ATHENS INSTITUTE

Abstract Book

19th Annual International Symposium on Agricultural Research
22-26 June 2026, Athens, Greece

Edited by
Timothy M. Young & Olga Gkounta

2026

Abstracts
19th Annual International Symposium on Agricultural Research

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9 Chalkokondili Street
10677 Athens, Greece
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(In Alphabetical Order by Author's Family Name)

Preface

This book includes the abstracts of all the papers presented at the *19th Annual International Symposium on Agricultural Research* (22-26 June 2026), organized by the Athens Institute.

A full symposium program can be found before the relevant abstracts. In accordance with Athens Institute's Publication Policy, the papers presented during this conference will be considered for inclusion in one of the Athens Institute's many publications only after a blind peer review process.

The purpose of this abstract book is to provide members of the Athens Institute and other academics around the world with a resource through which they can discover colleagues and additional research relevant to their own work. This purpose is in congruence with the overall mission of the association. Athens Institute was established in 1995 as an independent academic organization with the mission to become a forum where academics and researchers from all over the world can meet to exchange ideas on their research and consider the future developments of their fields of study.

To facilitate the communication, a references section includes all the abstract books published as part of this symposium (Table 1). I invite the readers to access these abstract books –these are available for free– and compare how the themes of the symposium have evolved over the years. According to the Athens Institute's mission, the presenters in these conferences are coming from many different countries, presenting various topics.

Table 1. *Publication of Books of Abstracts of Proceedings, 2010-2026*

Year	Papers	Countries	References
2026	21	13	Young and Gkounta (2026)
2025	19	11	Young and Papanikou (2025)
2024	23	18	Young and Gkounta (2024)
2023	35	23	Young and Gkounta (2023)
2022	34	23	Uddin and Gkounta (2022)
2021	11	10	Papanikos (2021)
2020	8	6	Papanikos (2020)
2019	29	18	Papanikos (2019)
2018	26	15	Papanikos (2018)
2017	41	23	Papanikos (2017)
2016	39	23	Papanikos (2016)
2015	87	43	Papanikos (2015)
2014	54	21	Papanikos (2014)
2013	53	29	Papanikos (2013)
2012	33	18	Papanikos (2012)
2011	63	24	Papanikos (2011)
2010	61	23	Papanikos (2010)

It is our hope that through Athens Institute's conferences and publications, Athens will become a place where academics and researchers from all over the world can regularly meet to discuss the developments of their disciplines and present their work. Since 1995, Athens Institute has organized more than 400 international conferences and has published over 200 books. Academically, the institute is organized into 7 divisions and 37 units. Each unit organizes at least one annual conference and undertakes various small and large research projects.

For each of these events, the involvement of multiple parties is crucial. I would like to thank all the participants, the members of the organizing and academic committees, and most importantly the administration staff of the Athens Institute for putting this symposium and its subsequent publications together.

Gregory T. Papanikos
President

Editors' Note

These abstracts provide a vital means to the dissemination of scholarly inquiry in the field of Agriculture. The breadth and depth of research approaches and topics represented in this book underscores the diversity of the symposium.

Athens Institute's mission is to bring together academics from all corners of the world in order to engage with each other, brainstorm, exchange ideas, be inspired by one another, and once they are back in their institutions and countries to implement what they have acquired. The *19th Annual International Symposium on Agricultural Research*, accomplished this goal by bringing together academics and scholars from 13 different countries (Brazil, Canada, Germany, India, Iraq, Israel, Poland, Portugal, South Africa, Switzerland, Thailand, Türkiye and the USA), which brought in the conference the perspectives of many different country approaches and realities in the field.

Publishing this book can help that spirit of engaged scholarship continue into the future. With our joint efforts, the next editions of this symposium will be even better. We hope that this abstract book as a whole will be both of interest and of value to the reading audience.

Timothy M. Young & Olga Gkounta
Editors

19th Annual International Symposium on Agricultural Research, 22-26 June 2026, Athens, Greece

Organizing & Scientific Committee

All Athens Institute's conferences are organized by the Academic Council. This symposium has been organized with the assistance of the following academic members of Athens Institute.

Dr. Gregory T. Papanikos, President, Athens Institute & Professor (Adjunct), University of Tennessee, Knoxville, USA.

Dr. Timothy M. Young, Head, Agriculture Unit, Athens Institute, Emeritus Professor, The University of Tennessee, USA & CEO and President, T.M. Young Institute, LLC, USA.

Dr. Ampalavanar Nanthakumar, Director, Sciences Division, ATINER & Professor, State University of New York (Oswego), USA.

FINAL CONFERENCE PROGRAM

19th Annual International Symposium on Agricultural Research, 22-26 June 2026, Athens, Greece

PROGRAM

Monday 22 June 2026

08:30-09:15
Registration
09:15-10:00 Opening Speech and Welcoming Remarks
Speaker: Timothy M. Young, Emeritus Professor, The University of Tennessee, USA & CEO and President, T.M. Young Institute, LLC, USA.

10:00-11:30 Session 1
Moderator: Timothy M. Young, Head, Agriculture Unit, Athens Institute, Emeritus Professor, The University of Tennessee, USA & CEO and President, T.M. Young Institute, LLC, USA.

1. **Agnieszka Faligowska**, Professor, Poznań University of Life Sciences, Poland.
   Katarzyna Panasiewicz, Professor, Poznań University of Life Sciences, Poland.
   Grażyna Szymańska, Associate Professor, Poznań University of Life Sciences, Poland.
   Karolina Ratajczak, Professor, Poznań University of Life Sciences, Poland.
   Anna Kolanoś, PhD Student, Poznań University of Life Sciences, Poland.
   ***Title**: The Influence of Different Methods of Cultivation Using Strip Sowing on White Lupin Yield.*
2. **Liping Di**, Professor and Director, Center for Spatial Information Science and Systems, George Mason University, USA.
   Liying Guo, Research Professor, George Mason University, USA.
   ***Title:** Making Stressed Rural Community Climate Resilient with Geospatial Digital Twin and GeoAI Technologies.*
3. **Katarzyna Panasiewicz**, Professor, Poznań University of Life Sciences, Poland.
   Agnieszka Faligowska, Professor, Poznań University of Life Sciences, Poland.
   Grażyna Szymańska, Associate Professor, Poznań University of Life Sciences, Poland.
   Karolina Ratajczak, Professor, Poznań University of Life Sciences, Poland.
   Anna Kolanoś, PhD Student, Poznań University of Life Sciences, Poland.
   ***Title**: The Effect of Different Methods of Cultivation Using Strip Sowing on Seeds Quality of White Lupin.*
4. **Cristiane Bernardo**, Associate Professor, São Paulo State University (UNESP), Brazil.
   ***Title:** Scientific Evidence for Formulating Public Policies Aimed at Rural Development: The Role of Scientific Dissemination.*

11:30-13:00 Session 2
Moderator: Liping Di, Professor and Director, Center for Spatial Information Science and Systems, George Mason University, USA.

1. **Stamatina Kotsakou**, Assistant Professor, California Polytechnic State University, San Luis Obispo, USA.
   ***Title:** Demand for Plant-Based Meat: Competition with Animal Proteins, Effects of Households' Health Status and Diet Concerns, and Implications for the Environment.*
2. **Nonkululeko Mfeka**, Lecturer, Cape Peninsula University of Technology, South Africa.
   Francis Bayo Lewu, Professor, Cape Peninsula University of Technology, South Africa.
   Azwimbavhi Reckson Mulidzi, Researcher, Agricultural Research Council, South Africa.
   ***Title:** Physiochemical Properties and Enzyme Activity of Different Growing Media in Blueberry Production.*
3. **Natthasit Tansakul**, Instructor, Kasetsart University, Thailand.
   ***Title:** Application of Hemp and Hemp Seed: Unlocking the Potential for Companion Animal.*

13:00-14:30 Session 3
Moderator: Dimitrios Goulias, Head, Civil Engineering Unit, Athens Institute and Associate Professor & Director of Undergraduate Studies Civil & Environmental Engineering Department, University of Maryland, USA.

1. **Glen Bright**, Dean of Engineering, University of KwaZulu-Natal, South Africa.
   ***Title**: Agricultural Potential of a Low-Cost, Intelligent Industrial UAV Seed Sowing System.*
2. **Rui Costa Neto**, Professor and Researcher, IN+ Center for Innovation, Technology and Policy Research, University of Lisbon, Portugal.
   Antonio Rolo Bual, Researcher, IN+ Center for Innovation, Technology and Policy Research, University of Lisbon, Portugal.
   ***Title**: Assessment of the Potential Consumption of Green Hydrogen in the Portuguese Industrial Sector as a Direct Feedstock and for High Heat Applications.*
3. **Pavel Ikonomov**, Professor, Western Michigan University, USA.
   Siddi Govardhan Reddy Karapureddy, PhD Student, Western Michigan University, USA.
   ***Title**: Vision-based AI/ML-Enabled Optimization for Hybrid Metal 3D Printing.*

14:30-15:30 Lunch

15:30-17:00 Session 4 – A Symposium on "The *Future of Science: Education, Research, and Innovation*"
Moderator: Timothy M. Young, Emeritus Professor, The University of Tennessee, USA & CEO and President, T.M. Young Institute, LLC, USA.

1. **Caroline Barakat**, Professor, Ontario Tech University, Canada.
   ***Title:** Reimagining Science for a Rapidly Changing World: Research, Education, and Innovation in an Era of Global Transformation and Human Challenges.*
2. **Cristiane Bernardo**, Associate Professor, São Paulo State University (UNESP), Brazil.
   ***Title:** Scientific Dissemination in Master's and Doctoral Programmes: Practices, Challenges and Impacts. A Case Study of the Graduate Program in Agribusiness and Development.*
3. **Seher Nur Sulku, Professor,** Ankara Haci Bayram Veli University, Türkiye.
   ***Title:** AI in Health: Rethinking Education, Research, and Innovation.*
4. **Dimitrios Goulias,** Associate Professor & Director of Undergraduate Studies Civil & Environmental Engineering Department, University of Maryland, USA.
   ***Title:** Multidisciplinary Transformative Aspects in Engineering Research & Education.*
5. **Virginia Sisiopiku**, Professor, The University of Alabama at Birmingham, USA.
   ***Title**: The Changing Landscape of Science & Engineering: Opportunities and Challenges.*
6. **Sundaravalli Narayanaswami**, Associate Professor, Indian Institute of Management Ahmedabad, India.
   ***Title:** Responsible AI: Trade-offs and Prospects for a Better Society.*

Interventions:

1. **Rainer Lehmann**, Professor, Technical University of Applied Sciences Lübeck, Germany.
2. **Ndakhona Bashingi**, Lecturer, Cape Peninsula University of Technology, South Africa.

18:00-20:00 Session 5 – Visit Aristotle's Lyceum

It requires pre-booking

20:30-22:30 Athenian Early Evening Symposium (Sequence of Events: Ongoing Academic Discussions, Dinner, Wine and Water, Music, Dance)

Tuesday 23 June 2026

09:00-10:30 Session 6
Moderator: Michaela Summerer, Independent Researcher, Switzerland.

1. **Lilach Iasur Kruh**, Senior Lecturer, Braude College of Engineering, Israel.
   Title: *Seed-Borne Microbiota from Wild Cicer as a Biological Tool to Enhance Growth and Disease Resilience in Domesticated Chickpea.*
2. **Jestinos Mzezewa**, Senior Lecturer, University of Venda, South Africa.
   Title*: Effects of Integrating Conservation Tillage and Manure Application on Soil Hydraulic Properties.*
3. **Jatuporn Rattanasrisomporn**, Instructor, Kasetsart University, Thailand.
   Natthasit Tansakul, Instructor, Kasetsart University, Thailand.
   Title: *Prevalence and Antimicrobial Susceptibility of Bacterial Isolates from Dogs with Cystitis.*
4. **Leyli Purrafee Dizaj**, Postdoctoral Researcher, Museum Für Naturkunde Berlin, Germany.
   Nadia Fröbisch, Professor, Museum Für Naturkunde Berlin, Germany.
   Florian Witzmann, Professor, Museum Für Naturkunde Berlin, Germany.
   Title: *The Cranial Dermal Bone Ornamentation in Extant and Extinct Amphibians: A Comprehensive Review.*

10:30-12:00 Session 7
Moderator: Leyli Purrafee Dizaj, Postdoctoral Researcher, Museum Für Naturkunde Berlin, Germany.

1. **Eastonce Gwata**, Professor, University of Venda, South Africa.
   Title*: A Survey of Grain Crude Protein and Selected Mineral Content among Finger Millet (Eleusine coracana) Traditional Varieties.*
2. **Ciro Righi**, Professor, University of São Paulo, Brazil.
   Title*: Land Use Impacts on Soil Fertility, Carbon Stocks, and Microbial Activity in the Amazonian Floodplains, Brazil.*
3. **Gizachew Tiruneh**, Researcher, University of São Paulo, Brazil.
   Title*: Integrating Spectroscopy with Machine Learning to Predict Soil Enzyme Activity and Carbon Stocks in Amazonian Floodplain Soils, Brazil.*
4. **Taulant Shabani**, PhD Student, Justus Liebig University Giessen, Germany.
   Rainer Waldhardt, Professor, Justus Liebig University Giessen, Germany.
   Title: *Evaluation of the Effects of the Seed Terminator on the Segetal Vegetation on Three Tillage Method.*

12:00-13:30 Session 8
Moderator: Taulant Shabani, PhD Student, Justus Liebig University Giessen, Germany.

1. **Michaela Summerer**, Independent Researcher, Switzerland.
   Title: *Economic Development in the Buffer Zones: An Imperative for Nature Conservation by the Example of Hustai National Park, Mongolia.*
2. **Aveil Oberhammer**, PhD Student, University of Guelph, Canada.
   Title: *Room to Roam: Conservation and Coexistence in Mongolia's Rangelands.*
3. **Didar Rahim**, Director of Studies, Vision Foundation for Strategic Studies, Iraq.
   Title*: Digital Market Intelligence and Agricultural Resilience in the Kurdistan Region of Iraq.*

13:30-14:30 Lunch

15:40-19:30 Session 9
Old and New-An Educational Urban Walk

The urban walk ticket is not included as part of your registration fee. It includes transportation costs and the cost to enter the Parthenon and the other monuments on the Acropolis Hill. The urban walk tour includes the broader area of Athens. Among other sites, it includes: Zappion, Syntagma Square, Temple of Olympian Zeus, Ancient Roman Agora

and on Acropolis Hill: the Propylaea, the Temple of Athena Nike, the Erechtheion, and the Parthenon. The program of the tour may be adjusted, if there is a need beyond our control. This is a private event organized by the Athens Institute exclusively for the conference participants.

20:30-22:30
Ancient Athenian Dinner

Wednesday 24 June 2026
An Educational Visit to Selected Islands
or Nafplio & Mycenae Visit

Thursday 25 June 2026
Visiting the Oracle of Delphi

Friday 26 June 2026
Visiting the Ancient Corinth and Cape Sounion

Cristiane Bernardo
Associate Professor, São Paulo State University (UNESP), Brazil

Scientific Evidence for Formulating Public Policies Aimed at Rural Development: The Role of Scientific Dissemination

The use of scientific evidence to formulate public policies is already common in many countries. And, in these countries, scientific dissemination has been a facilitating instrument for research results to reach public policy makers. However, in Brazil, public policy makers and scientists have not yet established a close dialogue, so that quality scientific evidence is used more frequently to support such policies. We understand, therefore, that strengthening scientific dissemination can be one of the best ways to facilitate this dialogue. Given the conceptual complexity surrounding rural development in Brazil and its many actors, it is necessary to bring research and public policy closer together to understand and meet the demands of rural areas, providing conditions for this development to occur sustainably and reach the various productive sectors. In this context, we aim to analyse how public rural development policies are making use of scientific evidence and the role of scientific dissemination in this use. To this end, research subjects were selected based on a report prepared by Overton (an international platform that aims to map the interface between science and public policy) and Agency Bori (an agency that aims to connect Brazilian science and knowledge production to society through communication), with 107 Brazilian researchers who influenced documents used by governments to support public policies between 2019 and 2025. Among the researchers cited in the report, 44 were selected whose research is involved in rural development. It was observed that most of the selected researchers are concentrated in the states of São Paulo (13), with emphasis on the University of São Paulo and the National Institute for Space Research; and Rio de Janeiro (12), with emphasis on the Federal University of Rio de Janeiro and the Pontifical Catholic University. Only 20.4% of the researchers are female, and there is a notable use of evidence in ecosystems and land use. Researchers most cited in rural development policies are also those receiving greater media attention, including interviews and press invitations to comment on current issues. Although these researchers appear frequently in traditional media, they rarely engage in active dissemination through their own social media. On LinkedIn, the six researchers with more than 500 citations in public policy maintain profiles but show limited activity. Nonetheless, they are

frequently mentioned by institutions and colleagues. YouTube searches reveal extensive audiovisual presence, with some of the six most cited researchers appearing in over 600 videos, including interviews, lectures, debates, and courses. This suggests that the press plays a central role in amplifying researcher's visibility and positioning them as references in public policy debates. Institutional affiliation also appears to matter. Researchers linked to prestigious institutions in major urban centres have greater access to policymakers and, consequently, more opportunities to provide scientific evidence. Overall, the findings indicate that media exposure, institutional prestige, and geographic location influence the circulation of scientific evidence in rural development policies. Strengthening structured channels of science communication may contribute to closer collaboration between scientists and policymakers, supporting evidence-based rural development policies in Brazil.

Glen Bright
Dean of Engineering, University of KwaZulu-Natal, South Africa

Agricultural Potential of a Low-Cost, Intelligent Industrial UAV Seed Sowing System

This study, researched and develop a low-cost, intelligent industrial UAV seed planting system, with sensor technology to support agricultural practices. Current methods of direct seeding are limited in terms of cost, scalability and are labour intensive. The mechanical structure of the UAV's seed sowing system was modularly designed, to fit onto a commercial drone and is pneumatically actuated for accurate and repeatable seedpod embedding. The microcontroller architecture targeted autonomous seed delivery, metering, pressure regulation and synchronicity with a remote operator. Real-time depth-adjustment and operator feedback over large-scaled isolated plots were enabled through LoRa telemetry. Critical safety features including identification of pneumatic faults and EEPROM-based data retention ensured continuous flight operation and improved system reliability. Ballistic simulations performed in Matlab allowed for optimization of key system parameters, which was used for selection of barrel length and system pressure rating. An ANSYS stress simulation was conducted to manufacture a plenum chamber. The component enabled the variation of planting depths, through pressurization of the system in an operating range up to 5 MPa. Experimental testing of the manufactured UAV's seed sowing system confirmed the dependence of seedpod terminal depth with muzzle velocity and soil hardness.

The results of the ballistics tests validated the performance of the system in terms of pressure regulation stability and repeatable seedpod embedding. An average terminal depth of up to 4 cm occurred in loose soil conditions at field capacity, despite varying soil structures. A custom class YOLOv5 model was trained to detect seedpods, for post-plant pitch evaluation and computation of ISO equipment performance indicators. The trained model achieved an accuracy of 94% (mAP@0.5) and provided a reliable foundation for use as dynamic feedback for real-time adjustment of seeding equipment. The integrated system is suitable for scalable aerial seeding platforms but cannot be fully adapted into the precision agriculture sector in isolation. The system should be used in combination with existing strategic methods for irrigation and soil maintenance. Future work could include PID adaption for improved pressure regulation and extended field trials to validate and optimize system autonomy and performance considering UAV flight dynamics.

Rui Costa Neto
Professor and Researcher, IN+ Center for Innovation, Technology and Policy Research, University of Lisbon, Portugal
&
Antonio Rolo Bual
Researcher, IN+ Center for Innovation, Technology and Policy Research, University of Lisbon, Portugal

Assessment of the Potential Consumption of Green Hydrogen in the Portuguese Industrial Sector as a Direct Feedstock and for High Heat Applications

The global need to decarbonize energy systems has intensified the search for alternative production, storage, and transport solutions. Among these, green hydrogen has emerged as a promising energy vector capable of supporting industrial and energy sector decarbonization. However, its large-scale deployment still faces significant technical, economic, and infrastructural challenges.

This work assesses the potential for green hydrogen consumption within the Portuguese industrial sector, with a particular focus on high-temperature heat applications and direct feedstock use. Through a geographically detailed approach, the analysis identifies major industrial players, their potential hydrogen demand under different blending scenarios (5%, 10%, and 20% with natural gas), and their spatial distribution across the country.

The study further distinguishes between hydrogen used as a feedstock, currently concentrated in key facilities such as Galp's Sines refinery and Bondalti's Estarreja chemical complex, and hydrogen used for heat applications, notably in sectors like cement, glass, and ceramics. This mapping provides insight into how green hydrogen infrastructure could be implemented, either through centralized blending within the existing gas network or through decentralized supply to major industrial consumers.

By combining industrial, geographical, and infrastructural perspectives, this work contributes to understanding how hydrogen demand could emerge regionally and identifies potential synergies to support the development of a sustainable green hydrogen economy in Portugal.

Liping Di
Professor and Director, Center for Spatial Information Science and Systems, George Mason University, USA
&
Liying Guo
Research Professor, George Mason University, USA

Making Stressed Rural Community Climate Resilient with Geospatial Digital Twin and GeoAI Technologies

Climate predication has shown that the rural region in the U.S., particularly in the Midwest, will experience significant increases in temperature, the frequency and intensity of extreme precipitation, and spatiotemporal unevenness of precipitation distribution. As the results, the rural region will experience significant deterioration of the natural environment with increased heatwaves, more frequent and intensive floods and droughts, and severer soil erosion potential. The deterioration will impact crop yield and shock the stressed and venerable natural and socioeconomic systems in the rural communities, which are characterized as relatively poor population and an environmentally dependent economy. Such characteristics will make the communities more venerable to climate variability and change, causing severe consequences to the environment, economy, and population if the communities in the region don't take preventive actions proactively to make the communities more climate resilient. Despite the anticipated significant impacts, many rural communities face considerable challenges in dealing with the impacts due to a lack of locally relevant actionable climate information, inadequate community awareness of the impacts and risks, and insufficient knowledge and inadequate tools to cope with them. Recent development in geospatial digital twin and GeoAI technologies provides great potentials to solve these challenges. GeoAI technology has demonstrated its capability to translate the coarse-resolution global climate predictions to high-resolution locally relevant actionable information. The geospatial digital twin provides the capability of serving communities with decision-ready information, "what-if" decision assistance, and automated decision-making services. In this project, a Rural Community Climate Resilience Digital Twin (RCCRDT) was developed as the major tool to support the rural climate resilience decision making and the Southern Five region of Illinois was selected as the test and demonstration region. Situated at the northernmost part of the Upper Delta Region and consisting of the Southernmost Illinois Counties of Alexander, Johnson, Massac, Pulaski,

and Union, this region is a federally designated Economic Development District (EDD). This region has historically faced unemployment and poverty rates two to four times higher than state and national averages. Geographically, the region is featured with steep topography and easy-toerosion soil type, making the region the highest erosion rate in the state of Illinois. Therefore, currently this rural region is both socioeconomically and environmentally stressed. To make the region climate resilient, with the support of RCCR-DT this project collaborated with the community partners to identify and prioritize the major climate risks in the region, design, test, and evaluate solutions to the risks through community-engaged "what-if" tradeoff study to find the best solution to specific climate risks, and help communities in the region to develop the climate resilience plan. The project also organized comprehensive outreach and capacity building activities to make local communities and individuals aware of climate change impacts to their communities and actions for resilience. In conclusion, this project has made the region more climate resilient. The methodology and RCCR-DT of this project can be directly replicated in the other U.S. rural regions for facilitating climate resilience.

Agnieszka Faligowska
Professor, Poznań University of Life Sciences, Poland
Katarzyna Panasiewicz
Professor, Poznań University of Life Sciences, Poland
Grażyna Szymańska
Associate Professor, Poznań University of Life Sciences, Poland
Karolina Ratajczak
Professor, Poznań University of Life Sciences, Poland
&
Anna Kolanoś
PhD Student, Poznań University of Life Sciences, Poland

The Influence of Different Methods of Cultivation Using Strip Sowing on White Lupin Yield

Soil tillage practices play a key role in shaping soil structure, nutrient availability, and water retention, which directly affect crop growth and productivity. In recent decades, non-plough tillage systems have gained increasing interest due to economic, environmental, and climatic considerations. Among them, partial plough tillage combined with strip-drill sowing has been proposed as an approach that may balance yield optimization with soil conservation. This study aimed to evaluate the effects of different tillage systems on the productivity and seed quality of white lupin.

The experiment was conducted from 2017 to 2019 at the Experimental Station in Brody (52°26′ N; 16°18′ E), belonging to the Department of Agronomy at the Poznań University of Life Sciences, located approximately 50 km west of Poznań in the Wielkopolska region of western Poland. The field experiment included four pre-sowing tillage systems: (1) plough tillage with conventional row sowing, (2) plough tillage with strip-drill sowing, (3) non-plough tillage with strip-drill sowing, and (4) zero tillage with strip-drill sowing. At full maturity, 15 plants from each plot were randomly collected to determine the number of pods per plant (PP), seeds per plant (PS), and seeds per pod (NSP). Plant density per 1 m² (PN) was assessed before harvest using the frame method, and thousand seed weight (WTS) was determined after harvest from two subsamples of 500 seeds per replication.

The results demonstrated that the applied tillage systems significantly influenced white lupin productivity, seed quality parameters, and selected soil properties. The variability in white lupin yield across the three years (2017–2019) in our study underscores the influence of annual environmental conditions. The highest seed yield

was found in 2018, where the rainfall sum during vegetation period was the highest (about 550 mm) and the air temperature at the level 15.0ºC. The experimental factor influenced significantly on yielding of white lupin. Compared to plough tillage with conventional row sowing, the non-plough tillage with strip-drill sowing caused increase of seed yield by 0.5 ton per hectare.

Eastonce T. Gwata
Professor, University of Venda, South Africa

A Survey of Grain Crude Protein and Selected Mineral Content among Finger Millet *(Eleusine coracana)* Traditional Varieties

Finger millet (*Eleusine coracana*) is a small-grain cereal which is cultivated primarily for human consumption. It originated in east Africa and is highly adapted to the drought conditions that are prevalent in the region. The grain contains considerable amounts of vitamins and minerals. However, the nutritional attributes, particularly protein content and mineral composition in the finger millet the traditional varieties in our collection, have not been determined adequately. This study examined the grain crude protein and key micro- and macro-elements among 20 traditional varieties which were raised under field conditions at a representative semi-arid ecotope in Limpopo Province (South Africa). Grain samples of each variety were analyzed in duplicate in the laboratory. The results showed that five varieties produced more than 10.65% grain protein in comparison with the check. Two varieties, FM-1 and FM-17 attained the highest (12.35%) and lowest (7.51%) grain protein content, respectively. Variety FM-6 achieved the highest phosphorus content (8.90 mg/kg) but relatively low calcium. In contrast, FM-14 attained the highest (26.05 mg/kg) grain sulphur content as well as a high (8.25 mg/kg) phosphorus content but low in potassium and calcium. On the other hand, variety FM-17 showed the highest iron content (11.65 g/kg) while both FM-18 and FM-19 were high in manganese grain content. In conclusion, these findings indicated marked variability that can be exploited in future improvement of local finger millet varieties aimed at enhanced nutrient content for end-users.

Lilach Iasur Kruh
Senior Lecturer, Braude College of Engineering, Israel
Adi Zeevi
Braude College of Engineering, Israel
Maya Lalzar
University of Haifa, Israel
Omer Frenkel
Department of Plant Pathology and Weed Research, Volcani Center, Israel
Shahal Abbo
The Levi Eshkol School Agriculture, The Hebrew University of Jerusalem, Israel
&
Abraham Gamliel
Volcani Center, Institute of Agricultural Engineering, Israel

Seed-Borne Microbiota from Wild *Cicer* as a Biological Tool to Enhance Growth and Disease Resilience in Domesticated Chickpea

Seed-borne bacteria are a unique group of microorganisms, capable of maintaining stable populations within plant tissues and seeds. These bacteria may benefit their host from germination to maturation and are of great interest for basic and applied plant-microbe interaction studies. Furthermore, many such beneficial bacteria, present in wild plant species, are missing in respective congeneric domesticated forms.

The objectives of the current study were to explore the bacterial communities within the seeds of wild *Cicer* species and to select beneficial bacteria which can be used to improve production of domesticated chickpeas. We analyzed the composition of seed-borne bacteria of chickpea (*Cicer* spp.) comparing wild and domesticated species from different geographic locations. Subsequently, we isolated the dominant and prevalent seed-borne bacteria from wild *Cicer judaicum*, and assessed its ability to colonize and affect growth of domesticated *C. arietinum* and other legume crops.

The composition and structure of seed-borne bacterial communities differed between wild and domesticated chickpea and across geographic locations, with *Burkholderia* dominating domesticated chickpea at all sites, while *Bacillus* or *Sphingomonas* predominated in wild *Cicer* depending on location.

An isolated *Bacillus* strain (designated CJ), representing the most prevalent bacterial taxon in wild *Cicer*, was applied to domesticated

chickpea via seed coating. *Bacillus* sp. CJ successfully colonized domesticated chickpea plants, enhanced plant growth parameters, and improved plant performance under *Fusarium* infection. These results demonstrate the potential of reconstructing the microbiota of crop plants by using seed-borne wild microbiota reservoir.

Pavel Ikonomov
Professor, Western Michigan University, USA
&
Siddi Govardhan Reddy Karapureddy
PhD Student, Western Michigan University, USA

Vision-based AI/ML-Enabled Optimization for Hybrid Metal 3D Printing

Hybrid metal 3D printing integrates metal additive manufacturing with subtractive machining, usually Wire Arc Additive Manufacturing (WAAM) with Computer Numerical Control (CNC) machining to enable fabrication of complex geometries while maintaining dimensional accuracy. Although metal WAAM supports high deposition rates, geometric non-uniformity introduced during layer-by-layer deposition requires machining. In hybrid workflows, machining is often done at the lowest point on the built surface to remove irregularities. Appropriate selection of the lowest point will decrease material waste, machining time, energy consumption, and cost.

This research proposes a vision-based, Artificial Intelligence (AI)-enabled in-situ surface geometry measurement for hybrid metal 3D printing. The system employs synchronized front-view and top-view cameras to capture weld bead geometry during deposition, with scalability to additional sensors depending on part complexity. An image-processing and machine learning (ML) model was developed using multiple weld bead samples to generate the deposition parameters. A vision-based measurement algorithm, using calibrated image segmentation techniques, was developed to automatically identify the width, highest and lowest points of weld beads. Calibration was performed under varying lighting conditions, camera angles, and corner detection to minimize pixel segmentation error. Through iterative calibration refinement, high resolution measurement can be achieved. The AI algorithm is used to extract geometric features including highest point, lowest point, and bead thickness in-process.

The extracted measurement data is correlated with the ML model to optimize deposition parameters and iteratively update the ML model. This process enables closed-loop optimization of the deposition process prior to subtractive machining.

By shifting inspection from post-process to in-process, this work supports unattended and automated hybrid 3D printing process, reducing excess material removal, and improving productivity while enhancing economic sustainability.

Stamatina Kotsakou
Assistant Professor, California Polytechnic State University, San Luis Obispo, USA

Demand for Plant-Based Meat: Competition with Animal Proteins, Effects of Households' Health Status and Diet Concerns, and Implications for the Environment

Three promotional branches have supported the second generation of plant-based meat, i.e., of the products that mimic the culinary properties of animal meat: protection of animal welfare, of the environment, and of consumers' health through the reduction of animal meat consumption. The goal of this study is to understand whether consumers view plant-based meat as a way to reduce meat consumption and, in turn, benefit their health and the environment.

To address this question I use a dataset that consists of households' protein purchases over time, combined with household demographic and health information. The data contain detailed information on 127,606 households' meat purchases, along with their demographic and medical information, from 2012 to 2022.

The empirical model of the study breaks a household's decision to consume plant-based meat into two processes ("hurdles"): the decision to participate, and, conditionalon participating, the decision of how much to consume. The key results from the double-hurdle model estimation suggest that only 29% of the household panelists considered participation in the plant-based meat market. The analysis showed that the prices of substitute proteins, education of the primary shopper, concerns about food and adoption of an ingredient-conscious diet were strong positive determinants of both participation and level of consumption. The price of plant-based meat does not play a role on the participation decision and it is consistently negatively correlated with expenditure, but the effect is not always statistically significant.

The households that permanently adopted plant-based meat over the years reduced meat consumption by 10% and increased seafood consumption by 13%. However, their overall expenditure on proteins (plant-based meat included) increased by 29% which implies that households increased the variety of proteins with plant-based meat but did not fully replace an animal protein with it.

Nonkululeko Mfeka
Lecturer, Cape Peninsula University of Technology, South Africa
Francis Bayo Lewu
Professor, Cape Peninsula University of Technology, South Africa
&
Azwimbavhi Reckson Mulidzi
Researcher, Agricultural Research Council, South Africa

Physiochemical Properties and Enzyme Activity of Different Growing Media in Blueberry Production

Soil health is a reliable indicator of the potential for optimum production of agricultural produce. However, due to limitations in natural resources, such as the availability of good-quality soil, production can be hindered. The use of growing media has gained attention over the years in most production systems due to the beneficial components available in the media, which support sustainable production. Fruit crops such as blueberries are mainly cultivated using soilless systems. The study aims to assess the physiochemical and microbial enzyme activity of four growing media compositions. The research study was conducted at the Cape Peninsula University of Technology Agri-Hub from 2022 to 2024. A pot experiment was laid out in a randomized complete block design with five replications. The initial and final growing media samples were taken for physiochemical and enzyme activity analysis. Macronutrient properties were determined using the Kjeldahl and Bray II methods and the β-glucosidase assay using the colorimetric determination of the release of p-nitrophenyl glucopyranoside. The growing media combination, which included coir, peat moss and mushroom compost, improved the media macronutrients. Enzyme activity β-glucosidase was improved by the media combination with 60% coir and 40% peat moss. The hydrolases of β-glucosidase activity demonstrate a strong positive correlation with nitrogen and carbon, which is critical in the carbon cycle and the production of glucose that is used by the microorganisms present in the growing media. These findings suggest that the growing media combination containing coir and peat moss can potentially improve macronutrient availability and enzyme activity for blueberries cultivated under soilless conditions.

Jestinos Mzezewa
Senior Lecturer, University of Venda, South Africa

Effects of Integrating Conservation Tillage and Manure Application on Soil Hydraulic Properties

Conservation agriculture (CA) has improved crop yield across southern Africa compared to the traditional conventional tillage (CT). The improvement in crop yields is perceived to be due to the improvement in soil hydraulic properties that determine water entry and storage in the plant root zone in CA compared CT. Manure application is also known to influence soil hydraulic properties. There are few studies that evaluated the combination of conservation tillage and manure application. This study investigated the effect of minimum tillage (MT) and CT combined with cattle manure on (i) water retention curve (SWRC) and (iii) soil pore size distribution (PSD) (determined from SWRC) on clay soils. The manual form of MT, which is a form of CA practiced by smallholder farmers in southern Africa was tested using a split-plot design with tillage (MT and CT) as main plots and cattle manure applied as sub-plots at three levels: 0, 5, and 10 t/ha. Sunflower crops were the test crop. Undisturbed soil cores (5 cm diameter x 5 cm height) were collected from each treatment in 3 replicates in the crop row from the 3 soil depths (0 – 5; 10-15 and 20-30 cm) to determine SWRC with a sandbox apparatus at matric potentials (ψ) of 0, -2.5, -10, -31.6, -50, -63.1, -100 cm. Disturbed soils were also sampled from the same depths for the determination of WRC at matric potentials of -330, -500, -1000, -3500, -10 000 and -15 000 cm using pressure plate apparatus. Other soil hydraulic soil properties such as infiltration and aggregate stability were also determined. Results showed that aggregate stability, bulk density and cumulative infiltration were improved in MT compared with CT. However, cattle manure application had no significant effects. This was attributed to the low rates applied. Generally, there were no main effects of tillage and manure application on SWRC and PSD but there were significant interaction effects depending on soil depths. It was concluded that integrating minimum tillage and manure application is a viable practice that can improve soil hydraulic properties although more studies are needed to evaluate higher manure application rates.

Aveil Oberhammer
PhD Student, University of Guelph, Canada

Room to Roam: Conservation and Coexistence in Mongolia's Rangelands

The American Centre for Mongolian Studies' 2025 field school course, "*Hustai National Park: Managing Biodiversity in the Home of Mongolia's Native Horses*," provided a valuable opportunity to explore equid welfare in a unique ecological and cultural context. The program engaged researchers in examining how societal management practices and environmental conditions shape equid well-being across wildlife settings using scientific and technological approaches.

Equids require more space, care, and nutritional input than most other livestock species. Consequently, horse owners struggle with these demands, particularly as pastureland becomes increasingly degraded and fragmented. Most equid research globally centers around ideal-case recommendations for equine care, but real-world constraints, including geographic, financial, and cultural barriers, often make those ideals difficult to meet. Mongolia is no exception. While it would be easy to critique horse management from an academic standpoint, direct engagement with herders and observation of local challenges highlight the importance of practical and flexible solutions.

In Mongolia, livestock roam freely across vast rangelands with minimal direct management. Herders rely primarily on natural water sources, and supplemental forage is rarely used due to cost and limited availability. As a result, many modern agricultural principles are impractical or irrelevant in this context. During the Managing Biodiversity program, it became clear that the strategies used to support the Takhi, the world's last truly wild horse, often aligned more closely with Mongolian livestock systems than with conventional farming models.

Understanding how the ecosystem functions holistically to support the reintroduction of the Takhi has broader implications for pastoral sustainability in Mongolia. Conservation cannot happen in isolation; it must involve a symbiotic relationship between herders, wildlife, and the landscape. The situation in Mongolia mirrors a growing global issue: wild equids such as the Takhi, African wild asses, and zebras are increasingly threatened by habitat loss, largely due to the expansion of agriculture and grazing systems that prioritize productivity over ecological balance.

Field observations at Hustai emphasized the interdependence of species within the ecosystem. Marmots act as soil engineers, aerating the ground and supporting nutrient cycling, while also serving as a key prey species for wolves. When marmot populations are stable, predators like wolves are less likely to target young Takhi. Red deer help prevent overgrowth that would otherwise displace marmots, and they, too, offer an alternate food source for carnivores. In turn, the Takhi contribute to biodiversity through seed dispersal in their manure, carbon sequestration, and groundwater access via well-digging behaviors that benefit other species.

The field school emphasized that the future of wild equids depends not just on protecting land, but on finding ways for them to coexist meaningfully with people and livestock. We cannot remove agriculture, but we can redesign how we share land. In this way, conservation is not about excluding humans; it's about including them strategically. By supporting healthy ecosystems, conservation efforts like the Takhi reintroduction also help ensure long-term access to grazing, water, and soil resources that herders depend on. Livestock can similarly contribute to pasture health but only when stocking densities remain within the land's ecological capacity; a balance that becomes more attainable when conservation efforts improve rangeland resilience and resource availability. In conclusion, protecting biodiversity and supporting traditional livelihoods are not opposing goals; when approached thoughtfully, they can be mutually reinforcing.

Katarzyna Panasiewicz
Professor, Poznań University of Life Sciences, Poland
Agnieszka Faligowska
Professor, Poznań University of Life Sciences, Poland
Grażyna Szymańska
Associate Professor, Poznań University of Life Sciences, Poland
Karolina Ratajczak
Professor, Poznań University of Life Sciences, Poland
&
Anna Kolanoś
PhD Student, Poznań University of Life Sciences, Poland

The Effect of Different Methods of Cultivation Using Strip Sowing on Seeds Quality of White Lupin

These findings highlight the need for a nuanced understanding of tillage systems tailored to specific agro-ecological conditions. Integrating moderate tillage approaches, such as plough tillage combined with strip-drill sowing, with sustainable management practices can support soil health, resilience, and productivity. Crop and soil management systems that improve soil health parameters (i.e., physical, biological, and chemical) while reducing farmers' costs through the development of appropriate equipment are essential for the successful adoption of these systems in agricultural practice.

Modern machinery has made it possible to prepare tilled strips in a single pass while simultaneously applying fertilizers and sowing seeds. In strip-tillage systems, strips of deeply loosened soil, several to several tens of centimeters wide, are prepared for seed placement.

The experiment was conducted from 2017 to 2019 at the Experimental Station in Brody (52°26′ N; 16°18′ E), belonging to the Department of Agronomy at the Poznań University of Life Sciences. The station is located approximately 50 km west of Poznań in the Wielkopolska region of western Poland. The field experiment included four pre-sowing tillage systems: (1) plough tillage with conventional row sowing, (2) plough tillage with strip-drill sowing, (3) non-plough tillage with strip-drill sowing, and (4) zero tillage with strip-drill sowing.

A standard germination test was conducted on 100 randomly selected seeds from each replication using the between-paper method at 20 ± 1 °C. Germination capacity was visually assessed after 8 days, and the results were expressed as percentages.

Weather conditions and experimental factors influenced the sowing value of white lupine. The lowest germination capacity was observed in

2017 (approximately 88%), whereas the highest was recorded in 2018 (approximately 93%). The sowing method in combination with soil tillage also modified the germination of white lupine seeds. Compared with plough tillage with conventional row sowing, strip-drill sowing increased significantly germination capacity.

Leyli Purrafee Dizaj
Postdoctoral Researcher, Museum Für Naturkunde Berlin, Germany
Nadia Fröbisch
Professor, Museum Für Naturkunde Berlin, Germany
&
Florian Witzmann
Professor, Museum Für Naturkunde Berlin, Germany

The Cranial Dermal Bone Ornamentation in Extant and Extinct Amphibians: A Comprehensive Review

The cranial dermal bone ornamentation represents a widespread and characteristic feature among extant and extinct amphibians, although its evolutionary origin and functional significance remain subjects of ongoing discussion. This research examines cranial sculpture in temnospondyls and Lissamphibia, with particular emphasis on its evolutionary development and distribution across these lineages. Evidence from both fossil specimens and modern histological studies is synthesized to describe the macrostructural patterns and microstructural organization of sculptured dermal bone. This review also discusses several functional hypotheses, including roles in mechanical reinforcement, physiological processes such as thermoregulation or fluid balance, and potential functions in ecological interactions or behavioural display. The biological and developmental mechanisms responsible for the formation and patterning of dermal ornamentation are also considered, providing insight into how these structures emerge and change through growth and evolution.

Didar Rahim
Director of Studies, Vision Foundation for Strategic Studies, Iraq

Digital Market Intelligence and Agricultural Resilience in the Kurdistan Region of Iraq

The agricultural sector in the Kurdistan Region of Iraq (KRI) is undergoing a significant transformation. The region has fertile land and good market linkages, but climate change, market instability, and fragmented institutions make it vulnerable. This causes food shortages, financial instability from emergency imports, and lower private sector investment. Poor governance and disconnected information systems hampered reform and externally sponsored digital projects. This policy research presents an innovative approach to enhance resilience and economic stability through a national Digital Market Intelligence Architecture (DMIA) supported by a legally recognized Digital Agriculture Authority (DAA). This study examines climate trends, production and trade data, fiscal vulnerabilities, and global comparisons to create a sovereign, integrated, and proactive agricultural intelligence framework.

The proposed DMIA seeks to consolidate various data streams, employ sophisticated analytics for yield and import forecasting, and deliver prompt market and climate insights to policymakers, farmers, and investors. Legal frameworks, data systems, capacity building, financing strategies, and risk management are needed to implement a five-year plan. This might reduce emergency food import prices by 20%, increase smallholder incomes by 30%, and attract USD 20-25 million in agricultural investments, improving regional food security and governance. The Vision Foundation for Strategic Studies plays a crucial role in evaluating, strategizing for the future, and enhancing capabilities, emphasizing transparency, data-driven approaches, and a commitment to international benchmarks in reform initiatives. The incorporation of advanced digital intelligence into resilient institutions enables KRI to shift from a reactive approach to crisis management to a proactive, inclusive, and investment-oriented framework for agricultural governance, thereby improving domestic stability and strengthening regional food resilience.

Jatuporn Rattanasrisomporn
Instructor, Kasetsart University, Thailand
Chantima Pruksakorn
Assistant Professor, Kasetsart University, Thailand
Phirabhat Saengsawang
Assistant Professor, Kasetsart University, Thailand
Kinpsiva Luekhong
Student, Kasetsart University, Thailand
Nantakon Titsungnoen
Student, Kasetsart University, Thailand
Pornchanun Manuskittikul
Student, Kasetsart University, Thailand
Reena Kiatchariyawat
Student, Kasetsart University, Thailand
Amonpun Rattanasrissomporn
Assistant Worker, Kasetsart University, Thailand
&
Natthasit Tansakul
Instructor, Kasetsart University, Thailand

Prevalence and Antimicrobial Susceptibility of Bacterial Isolates from Dogs with Cystitis

Cystitis is a prevalent condition in dogs, primarily caused by bacterial infections that require specific antimicrobial treatment, which highlights the need to understand local bacterial pathogens and antimicrobial resistance. This study aimed to identify the bacterial species and determine their antimicrobial susceptibility in canine cystitis cases at the Kasetsart University Veterinary Teaching Hospital (KUVTH), Bangkok, Thailand, from 2022 to 2023. Analysis of 90 urine samples (collected via cystocentesis and voiding methods) yielded 106 bacterial isolates. Gram-negative bacteria predominated, led by *Proteus mirabilis* (28.3%) and *Escherichia coli* (23.6%), while the *Staphylococcus intermedius* group (18.9%) was the most frequent Gram-positive isolate. Regarding common first-line drugs, susceptibility rates were moderate: *P. mirabilis* showed 73.3% susceptibility to amoxicillin-clavulanic acid (AMC); *E. coli* showed 64% susceptibility to both AMC and sulfa-trimethoprim; and the *Staphylococcus* group exhibited 80% susceptibility to AMC and cephalexin. Critically, all identified species showed high susceptibility (exceeding 80%) to injectable drugs like amikacin, ceftriaxone, imipenem, and meropenem. These findings provide essential data to guide the selection of empirical antimicrobial agents for

more effective clinical treatment at KUVTH, establish a baseline for monitoring future AMR trends, and contribute vital veterinary data essential to the regional 'One Health' approach to antimicrobial stewardship.

Ciro Righi
Professor, University of São Paulo, Brazil

Land Use Impacts on Soil Fertility, Carbon Stocks, and Microbial Activity in the Amazonian Floodplains, Brazil

In this study, we evaluated the effects of land use on soil properties in the floodplains of the Amazon River estuary in Brazil. Soils were sampled to a depth of 2 m under açaí (Euterpe oleracea) agroforestry, upper and lower floodplain (várzea) forests, regenerated forest, and mangrove ecosystem. Analyses included chemical properties, soil organic carbon (SOC) content and stock (SOCS), microbial indicators [β-glucosidase activity (BG) and microbial biomass carbon (MBC)], soil moisture, and bulk density. SOC ranged from <0.3% in upper floodplain (várzea) forests to 2.8% in mangrove soils. SOCS varied from 27.6 Mg C ha^{-1} (regenerated and lower floodplain forests) to 52 Mg C ha^{-1} (mangroves). BG activity ranged from 1.28 µg pNP g^{-1} h^{-1} (lowest in deeper layers of várzea) to 14.76 µg pNP g^{-1} h^{-1} (highest in açaí agroforestry), while MBC ranged from 59 mg C kg^{-1} (upper floodplain subsoil) to 544 mg C kg^{-1} (mangrove subsoil). Regression analyses showed significant pH -carbon relationships, while SOC, available phosphorus, cation exchange capacity, and MBC were significantly correlated. Our results indicate that land use and soil depth significantly affect carbon storage and nutrient cycling, as reflected by microbial, chemical, and physical indicators. Mangrove soils act as important deep carbon reservoirs, highlighting the interaction of hydrology, vegetation, and soil processes in regulating floodplain fertility.

Taulant Shabani
PhD Student, Justus Liebig University Giessen, Germany
&
Rainer Waldhardt
Professor, Justus Liebig University Giessen, Germany

Evaluation of the Effects of the Seed Terminator on the Segetal Vegetation on Three Tillage Method

Given profound changes in the framework conditions for German crop production - driven by e.g., climate change, greenhouse gas reduction targets, societal demands to minimize pesticide use, the rise of herbicide resistant weed species, and ongoing biodiversity loss - cropping systems must be fundamentally reconsidered and adapted. In this context, the technology of the Seed Terminator might play an important role in the near future. As an innovative technology, the Seed Terminator provides a sustainable means to reduce weed seed input into the soil seed bank, thereby lowering weed pressure and decreasing herbicide dependence.

Given this background, we have been assessing the efficacy of the Seed Terminator under practical farming conditions across three cultivation systems with direct sowing, mulching, and plowing on agricultural land in Hesse (Germany) in a four-years project. During the first project year, comprehensive soil seed bank analyses and systematic weed relevés were conducted across all experimental sites. In the presentation, the research concept and first results on the dynamics of the segetal vegetation of the fields under study will be presented and discussed.

Michaela Summerer
Independent Researcher, Switzerland

Economic Development in the Buffer Zones: An Imperative for Nature Conservation by the Example of Hustai National Park, Mongolia

Economic development is often seen in direct opposition to nature conservation. This paper argues, through the example of Hustai National Park (HNP) in Mongolia, that economic development is in fact a key pathway to enable effective nature conservation.

The buffer zones surrounding national parks harbor large communities. In the case of HNP, many herders settle around the national park with their livestock. Reducing the livestock numbers is of utmost importance to reduce the related pressure on the pasture, that is often lusher in the national park and leads to frequent infringement of its boundaries. In addition, the lucrative trade in protected species increases pressure on nature conservation efforts, driven by perceived economic opportunity.

The paper analyses various economic opportunities and activities for buffer zones areas in line with nature conservation efforts, which may serve as additional income streams for the surrounding communities. It underlines the importance of including the communities in the border areas, buffer zones and its economic development in effective nature conservation plans.

The paper further advocates for a broader understanding that effective nature conservation can only be achieved in collaboration with the local communities, in a symbiotic relationship leveraging the synergies and thereby reducing the pressures on the national park. Sustaining local livelihoods may also sustain nature conservation efforts for generations to come.

Natthasit Tansakul
Instructor, Kasetsart University, Thailand

Application of Hemp and Hemp Seed: Unlocking the Potential for Companion Animal

Hemp oil, particularly cannabidiol (CBD), and hemp seeds are being increasingly appreciated for their potential applications in companion animal care. Both components of Cannabis sativa L. play significant roles in nutrition, wellness, and alternative medicine for animals.

Hemp-derived CBD is recognized for its bioactive cannabinoids, which include over 140 compounds with potential health benefits. This makes CBD a prospective therapeutic aid for various conditions in animals such as anxiety, pain, and possibly even behavioral disorders. However, more research is necessary to fully understand its safety and efficacy.

Hemp seed oil is another valuable product derived from hemp seeds. It is rich in omega-6 and omega-3 fatty acids, providing essential nutrients for maintaining healthy skin and coat in animals. In companion animal nutrition, hemp seeds and oil can serve as supplements, enriching diets with high-quality protein and favorable fatty acids such as linolenic and linoleic acids. These components could enhance the health of the companion animals.

Furthermore, hemp seeds have been utilized in animal feed, showing increases in beneficial fatty acids in the animal products. The protein-rich nature of hemp seeds is also beneficial for formulating nutritionally complete animal diets. Hemp-derived ingredients are also seen in cosmetics aimed at animal care, where their efficacy and safety are closely monitored. Here we conducted experimentally use of hemp and derived in dogs.

In summary, hemp oil and hemp seeds present numerous opportunities for enhancing companion animal health through dietary and topical applications. While they hold promise, it is essential to conduct further studies to comprehensively evaluate their benefits and address any potential risks in the application to animals

Gizachew Tiruneh
Postdoctoral Researcher, University of São Paulo, Brazil

Integrating Spectroscopy with Machine Learning to Predict Soil Enzyme Activity and Carbon Stocks in Amazonian Floodplain Soils, Brazil

Soils of the tropical regions harbor a rich diversity of microorganisms that drive essential ecosystem services such as nutrient cycling, carbon flux, and dynamics of soil organic carbon stock (SOCs). However, the biochemical direct quantification of the enzyme activities and the estimation of SOCs are laborious, cost-intensive, and not feasible for large-scale and/or long-term studies. This study evaluated whether proximal soil reflectance spectroscopy, combining visible–near-infrared, shortwave-infrared (Vis-NIR–SWIR) and mid-infrared (MIR) domains, can reliably predict β-glucosidase (BG) activity and SOCs across contrasting land uses and depths in Amazon floodplain soils, Brazil. A total of 73 soil samples were collected under açaí agroforestry, lower forest, regenerated forest, and upper forest systems at four depths (0–5, 5–10, 25–30, and 45–50 cm). The samples were characterized for chemical fertility, SOCs, BG activity, and spectral signatures, followed by spectral preprocessing, feature attribution, and supervised machine-learning modeling. SOCs showed marked depth effects, with maximum value at 5–10 cm in açaí agroforestry (9.15 Mg C ha^{-1}) and at 25–30 cm in regenerated forest (8.98 Mg C ha^{-1}). BG activity had its maximum in regenerated forest between 25-30 cm (94.8 μmol g^{-1} h^{-1}) and a minimum in upper forest (72.2 μmol g^{-1} h^{-1}). Machine- learning based models exhibited excellent predictive accuracy for BG using raw Vis-NIR–SWIR spectra (R^2 = 0.85, RMSE = 1.95, RPD = 7.68), while the prediction of SOCs was weaker even using MIR (R^2 = 0.529, RMSE = 2.693 Mg C ha^{-1}, RPD = 1.36). Regenerated forest and açaí agroforestry maintained high SOCs and BG activity, enhancing subsoil carbon storage and microbial functioning across the Amazon. Additionally, spectroscopy, especially Vis-NIR-SWIR for BG activity and MIR for SOCs, was a fast and non-destructive method to incorporate biological factors in soil health assessment under the influence of land use changes. Future studies should include diverse soil types and climates, larger sample sizes, seasonal variability, and advanced modeling approaches to improve the prediction of BG activity and SOCs.

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