding rates.

Keywords: Mechanical harvest, hazelnut, work efficiency, harvesting efficiency, husking efficiency

PP-08. Transmission Raman Spectroscopy for Inner Layers Chemical Analysis of Fresh Produce

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We show the development of transmission Raman spectroscopy system and analysis techniques for identification of chemical properties at the inner tissues of fresh produce. Successful chemical analysis of inner tissues would enable us to identify major issues plaguing the agriculture supply chain like off-flavors and core-rot, since these are caused by or accompanied by known chemical elements. Current common non-destructive spectroscopic techniques rely on IR or near IR wavelengths that cannot penetrate very deep into the produce tissues, and therefore their interpretation relies on the existence of some biological mechanism that will manifest the properties of the inner layers outwards onto the surface. Our method consists of locating an optimal spectral window, and using the strongest possible LASER source in that range. The strong source power and large measured volume compensate for the weak 2nd order interaction strength, and so a signal of sufficient strength is measured. The goal of quantifying every spectral component is hindered by the lack of a chromatography step which usually accompanies analysis with mass spectroscopy / IR. This is compensated by using a convolution neural network trained with a mixture of image, synthetic spectroscopic, and measured spectroscopic datasets on the complex spectra in order to quantify their components.

Keywords: Raman spectroscopy, Post-harvest, neural network

PP-09. Hyperbaric Inactivation – a New Pressure-Based Method to Inactivate *Bacillus subtilis* Endospores at Room Temperature?

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Hyperbaric inactivation (HI) is a nonthermal, low pressure-based processing methodology that makes use of moderate hydrostatic pressures (up to 250 MPa) for long dwell times (hours to days) to achieve pasteurization standards in heat and pressure-sensible foods. Recently, this methodology has shown great potential to not only inactivate vegetative microorganisms but also bacterial spores, which are highly resistant either to conventional thermal pasteurization or high-pressure processing, being required temperatures above 100 ºC for several minutes to inactivate them. Considering the importance of bacterial spores for both food safety and shelf-life, it is of upmost importance to evaluate the feasibility of this methodology for endospore inactivation in a range of pH-values important for food safety. The present work aimed evaluating the potential of HI to destroy *Bacillus subtilis* endospores, and the dependence of pH and nutrient-availability for endospore inactivation, and the inherent kinetic parameters. To do so, *B. subtilis* endospores were inoculated in nutrient-free McIlvaine buffer and Brain-heart infusion broth at three different pH levels (4.50, 6.00 and 7.50) and kept under hyperbaric inactivation (150, 200 and 250 MPa) up to 7 days at uncontrolled room temperature (18-25 ºC). The results demonstrated a clear dependence of nutrient-availability and pH upon endospore inactivation under HI conditions, which allowed to fit both linear and non-linear (Weibull, Log-logistic and Biphasic) kinetic models frequently used to describe endospore inactivation patterns. Lower pH values hindered endospore inactivation at 150 MPa, even in the presence of nutrients, which could be surpassed at and above 200 MPa. Additionally, the presence of nutrients accelerated endospore inactivation, which ultimately impacted the inactivation kinetic parameters. Curiously, a pressure increase from 200 to 250 MPa did not accelerate endospore inactivation at both pH 6.00 and 7.50. Moreover, phase-contrast microscopy images revealed that the endospores were inactivated without reaching the vegetative state, which is an important outcome for food safety. There results show that HI can be an interesting approach for the inactivation of bacterial spores at room temperature, without applying any heat, which could be particularly interesting for heat-sensible foods and other matrices.

Keywords: Hyperbaric inactivation, *Bacillus subtilis*, endospores, germination control

PP-10. Hyperbaric Storage as a New Food Preservation Methodology to Control the Germination and Development of *Clostridium perfringens* Spores

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Clostridium perfringens is a pathogenic spore-forming bacteria commonly associated with foodborne illness. One of the significant concerns related to *C. perfringens* in food safety is its ability to form highly resistant spores termed endospores. These endospores can survive harsh conditions, such as high temperatures and low nutrient availability, making them challenging to eliminate from food products, being prevalent in pasteurized foods[2]. To temporarily delay endospores' germination and development, refrigeration is the most used strategy, yet with considerable energetic costs associated. Hyperbaric storage (HS) is a novel food preservation technique that controls storage pressure and temperature, aiming to inhibit microbial growth similarly to the conventional refrigeration processes. HS offers several advantages over refrigeration, particularly when applied at uncontrolled room temperatures (RT). This study focuses on evaluating the potential of HS in inhibiting the development of pathogenic microorganism *Clostridium perfringens*' endospores and comparing it with the conventional refrigeration. To do so, *C. perfringens* spores were inoculated in brain-heart infusion (BHI) broth, used as a model system, and coconut water, used as a real food product for validation. Various HS conditions were tested, ranging between 75-200 MPa, for up to 30 days at uncontrolled RT. Control samples at atmospheric pressure and refrigerated at 4 ºC were also evaluated. The enumeration of endospores was conducted by spread plating in BHI-agar, which were incubated anaerobically at 37 ºC for 24 hours. To assess the thermal-resistant fraction, a portion of each sample was heat-treated at 70 ºC for 10 minutes, followed by plating and incubation under the aforementioned conditions. The results revealed that HS/RT effectively inhibited the germination of *C. perfringens* endospores in both BHI broth and coconut water, surpassing the performance of refrigeration. However, the efficacy of HS was found to be pH-dependent, particularly in the case of BHI broth. In coconut water, HS led to a significant reduction of endospores by up to 3-log units after 30 days, regardless of the storage pressure. Conversely, minor reductions of approximately 1-log unit were observed in BHI-broth. Furthermore, HS did not sensitize the endospores to heat treatment, as minor variations in the thermal-resistant fraction were observed for both BHI broth and coconut water. In conclusion, HS/RT demonstrated the ability to prevent the development of *C. perfringens* endospores in a model system (BHI-broth), and this finding was furtherly validated in highly perishable coconut water. Moreover, HS exhibited the potential for inactivating *C. perfringens* spores during storage, particularly in coconut water. The use of HS as a tool for inactivating bacterial spores holds great potential for ensuring food safety.

Keywords: Hyperbaric storage, *Clostridium perfringens*, endospores, germination control

PP-11. Applying Nature-Inspired Optimization and Machine Learning for Strawberry Leaf Scorch Detection and Classification

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The use of image processing and artificial intelligence in agriculture is one of the most widely used issues in the field of plant disease recognition. Therefore, extensive research has been done in the field of plant pathology. However, the designed algorithms have a great diversity in terms of structure and components. The result of this structure is effective in speeding up the diagnosis process and the level of diagnosis accuracy. Therefore, the use of new and combined methods that increase the accuracy of diagnosis are important. Feature selection is one of the methods that removes additional data in feature extraction stages and presents the most important and best extracted features for disease diagnosis. Various algorithms are used for feature selection, but the use of feature extraction methods inspired by nature, including Whale algorithm, is one of them. In this research, image processing and machine learning were used to diagnose leaf scorch disease in strawberry plants. For this purpose, after extracting texture, color and shape (GLCM, Color Moment and Zernike), k-Nearest Neighbor (k-NN) was used for classification. Then, to present the best extracted features, Whale feature selection algorithm was used. The results for classification and recognition with k-NN and Whale feature selection algorithm were 99.04 and 96.49%, respectively. Also, five important features for diagnosing leaf scorch disease in strawberry plants were introduced to the researchers. The results showed that the method presented in this research has a good potential in diagnosing and classifying plant diseases.

Keywords: Artificial Intelligence; Image Processing; Plant Disease Detection; Whale Feature Selection

PP-12. The influence of combustion temperature on the emission of pollutants in a low-power wood biomass boiler

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In Poland, the heating sector of households and single-family buildings is responsible for the largest emissions of pollutants. They usually use outdated and high-emission designs of feed boilers or modern and automated solutions using standardized and homogeneous fuel. Users living in villages and smaller towns have access to cheap woody biomass obtained as a result of phytosanitary cleaning of orchards and bushes. However, burning such fuel is problematic and generates high atmospheric pollution, especially with carbon oxides.

Work was undertaken to develop a low-emission boiler using heterogeneous woody biomass fuel. High combustion temperature (>700-800°C), low fuel moisture, good mixing of air with wood gas and an appropriately long residence time in the wood gas combustion zone help reduce pollutant emissions.

The paper presents the results of testing NOx and CO emissions and efficiency in a low-power solid fuel boiler with a high-temperature combustion chamber. A combustion chamber model was used with electrically powered heating spirals built inside, which heated the surrounding space in individual combustion phases. The fuel used for the tests was birch wood and heterogeneous coniferous wood chips with varying moisture content. The material was poured into a large fuel chamber, where intensive gasification took place and the resulting wood gas flowed into the combustion chamber and mixed with the supplied heated secondary air. The combustion process took place in several phases, which were characterized by different demand for primary and secondary air, which translated into the content of pollutants in the exhaust gases. The emission of CO, NOx, combustion temperatures inside the chamber and the efficiency of the process during the ignition, proper combustion and after-combustion phases were examined with and without preheating the combustion chamber.

The test results ranged from 200mg/m3 of CO to over 5000mg/m3. The content of nitrogen oxides NOx did not exceed 200 ppm and the combustion temperature reached up to 1000°C. The best results were obtained by burning birch wood with a moisture content of 17%. Research also shows that heating the combustion chamber using electric heating spirals reduces pollutant emissions, especially in the initial phase of combustion. However, this method is very susceptible to the destructive effects of exhaust gases and periodic temperature changes.

Keywords: gasification, biomass boiler, secondary air, combustion temperature, combustion, air pollution

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