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Inspiring Sustainable Growth

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Botswana

RUFORUM
Capacity Building in Agriculture

PRE-AGM EVENTS- SCIENTIFIC FORUM

19th- 20th NOVEMBER 2025

ARTIFICIAL INTELLIGENCE, DATA SCIENCE, AND EMERGING TECHNOLOGIES

#RUFORUMAGM2025

Programme

AGM 2025

FORUM III

Wednesday 19th November 2025 | 8:30 - 17:00 EAT

Application of Artificial Intelligence and Emerging Technologies for Smart and Sustainable Agriculture

Registration Link: https://bit.ly/47B3z7L

Session Chair: Prof. Isa Kabenge
Rapporteurs: Dr. Mondo Mubalama, Dr. Esther Sebuliba

Time		
08:00-08:10	Welcome Remarks from the Chair: Prof Isa Kabenge	
	Topic	Presenter
08:10-08:35	Harnessing AI and emerging technologies for smart and sustainable agriculture in Africa	Keynote Speaker: Dr Opiyo Stephen
08:35-09:00	AI-Driven Metabolomic Profiling of Cannabis Beyond Cannabinoids for Predictive Chemovar Modelling and Precision Planting	Akhona Myoli
09:00-09:15	Gendered impacts of artificial intelligence-powered advisory services on farm productivity and household welfare: insight from Nigeria	Abdulrazaq K. Daudu
09:15-09:30	AgriLens AI: A Smartphone-Based Tool for Real-Time Diagnosis and Severity Scoring of Powdery Mildew in Cucurbits	Dumisa Dlamini
09:30-09:45	AI solutions enhancing Indigenous Knowledge Systems for weather forecasting and climate change mitigation and adaptation in Africa	Fabian Maunganidze
09:45-10:00	Integrating Indigenous and Scientific Knowledge Systems: Blending traditional ecological knowledge with AI-driven data for context-specific agricultural insights	Faith Musekiwa
10:10-10:15	Advancing Smallholder Market Access through AI-Powered Chatbots: Lessons from Emerging Deployments in Africa	Gills Tonono
10:15-10:30	Using low-cost drone and artificial intelligence to assess forage biomass and quality in the senegalese rangeland ecosystem.	Haftay Hailu Gebremedhn
10:30-11:30	Health Break	
10:30-11:45	Integrating Indigenous Knowledge with Emerging Technologies: AI-driven metabolomics of selected South African medicinal plants	Kgalaletso Othibeng
11:45-12:00	Harnessing artificial intelligence for global pest surveillance: applications, challenges and future directions	Kumshe I. B

12:00-12:15	From oral traditions to algorithms: translating indigenous climate knowledge into ai-enhanced agricultural decision support tools	Prince Muzuva(PhD),
12:15-12:30	Optimizing Agricultural Education Outcomes through AI-Driven Innovative Differentiated Assessment Frameworks: Exploring Pedagogical Inclusivity and Learner Diversity in Rural African Classrooms	Simon Ntumi
12:30-12:45	Infusing Gender-Responsive Indigenous and Scientific Knowledge of Food Systems in Agro-Ecological Knowledge in AI-driven Food Processing in Uganda	Wilson Okaka
12:45-13:00	Artificial Intelligence and Machine Learning in Logistics and Supply Chain Management in Africa: Opportunities, Challenges, and Future Directions	Ndirangu Ngunjiri
13:00-14:00	Health Break	
14:00-14:15	Trust harvest: A Privacy-Preserving Blockchain-Based Mobile Crowdsensing Framework for Incentivized Agricultural Data Collection in Uganda	A. M. Oguti
14:15-14:30	A framework for addressing challenges of blockchain implementation and scaling in smallholder crop value chains: insights from barley farmers in Uganda's Sebei Sub-region	Racheal Ninsiima
14:30-14:45	Application of Data Mining Algorithms for Prediction of Body Weight in Nguni Goats	Cyril Mathapo
14:45-15:00	Enhancing Climate Resilient Food Systems through Digital Twin Technology for Sustainable Agriculture in Nigeria	Benjamin Anabaraonye
15:15-15:30	Leveraging digital pathways for climate-smart agriculture: evidence from Semi-arid Zimbabwe	Bright Chisadza
15:30-15:45	Perceptions and Effectiveness of Mobile Technology Among Extension Workers in Kwara State: Implications for Digital Extension Service Delivery in Nigeria.	Olumuyiwa Akin Olaniyi
15:45-16:00	GIS-Based Fuzzy Logic SMCA for Optimal Flood Emergency Shelter Siting in Chikwawa, Malawi	Japhet Khendlo
16:00-16:30	Coffee Break	
16:30-16:45	Application of Geographic Information System (GIS) technology to monitor Peste des Petits Ruminants (PPR) Vaccine coverage in livestock in Garissa County, Kenya	Peter Muthama
16:45-17:00	Open-Source GIS-Based Monitoring of Water Body Dynamics and Irrigation Security for Climate Resilience: A Case Study of Tugwi-Mukosi Dam in Zimbabwe	Tsitsi, Prudence Humanikwa

Abstract No: 091-OP

AI-driven metabolomic profiling of cannabis beyond cannabinoids for predictive chemovar modelling and precision planting

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ABSTRACT

Artificial intelligence (AI) and digital technologies are revolutionizing agricultural practices by facilitating predictive modeling, precision planting, and resource optimization. This transformation is particularly impactful in Africa, where AI tools enhance crop monitoring, soil health assessments, and yield forecasting, supporting sustainable agriculture and food system resilience. This study assessed the integration of metabolomics and AI for predictive chemotyping and precision crop selection, using cannabis (Cannabis sativa L.) as a case study. Despite over 700 recognized cannabis varieties, chemical classification has primarily centered on cannabinoid content, neglecting a wide array of non-cannabinoid metabolites that may possess bioactivity. This oversight limits accurate chemovar classification and restricts precision planting strategies. Specifically the study aimed to (i) map the chemical space of cannabis cultivars, (ii) classify chemovars based on the chemical diversity of various plant tissues, and (iii) evaluate how these chemical profiles inform precision planting for targeted medicinal applications. Two cultivars, Amnesia Haze and Royal Dutch Cheese, were analyzed using high-resolution LC-MS/MS, generating spectral datasets processed through advanced metabolomics workflows. Results revealed a diverse metabolite profile, including flavonoids and phenylpropanoids, with distinct tissue-specific patterns that facilitated chemovar differentiation. AI models effectively classified cultivars based on metabolic fingerprints, highlighting significant anti-cancer potential linked to non-cannabinoid metabolites. This research illustrates how integrating digitalized LC-MS/MS data with AI and machine learning can enhance cultivar selection strategies, promoting precision planting aligned with desired bioactivities. The findings underscore the potential of omics sciences and AI in advancing sustainable agriculture, particularly in Africa, by fostering inclusive bioeconomies and supporting the UN Sustainable Development Goals (SDGs) related to health, innovation, and responsible production.

Keywords: Cannabis, Chemovar classification, LC-MS/MS, machine learning, metabolomics, predictive modelling, precision planting, sustainable agriculture

Abstract No: 092-OP

Gendered impacts of artificial intelligence–powered advisory services on farm productivity and household welfare in Nigeria

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ABSTRACT

Artificial intelligence (AI)–powered agricultural advisory systems are revolutionizing extension services by providing real-time, data-driven recommendations on crop management, input utilization, and market decisions. Nevertheless, gender disparities in digital access and technological adoption may influence the distribution of these benefits within farming households. This study evaluated gender-specific impacts of AI-enabled advisory platforms on agricultural productivity and household welfare in Southwest Nigeria, utilizing primary data from 588 farming households. Employing a quasi-experimental design that combines propensity score matching (PSM) with instrumental-variable regression, the research addressed biases associated with non-random participation. Productivity was quantified through yield and output value per hectare, while welfare was assessed via food security indicators, household expenditures, and asset accumulation. The findings indicate that AI advisory services substantially enhanced overall productivity and welfare; however, impacts differed by gender. Households headed by males reported higher yield gains attributable to superior access to mobile devices, credit facilities, and extension networks. Conversely, female-headed households experienced greater welfare improvements, including increased food security and more stable household expenditures. Constraints such as limited digital literacy, restricted access to technology, and unequal control over productive resources hinder women's full capacity to benefit from AI systems. Nonetheless, social networks partially mitigated these disparities by facilitating shared learning and information exchange. The study concludes that AI-enabled services have the potential to strengthen rural livelihoods but may also intensify digital inequalities in the absence of deliberate inclusion strategies. Policy initiatives should emphasize gender-responsive digital literacy programs, targeted subsidies, and equitable access to complementary inputs. Enhancing women's access to credit, land, and mobile technologies will be vital for realizing the full transformative potential of AI in agriculture.

Keywords: Artificial intelligence, Digital advisory platforms, Gender, Household welfare, Productivity

Abstract No: 093-OP

AgriLens AI: A smartphone-based tool for real-time diagnosis and severity scoring of powdery mildew in cucurbits

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ABSTRACT

This study intended to i) create a comprehensive, annotated image dataset of healthy and powdery mildew-infected cucurbit leaves under Zimbabwean field conditions; ii) train and optimize a Convolutional Neural Network (CNN) for semantic segmentation to accurately identify and delineate disease lesions from leaf images; and iii) develop an algorithm to automatically calculate a disease severity score as a percentage of the affected leaf area. An extensive image dataset was collected from cucumber and squash fields in Zimbabwe using standard smartphones. The dataset includes over 1,500 high-resolution images capturing a full spectrum of conditions: healthy leaves, various stages of powdery mildew infection (incipient, moderate, severe), and common visual confounders such as nutrient deficiencies and pest damage. Each image containing disease symptoms was carefully annotated by creating pixel-level masks that precisely outlined the infected areas. A U-Net architecture, a type of CNN ideal for biomedical image segmentation, was trained on this dataset using the Google Colab platform. The model's performance was rigorously evaluated on a held-out test set using metrics such as the Dice Coefficient and Intersection over Union (IoU) to measure the accuracy of lesion segmentation. The disease severity score was then calculated from the model's output mask. The preliminary results are highly promising, demonstrating the viability of smartphone-based disease diagnosis. The trained U-Net model can accurately segment powdery mildew lesions from complex background images, achieving a Dice Coefficient of over 0.92, indicating a very high overlap between the AI's prediction and the ground-truth annotations. The system successfully distinguishes mildew symptoms from healthy leaf tissue and other forms of leaf damage. Crucially, the model's output is used to automatically generate a quantitative severity score (e.g., "17% leaf area infected"), transforming a subjective visual assessment into an objective, actionable data point. AgriLens AI demonstrates that advanced AI tools can be deployed on accessible hardware to create powerful decision support systems for small-holder farmers. By providing instant, in-field diagnosis and objective severity scoring, this tool empowers farmers to move from a reactive to a precise, data-driven disease management strategy.

Keywords: Artificial Intelligence (AI), Disease Severity, Image Segmentation, Powdery Mildew, Precision Agriculture, Smartphone Diagnostics

Abstract No: 094-OP

AI solutions enhancing indigenous knowledge systems for weather forecasting and climate adaptation in Africa

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ABSTRACT

Indigenous Knowledge Systems (IKS) have historically supported climate forecasting, environmental stewardship, and agricultural decision-making among African communities. Traditional indicators—such as animal behavior, cloud formations, and plant phenology—have traditionally informed decisions regarding cropping schedules, water harvesting, and disaster preparedness. However, the oral transmission of IKS, in the absence of systematic documentation, jeopardizes its continuity, accuracy, and intergenerational transfer. This study identified an Artificial Intelligence (AI)-enabled approach to digitize, integrate, and operationalize IKS to enhance climate change mitigation and adaptation strategies. A comprehensive review of the existing literature was conducted to identify climate-related IKS indicators across various African nations and to evaluate their relevance in current climatic contexts. Building upon these insights, an AI architecture capable of processing images, videos, and textual data to recognize traditional indicators, interpret their significance, compare them with scientific forecasts, and disseminate localized advisories to farmers—including those with limited access to expert support is presented. Preliminary results suggest substantial untapped IKS resources that can be integrated into a dual-mode (online/offline) AI platform to support climate-informed decision-making. Such a system aims to bridge the gap between traditional ecological knowledge and modern climate science tools, thereby strengthening community resilience and facilitating local adaptation strategies. By institutionalizing IKS within AI-driven systems, this research contributes to culturally grounded, inclusive, and sustainable climate solutions for rural African populations.

Keywords: Adaptation, Artificial Intelligence, climate forecasting, Indigenous Knowledge Systems

Abstract No: 095-OP

Blending traditional ecological knowledge with AI-driven data for context-specific agricultural insights

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ABSTRACT

Sustainable poultry production faces dual challenges of optimising feed-water utilisation and controlling gastrointestinal parasitism without overreliance on synthetic chemotherapeutics. Indigenous phytogenic resources, such as Neorautanenia brachypus, traditionally valued for medicinal properties, hold potential for integration into modern poultry systems. Coupling this ecological knowledge with AI-supported data analysis enables context specific insights into animal health and productivity, contributing to smart and resilient agriculture. A total of 400 Cobb 500 day-old broiler chicks were assigned to five dietary treatments under a Randomized Complete Block Design (RCBD): (E0) basal diet (control), (E1) basal diet + 2 g/kg N. brachypus powder in feed, (E2) basal diet + vitamin–mineral premix, (E3) basal diet + vitamin–mineral premix + 2 g/L N. brachypus in drinking water, and (E4) basal diet + vitamin–mineral premix + 2 g/kg N. brachypus in feed. Each treatment had four replicates (n = 20). Voluntary feed intake (VFI) and voluntary water intake (VWI) were measured daily, with weekly growth performance recorded. On Day 35, fecal samples (n = 12 per Treatment and n=3 per replicate) were pooled and analyzed using the modified McMaster technique to quantify Davainea proglottina eggs per gram (epg) and Eimeria maxima oocysts per gram (opg). Statistical analyses were performed in SAS 9.4 and supplemented with AI assisted pattern recognition to model interactions among intake, growth, and parasitic load. Significant treatment effects were observed ($p < 0.05$). VWI was highest in E3 (1791.66 ± 84.95 mL; $p < 0.0001$), while E2 recorded the lowest (1484.1 ± 84.94 mL). Feed intake peaked in E1 (945.1 ± 43.78 g; $p < 0.0001$) but was lowest in E3 (800.2 ± 43.78 g), indicating enhanced feed utilization efficiency. Growth performance followed the order E3 > E4 > E1 > E2 > E0, with E3 achieving the highest body weight (2589.0 ± 43.78 g at week 5; $p < 0.0001$). Parasitological assessment revealed significant reductions in D. proglottina and E. maxima burdens across all supplemented groups, with the strongest suppression in E1, E3, and E4 ($p < 0.0001$). Administration route did not alter antiparasitic efficacy. N. brachypus supplementation improved hydration, feed conversion, growth, and resistance to gastrointestinal parasites in broiler chickens. Supplementation through drinking water combined with vitamin–mineral premix (E3) was particularly effective. This study demonstrated how indigenous phytogenic knowledge, when integrated with rigorous experimentation and AI-driven analytics, can inform sustainable poultry production. The findings highlight N. brachypus as a functional phytogenic

alternative to synthetic chemotherapeutics and indicated positive effects on the potential of blending traditional ecological knowledge with emerging technologies for smart and sustainable agriculture.

Keywords: AI-assisted agriculture, Broiler chickens, Chemotherapeutics, Gastrointestinal parasitism, Neorautanenia brachypus, Sustainable poultry production

Abstract No: 096-OP

Using low-cost drone and artificial intelligence to assess forage biomass and quality in the Senegalese rangeland ecosystem

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ABSTRACT

Accurate assessment of forage biomass and nutritive value is essential for effective rangeland management in the Sahel region. However, traditional field-based sampling methods are labor-intensive, limited in spatial coverage, and financially costly. This research evaluated the potential of affordable drone imagery combined with artificial intelligence (AI) to estimate biomass and forage quality attributes across rangelands in Senegal. RGB imagery obtained from drones was processed to derive vegetation indices, which were then utilized as explanatory variables in Random Forest models calibrated against field-measured biomass and quality parameters. Validation results indicated strong predictive capability, with relative RMSEs of 31% for fresh mass and 37% for dry mass. Additionally, parameters such as crude protein, neutral detergent fiber, acid detergent fiber, and organic matter digestibility were predicted with RRMSE values of 32%, 9%, 8%, and 17%, respectively. Principal Component Analysis revealed that the first two components accounted for 53.3% of the total variance, demonstrating robust multivariate relationships between drone-derived vegetation indices and plant attributes. These findings suggest that low-cost drones, when integrated with machine-learning techniques, can produce reliable spatial estimates of forage biomass and quality, thereby offering a practical alternative to invasive sampling methods. This methodology presents significant advantages for pastoral resource monitoring, enabling rapid, scalable, and cost-effective assessments across heterogeneous landscapes. The integration of drone-AI systems into rangeland monitoring programs could significantly enhance decision-making related to grazing management, early warning systems, and climate-resilient pastoral practices in West Africa.

Keywords: Drone imagery, Forage quality, Machine learning, Photogrammetry, Rangeland monitoring

Abstract No: 097-OP

Integrating indigenous knowledge with emerging technologies: AI-driven metabolomics of selected South African medicinal plants

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ABSTRACT

Medicinal plants serve as a vital intersection of biodiversity, Indigenous Knowledge Systems (IKS), and modern science, providing a rich source of natural products with significant therapeutic potential. In Africa, communities have utilized medicinal plants for centuries to treat various ailments, including malaria and cancer. In South Africa, Melianthus comosus and Hypoxis hemerocallidea are noted for their anti-venom, wound-healing, and anti-inflammatory properties. However, the phytochemical diversity and biochemical pathways of these plants remain poorly characterized, hindering systematic validation and integration into sustainable healthcare and agriculture. Recent advancements in Artificial Intelligence (AI) and computational metabolomics present opportunities to decode complex plant metabolomes. This study aimed to characterize the metabolomes of M. comosus and H. hemerocallidea using AI-enabled computational metabolomics with three objectives: (i) to generate comprehensive metabolomic profiles of leaves and roots, (ii) to integrate IKS with metabolomic evidence to elucidate plant uses in traditional medicine, and (iii) to explore sustainable cultivation and breeding strategies informed by this integration. Using methanol extracts analyzed via liquid chromatography-tandem mass spectrometry (LC-MS/MS), the study employed computational workflows for structural annotation and interspecies comparison. Results revealed a diverse chemical landscape, with M. comosus showing higher flavonoid abundance consistent with its anti-inflammatory applications, while H. hemerocallidea was rich in lipid-like compounds linked to wound healing. Integration with IKS validated traditional uses and identified bioactive compounds. This research demonstrates the transformative potential of combining AI-enabled metabolomics with IKS, highlighting its application in optimizing bioactive compound production, supporting predictive chemotyping, and promoting sustainable agricultural practices. By bridging traditional knowledge with modern science, this approach empowers local communities and fosters inclusive innovation in medicinal plant research and therapeutic development. It underscores the

importance of integrating heritage knowledge with advanced technologies to drive sustainable and context-specific solutions in agriculture and healthcare.

Keywords: Artificial intelligence, Anti-venom, Anti-inflammatory, Computational metabolomics, Hypoxis hemerocallidea, Medicinal plants, Melianthus comosus, Natural products

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Abstract No: 097-OP

Harnessing artificial Intelligence for Global Pest Surveillance: Applications, challenges and future directions

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ABSTRACT

Pest surveillance is a cornerstone of agricultural production, enabling farmers, researchers, and policymakers to detect, monitor, and manage pest populations before they reach economically damaging thresholds. Traditional surveillance approaches such as manual scouting, pheromone traps, and farmer reports have provided valuable information but are constrained by labor intensity, subjectivity, and delays in data processing. With the growing threat of invasive species, climate change-driven pest expansions, and rising pesticide resistance, there is an urgent need for scalable, accurate, and real-time surveillance systems. Artificial Intelligence (AI) has emerged as a transformative tool for revolutionizing pest surveillance, offering unprecedented opportunities for precision agriculture and integrated pest management (IPM). This paper reviews global advancements in AI-driven pest surveillance systems, highlighting the use of machine learning algorithms, computer vision, remote sensing, drones, and IoT-based smart traps. Applications in both developed and developing countries are discussed, alongside challenges such as data availability, model accuracy, and integration with existing pest management systems. How AI-based models improve early detection, enable predictive analytics, and support decision-making platforms for farmers. Case studies from Africa, Asia, Europe, and the Americas demonstrate AI's role in controlling pests such as fall armyworm (Spodoptera frugiperda), desert locusts (Schistocerca gregaria), rice plant hoppers, aphids, and fruit flies. Benefits include reduced pesticide misuse, enhanced food security, and improved farmer livelihoods. However, challenges remain in terms of data quality, infrastructure costs, algorithmic bias, farmer digital literacy, and ethical considerations related to data ownership. Future directions point toward combining AI with genomics, robotics, edge computing, and climate-smart agriculture for more resilient food systems.

AI-powered pest surveillance is not a replacement for traditional methods but an enabler of smarter, faster, and more sustainable pest management strategies aligned with the Sustainable Development Goals (SDGs).

Keywords: Artificial Intelligence; Machine Learning; Internet of Things; Drones; Precision Agriculture; Integrated Pest Management; Climate-Smart Agriculture.

Abstract No: 098-OP

From oral traditions to algorithms: Translating indigenous climate knowledge into AI-enhanced Agricultural Decision Support Tools

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ABSTRACT

This research addresses the critical need to integrate Indigenous Knowledge (IK) into climate adaptation strategies for agriculture, which is often excluded from mainstream scientific models despite its deep temporal and place-based wisdom. The background recognises that Indigenous oral traditions hold invaluable insights into ecological patterns, seasonal cycles, and resilient practices that are increasingly relevant in the face of climate change. The primary objective was to develop a novel framework for ethically translating and codifying these oral knowledge systems into a format compatible with artificial intelligence (AI) and machine learning (ML) algorithms. The methodology employed a community-based participatory approach, working directly with local knowledge holders in Zimbabwe, Mozambique and South Africa to document, contextualise, and digitise qualitative narratives and observations on AI-IK hybrid system. This translated data can then be used to train and enhance an agricultural decision support tool (DST), where AI models integrating IK with quantitative meteorological and satellite data generate hyper-localised planting and harvesting recommendations. Key results indicate that the hybrid IK-AI model significantly improves the accuracy of seasonal forecasting and crop resilience advice compared to systems relying on scientific data alone. The study concludes that this synthesis creates more robust, culturally relevant, and equitable decision-support systems. The implications are profound, offering a pathway to bridge the gap between traditional and scientific knowledge, empower Indigenous communities, and foster climate-resilient agriculture through ethically aligned technology.

Keywords: Agricultural decision support, Artificial Intelligence, climate resilience, community-based participatory research, indigenous knowledge, knowledge translation

Abstract No: 098-OP

Optimizing agricultural education outcomes through AI-driven innovative differentiated assessment frameworks: Exploring pedagogical inclusivity and learner diversity in rural African classrooms

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ABSTRACT

Rural African agricultural education systems will continue to face challenges related to learner diversity, resource limitations, and the need for innovative pedagogical approaches. Traditional uniform assessment methods are expected to inadequately address the varied learning needs of students, thereby limiting educational inclusivity and effectiveness. AI-driven differentiated assessment frameworks are anticipated to offer novel solutions by enabling personalized, adaptive learning experiences. This study will investigate how AI-driven innovative differentiated assessment frameworks can optimize agricultural education outcomes by promoting pedagogical inclusivity and addressing learner diversity in rural African classrooms. A mixed-methods research design will be employed, involving a purposive sample of approximately 250 students and 15 agricultural educators from rural schools across three districts in sub-Saharan Africa. AI-enabled assessment tools, including adaptive learning platforms and real-time analytics, will be implemented over 2 months period. Data will be collected through classroom observations, semi-structured interviews, and quantitative analysis of student performance metrics to evaluate the effectiveness and feasibility of these frameworks. It is anticipated that the AI-enhanced differentiated assessment frameworks will improve educators' capacity to identify individual learning needs and tailor instruction accordingly. Students are expected to demonstrate increased engagement, improved mastery of agricultural skills, and enhanced critical thinking. The study will also identify potential barriers such as digital literacy and infrastructure challenges, while proposing strategies to mitigate these issues. The integration of AI-driven differentiated assessment frameworks is expected to transform agricultural education in rural African settings by fostering inclusivity and innovation. Recommendations will be made for policy support, capacity building, and infrastructural investments necessary to scale these approaches, ultimately contributing to the development of a skilled and resilient agricultural workforce.

Keywords: Agricultural Education, Adaptive Learning, Artificial Intelligence, Differentiated Assessment, Learner Diversity, Pedagogical Inclusivity

Abstract No: 099-OP

Artificial Intelligence and Machine Learning in logistics and supply chain management in Africa: Opportunities, challenges, and future directions

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ABSTRACT

Artificial Intelligence (AI) and Machine Learning (ML) are increasingly transforming logistics and supply chain management (SCM) globally, yet their adoption and contextual performance in Africa remain underexplored. This study investigated the current state, opportunities, and challenges of integrating AI and ML into African logistics systems using a mixed-methods approach that combines qualitative insights from expert interviews, focus group discussions, and case studies with quantitative data from surveys across logistics firms in South Africa, Kenya, Nigeria, Egypt, and Ghana. Results show that approximately 60% of surveyed firms employ some form of AI or ML, with predictive analytics (45%), inventory forecasting (50%), and route optimization (35%) emerging as the most widely adopted applications. Firms perceive AI and ML as offering substantial benefits, including cost reduction (reported by 60% of respondents), improved operational efficiency (65%), strengthened demand forecasting (55%), and enhanced risk management (50%). Despite this promise, adoption remains uneven due to outdated infrastructure, limited access to quality data, insufficient digital skills, and high investment costs. Country-level disparities are pronounced: while 70% of South African firms report active AI/ML use, adoption levels are considerably lower in Nigeria (50%) and Ghana (45%). The study highlights the need for improved digital infrastructure, targeted capacity-building, regulatory frameworks that support data governance, and incentives for technological investment. AI and ML can substantially enhance African logistics performance and resilience if integrated into local contexts through participatory design, cross-sector collaboration, and sustained policy support.

Keywords: Artificial intelligence, Digital transformation, Logistics, Machine learning, Supply chain management

Abstract No: 100-OP

Application of Geographic Information System (GIS) technology to monitor Peste des Petits Ruminants (PPR) Vaccine Coverage in Livestock in Garissa County, Kenya.

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ABSTRACT

Peste des Petits Ruminants (PPR) remains a major constraint to small ruminant production in pastoral regions, yet vaccination coverage patterns and their spatial distribution are poorly documented. This study applied Geographic Information System (GIS) technology to assess PPR vaccination coverage in Garissa County, Kenya, over a five-year period (2018-2023) and to develop a real-time monitoring tool to support eradication efforts. Using retrospective vaccination records, livestock population data, and reported PPR incidences and mortalities, the study quantified the proportion of sheep and goats vaccinated and mapped the spatial distribution of vaccination activities across sub-counties, wards, and villages. Results show that only 1.76 million small ruminants representing 26.7% of the county's estimated 6.6 million sheep and goats were vaccinated, a level far below the recommended 70-80% threshold required to achieve herd immunity. Spatial analysis revealed significant geographic disparities, with minimal vaccination activity along the Kenya-Somalia border, an area characterized by insecurity and high livestock mobility. To enhance monitoring and decision-making, a PPR Vaccination Coverage Dashboard was developed using ArcGIS, integrating Survey123 for real-time field data collection and interactive mapping. The tool enables visualization of vaccination hotspots, gaps, and temporal trends, providing an evidence-based framework for targeted interventions. The findings underscore the need for increased vaccine supply, higher vaccination frequency, and prioritized coverage of high-risk, cross-border pastoral populations to advance PPR control and eradication in Garissa County.

Keywords: Peste des Petits Ruminants (PPR), GIS, vaccination coverage, small ruminants, Garissa County

Thursday 20th November 2025 | 8:30 - 17:00 EAT

Application of Artificial Intelligence and Emerging Technologies for Smart and Sustainable Agriculture

Registration Link: https://bit.ly/47B3z7L

Session Chair: Dr. Kennedy Machira
Rapporteurs : Dr. Mondo Mubalama, Dr. Esther Sebuliba

Time		
08:00-08:10	Welcome Remarks from the Chair: Dr Kennedy Machira	
	Topic	Presenter
08:10-08:35	Leveraging Machine Learning and Digital Innovations for Precision Pest, Disease, and Soil Health Management in African Agriculture	Amodu Godwin
08:35-09:00	Factors that hinder machine learning technological adoption among smallholder farmers and potential recommendations for convenient implementation and adoption of the technology: a review of malawi smallholder farmers	Mathews Laston Kambani
09:00-09:15	Using Chemometrics, Machine Learning and Near-Infrared Spectroscopy for improved Soil Quality Assessment	Tasisa T. Tolossa
09:15-09:30	Classification of Botswana Sorghum Seed Varieties Using Deep Convolutional Neural Networks	Pius Emesu
09:30-09:45	Plant health estimation using drone images	Ajayi, O. G
09:45-10:00	Adoption of Digital Climate-Smart Agriculture Tools among Smallholder Farmers in Central Uganda	Alex Ronald Mwangu
10:10-10:15	Application of Remote Sensing and Machine Learning in Soil Salinity Management in the Chokwé Irrigation Scheme	Elton Valeriano Manhique
10:15-10:20	Building the Why: Our Career Insights and Community Strategy	Craig Akiri
10:30-10:35	Closing remarks from the chair and RUFORUM Representative	

Abstract No: 101-OP

Leveraging machine learning and digital innovations for precision pest, disease, and soil health management in African agriculture

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ABSTRACT

Smallholder farmers in Africa face persistent challenges from pests, diseases, and declining soil fertility, which collectively reduce yields, threaten food security, and increase vulnerability to climate change. Conventional diagnostic methods are slow, costly, and often inaccessible in rural settings, resulting in delayed responses and substantial losses. Recent advancements in Artificial Intelligence (AI) and Machine Learning (ML) offer a transformative opportunity to deliver realtime, cost-effective, and scalable solutions for farm-level decision-making. This work explores the integration of AI-powered predictive models and digital platforms for early detection of pests and diseases, soil health diagnostics, and actionable decision support to enhance productivity and resilience in smallholder farming systems. We propose the deployment of ML algorithms such as Convolutional Neural Networks (CNNs) for image-based detection of pests and diseases and Random Forest models for yield risk forecasting, trained on multisource datasets including satellite imagery, soil test data, and farmer-reported observations. These models will be integrated into a mobile-enabled platform providing tailored recommendations on pest management, disease control, and nutrient application. Pilot implementation will focus on diverse agro-ecological zones to ensure model adaptability and local relevance. Previous studies demonstrate that CNN-based models can achieve over 90% accuracy in detecting crop diseases from field images, while integrated ML approaches improve precision in nutrient and pest management. Preliminary simulations indicate that combining AI-based diagnostics with real-time farmer feedback can reduce crop losses by up to 30% and optimize fertilizer use by 20%, leading to higher yields and reduced input costs. AIdriven solutions have the potential to close information gaps, reduce yield losses, and promote climate-smart agriculture across Africa. By coupling machine learning with locally relevant datasets and mobile technology, this approach can democratize access to precision agriculture tools, empower farmers, and accelerate the transition to sustainable agri-food systems.

Keywords: Artificial Intelligence, Detection, Machine Learning, Pest and Disease
Precision Agriculture

Abstract No: 102-OP

Using chemometrics, machine learning and near-infrared spectroscopy for improved soil quality assessment

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ABSTRACT

Accurate and rapid soil quality assessment is essential for sustainable nutrient management and precision agriculture. Conventional wet-chemistry approaches, although reliable, are often labor-intensive, costly, and slow, limiting their suitability for real-time decision-making. This study integrates near-infrared (NIR) spectroscopy with chemometrics and machine learning to enhance the efficiency, accuracy, and environmental sustainability of soil analysis. A total of 120 soil samples (0–20 cm depth) were collected from pineapple fields in Ghana under different organic and inorganic amendment regimes. Samples were analyzed for key fertility indicators, including clay, organic matter, pH, CEC, and exchangeable nutrients, and scanned using a FieldSpec 4 spectrometer (900–2500 nm). Calibration and validation datasets were generated using the Kennard–Stone algorithm, while the Successive Projections Algorithm (SPA) was applied to optimize wavelength selection and reduce multicollinearity. Multiple machine learning models, PLSR, Random Forest, Artificial Neural Networks, Naïve Bayes, and Multiple Linear Regression, were trained to predict soil properties from spectral data. Random Forest consistently achieved the highest predictive accuracy, outperforming PLSR and ANN, particularly for clay content and exchangeable Ca, Mg, and K. MLR yielded strong predictions (R^2 = 0.90–0.93) for most attributes when stabilized using QR decomposition. However, all models showed reduced performance for pH and available phosphorus, indicating the need for further methodological refinement. Overall, the integration of NIR spectroscopy, chemometrics, and machine learning demonstrates significant potential for rapid, non-destructive, and scalable soil assessment. These approaches support more informed soil management decisions, enhance precision agriculture practices, and contribute to sustainable agricultural intensification across smallholder production systems.

Keywords: Chemometrics, machine learning, near-infrared spectroscopy, precision agriculture, soil quality, sustainability

Abstract No: 103-OP

Adoption of digital climate-smart agriculture tools among smallholder farmers in central Uganda

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ABSTRACT

The Sub-Saharan African economy heavily relies on agriculture, a sector that's increasingly vulnerable to climate change, leading to acute food insecurity—a 159% increase since 2019. Paradoxically, the global agrifood system is also a major contributor to Greenhouse Gas (GHG) emissions. Smallholder farmers, dependent on rain-fed systems, face the highest risks. To address these interconnected challenges, the concept of Climate Smart Agriculture (CSA) emerged. CSA aims to simultaneously increase productivity, enhance resilience (adaptation), and reduce GHG emissions (mitigation) by employing context-specific technologies and practices. The potential of CSA is amplified by digital technologies (e.g., mobile apps, weather platforms) that provide timely information for better farm management and value chain connection. Despite the growing recognition of these digital CSA tools globally, their adoption status among smallholder farmers in Mukono and Kayunga districts, Uganda, remains undocumented. This study was therefore conducted to assess the extent of adoption of these tools, identify the socio-economic, institutional, and infrastructural factors influencing their use, and explore farmers' perceptions of their benefits and challenges. The findings will inform targeted interventions to build more resilient agricultural systems.

Key words: Agriculture, climate change, food insecurity, smallholder farmers, Sub-Saharan countries

Abstract No: 104-OP

Plant health estimation using drone images

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ABSTRACT

Traditional plant health assessment methods in sub-Saharan agriculture, including manual scouting and periodic satellite imagery, are labor-intensive and often inadequate for timely stress detection. This study explored the use of unmanned aerial vehicles (UAVs) equipped with visible-spectrum cameras as a cost-effective alternative for rapid crop health estimation, validated against conventional laboratory nutrient tests. The objectives included acquiring high-overlap drone imagery over a 21-hectare commercial farm in Niger State, Nigeria, and establishing ground control points for accurate georeferencing. The UAV imagery was processed to create a geo-rectified orthomosaic and derive various vegetation index maps, including the Normalized Difference Vegetation Index (NDVI). The UAV data acquisition involved flying a multirotor drone in an 80% overlap grid, while Pix4DMapper software was used for image stitching and vegetation index computation. Crop nutrient health was estimated from UAV-derived indices and validated through laboratory analyses of nitrogen, phosphorus, and potassium (NPK) content in leaf samples from maize, soybean, cassava, groundnut, yam, and rice. Results demonstrated that the UAV-based NDVI effectively captured the range of vegetation health, correlating strongly with laboratory nutrient measurements, particularly in cassava (r 1.00) and rice (r 0.85). Alternative indices, such as the Normalized Excess Greenness (NExG), showed weaker correlations. This study concludes that UAV imaging combined with NDVI analysis offers a rapid and reliable precision agriculture tool, particularly valuable in resource-limited contexts. The approach enhances farm management through timely nutrient deficiency identification, supporting proactive agricultural practices and sustainable crop management in Nigeria and across Africa.

Keywords: NDVI, Precision agriculture, Remote sensing, UAV, Vegetation index

Abstract No: 105-OP

Adoption of digital climate-smart agriculture tools among smallholder farmers in Central Uganda

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ABSTRACT

Agriculture remains central to national economies and food security across Sub-Saharan Africa, yet it is increasingly threatened by climate change, marked by erratic rainfall, droughts, flooding, and rising pest and disease pressures. With severe food insecurity affecting 58% of Africa's population, there is growing urgency to enhance agricultural productivity while strengthening resilience and reducing greenhouse gas emissions. Digital Climate-Smart Agriculture (CSA) technologies—such as mobile-based weather advisories, digital extension, and market information systems—offer promising pathways for improving smallholder adaptive capacity. However, evidence on their adoption and use in many rural contexts remains limited. This study assessed the extent, determinants, and perceived benefits of digital CSA tool adoption among 428 smallholder farmers in Mukono and Kayunga districts of central Uganda using a mixed-methods approach involving household surveys, focus group discussions, and key informant interviews. Results show high access to mobile phones (98%), with farmers adopting multiple CSA technologies including soil fertility management (69%), mobile weather advisories (64%), irrigation and water harvesting (58%), and digital extension services (57%). Adoption was higher in peri-urban Mukono than in Kayunga. Key determinants included education, digital literacy, smartphone ownership, participation in farmer groups, and access to extension services. Gender and income disparities significantly constrained uptake, particularly among women. Reported benefits included improved farm planning, reduced crop losses, better market access, increased incomes, and reduced dependence on traditional extension. Major barriers included high data costs, poor network coverage, low digital literacy, limited localized digital content, and unreliable power supply.

Strengthening digital literacy, expanding rural ICT infrastructure, promoting gender-sensitive interventions, and fostering public–private partnerships are essential for scaling digital CSA and supporting resilient, food-secure farming systems in Uganda.

Keywords: Adoption, Climate-Smart Agriculture, Digital Technologies, Smallholder Farmers, Uganda, Vulnerability

Abstract No: 106-OP

Application of remote sensing and machine learning in soil salinity management in the Chokwé Irrigation Scheme

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ABSTRACT

Soil salinization poses a significant threat to global agriculture, impacting approximately 1 billion hectares (7% of the Earth's surface) across over 100 countries. In Mozambique's Chokwé Irrigation Scheme, around 30% of the irrigated area is affected, jeopardizing agricultural production and food security in the Southern Region. Urgent measures are needed to combat salinization. While conventional salinity measurement methods are accurate, they are time-consuming, expensive, and limited in coverage due to financial constraints. This study proposes the integrated use of remote sensing techniques and machine learning algorithms for the early detection of saline and potentially saline areas, focusing on the early delineation of priority zones for mitigation and recovery actions. The study will use imagery from Landsat 9 (30 m spatial resolution) and Sentinel-2 (10 m spatial resolution), processed on the Digital Earth Africa Sandbox platform, which provides an interactive and flexible work environment based on the Python programming language through Jupyter Lab. This approach will enable the generation of detailed soil salinity maps in the irrigation scheme, based on the calculation of vegetation and salinity spectral indices, which will serve as predictor variables for machine learning models. Four algorithms will be tested, namely: Random Forest (RF), Support Vector Machine (SVM), Artificial Neural Network (ANN), and k-nearest Neighbours (K-NN). The validation and calibration of the machine learning models will be based on soil sample collection using random sampling at a depth of 20 cm. Model validation will be conducted using variables such as Root Mean Square Error (RMSE), Coefficient of Determination (R), and others derived from the confusion matrix, including accuracy, precision, and F1-score. The expected results will contribute to the sustainable management of irrigated agriculture in the Chokwé Irrigation Scheme through: (i) identifying the most effective algorithm for salinity prediction, (ii) generating high spatial resolution soil salinity maps, (iii) identifying spatio-temporal patterns of salinization, and (iv) providing technical support for the implementation of sustainable management strategies and the recovery of degraded soils.

Keywords: Electrical conductivity, Irrigated soils, Machine learning, Spectral index