



AGRICULTURAL WATER MANAGEMENT
LABORATORY (LMEA)

RESEARCH BOOK



2024-2025



Director's Foreword: Editorial 2024–2025

It is with great pride that I present this Research Book, which bears witness to the scientific vitality of the Laboratory for Agricultural Water Management (LMEA) for the period 2024–2025. Since its establishment in 2001 within the National Higher School of Agronomy (ENSA), our laboratory has continuously evolved to address the crucial challenges facing our country.

The current climatic context places unprecedented pressure on water resources and food sovereignty. In response to these challenges, LMEA has been structured around four multidisciplinary research teams. Our 33 researchers and doctoral students combine their expertise in hydraulics, agricultural machinery, soil sciences, and new agricultural technologies to propose pragmatic and innovative solutions.

The past two years have been marked by major achievements, including a significant increase in scientific output (55 scientific publications since 01/01/2021), with numerous papers published in high-ranking (Category A) journals. These works address wastewater reuse, soil erosion, precision agriculture, climate change, and agricultural machinery. In addition, the opening of a doctoral training program within LMEA in 2025, with the recruitment of three doctoral students, represents a major milestone.

LMEA does not merely produce knowledge; it builds bridges between science and the socio-economic world. Our collaborations with public and private partners, as well as our national (PRFU) and international (PRIMA) projects, demonstrate our commitment to anchoring research in operational reality.

By browsing this book, you will discover the richness of our work and the commitment of our teams to sustainable and resilient agriculture. I would like to thank all members of the laboratory for their dedication, as well as our partners for their valuable support in bringing these works to fruition.

Enjoy your reading.

Prof. FEDDAL Mohamed Amine
Director of the LMEA Laboratory

1. Vision and Governance

Founded in 2001 and revitalized in 2015, 2018 and 2023, the Laboratory of Agricultural Water Management (LMEA) is positioned as a key actor in food security in Algeria. Under the leadership of Prof. Feddal Mohamed Amine, the laboratory brings together multidisciplinary researchers and doctoral students working on water, soil, agricultural machinery and innovative technologies.

Key Figures (2024–2025):

- **Staff:** 33 members (researchers and doctoral students)
- **Research units:** 4 multidisciplinary teams
- **Infrastructure:** New facilities within the Rural Engineering Department including offices and storage areas.

2. Activity Report of team 1

2.1. Presentation of team 1 :

Team Title: Water Resources and Environmental Degradation
Team Leader : Professor HANK Dalila (dalila.hank@edu.ensa.dz)
Scientific Description of the Research Program <p>The agricultural sector is considered the main consumer of water. The reuse of treated wastewater can be regarded as an integral component of environmental pollution control and water management strategies. Recent advances in irrigation water management have opened new pathways for pollution mitigation and the reuse of treated non-conventional water for efficient and value-enhancing irrigation management.</p> <p>Indeed, the use of non-conventional water represents an additional irrigation resource, while treated wastewater constitutes a source of fertilizing elements, allowing for reduced fertilizer use.</p> <p>This theme is addressed by a multidisciplinary team through research focused on the valorization of non-conventional water resources, the development of efficient irrigated agriculture, and water-saving strategies within the current climatic context, taking into account projected climate change.</p>

2.2.Scientific Output :

Year	Article	Journal	Cat.	Link
2025	Integrating the Nexus approach in sludge management: co-composting wastewater sludge and green waste for enhanced forestry	Journal of Environmental And Sciences	A	https://doi.org/10.1007/s13762-025-07007-x
2025	Agricultural Valorization of Urban Sewage Sludge: Short-Term Effects on Trace Elements Contamination in Cultivated Soil	Nature Environment Pollution Technology.	A	https://editorial.neptjournal.com/index.php/1/article/view/1442/267
2025	Massire project: Strengthening networks for agricultural and rural innovation in oases and arid zones of the Maghreb. Approach, activities and results	Cirad-Agritrop	-	http://agritrop.cirad.fr/612415/1/MassireProject-ApproachActivitesAndResults.pdf
2025	Agricultural Water Management under Water Scarcity in Algeria: Practices and Future Perspectives	The Open Agriculture Journal	B	https://www.openagriculturejournal.com/VOLUME/19/ELOCATOR/e18743315442659/PDF/
2024	An engineering approach to support user-led innovation in improving the performance of artisanal irrigation pivots in the Algerian Sahara	Agricultural Water Management	A	https://www.sciencedirect.com/science/article/pii/S0378377424005377/pdf?md5=25283cdce57821033ca2205b655e85d2&pid=1-s2.0-S0378377424005377-main.pdf
2024	A story of hope and frustration: a wastewater-based agricultural frontier in the Algerian Sahara	International Journal of Water Resources Development	A	https://www.tandfonline.com/doi/full/10.1080/07900627.2024.2311803?scroll=top&needAccess=true
2024	Shedding the Light on Irrigation Systems Degradation in the Algerian Desert	Chapter book : Climate Change and Environmental Degradation in the MENA Region	-	https://link.springer.com/chapter/10.1007/698_2024_1111
2024	Unlocking the Reclaimed Wastewater Reuse in a Pioneer Front, in Beriane, Algeria	Conference paper : Recent Advances in Environmental Science from the Euro-Mediterranean and Surrounding Regions (3rd Edition)	-	https://link.springer.com/chapter/10.1007/978-3-031-43922-3_84
2024	Forecasting Oligochaeta Abundance using the Apparent Electrical Conductivity of Irrigated Soils with Reclaimed Wastewater: Evidence from	Agricultural Science Digest	B	https://arccjournals.com/journal/agricultural-science-digest/DF-599

2.3. Ongoing Research Projects

Période (Début_ Fin) du projet	Intitulé du Projet	Porteur de projet
2022/2025 (Ongoing)	Etude de faisabilité pour une recharge artificielle de l'aquifère de la Mitidja par les eaux usées épurées (<i>PRFU</i>)	Project Leader: Pr. Chabaca M Nacer
2021/2023 (Completed)	Maitrise et Évaluation de la Réutilisation des Eaux Usées traitées en Agriculture et mise en place d'un système de Monitoring en temps réel. (<i>Projet de recherche international</i>)	Project Leader: Pr. Chabaca
2023/2026 (Ongoing)	PRIMA SWRIPS Sustainable Wastewater Re-Use with Innovative Purification and Sensing system for the agrifood supply chain	Project Leader: Pr. Hartani
2025 - 2028 (Ongoing)	Morfeus. PRIMA S1 Mediterranean Operational Resilience Framework for nexus-based territorial Solutions	Project Member: Pr. Hartani
2023-2025	Careful Irrigation. Agro-ecology for sustainable and just groundwater governance	Project Member: Pr. Hartani

2.4. Doctoral Theses Defended (2022–2025)

- **Ouradi L. (2025)**
Effect of Irrigation with Treated Wastewater on Soil Biodiversity (Oligochaetes) in the Corso Region (Boumerdes).
Doctorate, ENS Kouba – Defended on 11/12/2025
- **Sara Bekkadour (2024)**
Unlocking Non-Conventional Water Resources Toward New Hydro-Agricultural Models in Arid Environments: The Case of Ghardaïa.
Doctorate, ENSA – Defended on 22/09/2024
- **Nadjiba Boulahia (2024)**
Development and Implementation of Biomaterials for Wastewater Treatment.
Doctorate, ENSA – Defended on 29/07/2024
- **Islem Bioud (2023)**
Impact of Pressurized Irrigation Techniques on Soil Salinization Phenomena: Case of Arid Zones.
Doctorate, ENSA – Defended on 20/12/2023
- **Khomri Zine-Eddine (2023)**
Modeling of the Quaternary Aquifer of Biskra: Recharge and Discharge Estimation.
Doctorate, ENSA – Defended on 09/05/2023

3. Activity Report of team 2

3.1.Presentation of team 2 :

Team Title	: Agricultural Machinery and Agro-Equipment Technology.
Team Leader:	Prof.FEDDAL Mohamed Amine (med-amine.feddal@edu.ensa.dz)
Scientific Description of the Research Program	
<p>The “Agricultural Machinery and Agro-Equipment Technology” research team conducts research aimed at improving the performance of agricultural equipment, cropping systems, and farming practices, with the objective of promoting sustainable, efficient, and resilient agriculture, particularly in the semi-arid regions of Algeria.</p> <p>Its main objective is to contribute to the optimization of agricultural production systems through the improvement of tools and cultivation techniques, as well as the integration of precision agriculture technologies, in order to enhance productivity while reducing environmental impacts.</p> <p>The research activities of the team are structured around the following main axes:</p> <ul style="list-style-type: none">• Improvement of cereal production under climate change conditions Study and optimization of cultivation practices and agricultural machinery to stabilize and increase cereal yields in Algerian semi-arid regions, while accounting for climate variability.• Evaluation of the performance of Conservation Tillage Systems (CTS) Comparative analysis of soil conservation systems (direct seeding, reduced tillage, etc.) and assessment of their agronomic and agro-environmental effectiveness under Algerian pedoclimatic conditions.• Modeling of traction performance Development of mathematical models to estimate various mechanical and agronomic variables related to traction performance.• Development of intelligent spraying systems Design and optimization of spraying devices enabling precise and adaptive dosing of phytosanitary inputs according to crop requirements and spraying conditions, with the aim of improving treatment efficiency and reducing losses.• Assessment of post-harvest cereal losses Analysis of harvest losses in different cereal-producing regions of Algeria in relation to combine harvester type, machine settings, and harvesting conditions.	

3.2.Scientific Output

Year	Article	Journal	Cat.	Link
2026	Assessment of Cereal Yields Under Climate Change Based on RCA 4 Regional Climate Model Simulations	Dynamic Evolution of Atmospheric, Ecological, and Hydrological Systems in Circum-Mediterranean Regions	A	https://doi.org/10.1007/978-3-031-86777-4_64
2024	Dimensional Analysis based Prediction Model for Fuel Consumption in the Deutz Agrotrac Tractor	AGRICULTURAL SCIENCE DIGEST	B	https://arccjournals.com/journal/agricultural-science-digest/DF-561
2024	Irrigation Water Quality Assessment in Egyptian Arid Lands, Utilizing Irrigation Water Quality Index and Geo-Spatial Techniques	SUSTAINABILITY	A	https://doi.org/10.3390/su16146259?urlappend=%3Futm_source%3Dresearchgate.net%26medium%3Darticle
2024	Irrigation Practices and Their Effects on Soil Quality and Soil Characteristics in Arid Lands: A Comprehensive Geomatic Analysis	SOIL SYSTEMS	A	https://doi.org/10.3390/soilsystems8020052?urlappend=%3Futm_source%3Dresearchgate.net%26medium%3Darticle
2025	Integrating RUSLE, AHP, GIS, and cloud-based geospatial analysis for soil erosion assessment under mediterranean conditions	Scientific Reports	A	https://doi.org/10.1038/s41598-025-22503-3
2025	Performance analysis of the "boudour" direct seed drill in comparison with three tillage systems and their impact on lentil cultivation under semi-arid conditions	ARPN Journal of Engineering and Applied Sciences	B	http://www.arpnjournals.org/jeas/research_papers/rp_2025/jeas_0425_9593.pdf
2025	Assessment of wheat yields under climate change based on RCA4 model simulations in Tiaret region, Algeria	JOURNAL OF AGROMETEOROLOGY	B	https://journal.agrimetassociation.org/index.php/jam/article/download/2900/1703
2024	Exploitation of the Genetic Variability of Diverse Metric Traits of Durum Wheat (<i>Triticum turgidum</i> L. ssp. durum Desf.) Cultivars for Local Adaptation to Semi-Arid Regions of Algeria	PLANTS	A	https://doi.org/10.3390/plants13070934?urlappend=%3Futm_source%3Dresearchgate.net%26medium%3Darticle

3.3. Ongoing Research Projects

Period (Start_ End) of project	Title of project	Project Leader
2022/2025	Amélioration de la production céréalière face aux défis des changements climatiques au nord de l'Algérie (<i>PRFU</i>)	Pr. FEDDAL Mohamed Amine

3.4. Doctoral Theses Defended (2022–2025)

- **ECHCHERKI Smain (2023).**
Analysis of the Technical and Agronomic Performance of Conservation Tillage Systems (CTS) and Their Impacts on Cereal Production in Algeria.
PhD dissertation, National Higher School of Agronomy (ENSA), defended on January 16, 2023.
- **MEBARKI Mohamed Nadhir (2022).**
Analysis of the Physico-Mechanical Behavior of Compacted and Non-Compacted Soils under Two Tillage Systems and Their Effects on Cereal Crop Development.
PhD dissertation, National Higher School of Agronomy (ENSA), defended on February 20, 2022.
- **YACHI Abdelouahid (2022).**
Direct Seeding in Algeria: Agronomic and Energy Analysis.
PhD dissertation, National Higher School of Agronomy (ENSA), defended on February 22, 2022.

4. Activity Report of team 3

4.1. Presentation of team 3 :

Team Title: Innovative Technologies and Mapping for Sustainable Agriculture (TICAD)
Team Leader : Doctor LARIBI Abdelkader (Abdelkader.laribi@edu.ensa.dz)
Research Areas: Soils, water resources, crops, agrometeorology, crop models, soil–plant–atmosphere transfer models, spatial analysis, geographic information systems (GIS), remote sensing, and agricultural landscapes.

4.2.Scientific Output

Year	Article	Journal	Cat.	Link
2024	Assessment of the capability of Landsat-8 satellite imagery for predicting soil organic carbon distribution	Journal of Degraded and Mining Lands Management	B	https://doi.org/10.15243/jdmlm.2024.121.6781
2024	Mapping nutrient and soil fertility indexes for Durum Wheat in the La Mina region of Algeria	Journal of the Saudi Society of Agricultural Sciences	A	https://doi.org/10.1016/j.jssas.2024.06.005

4.3.Ongoing Scientific Projects

Period (Start_ End) of projet	Project title	Project leader
2023/2026	Evaluation du niveau de fertilité des sols en utilisant l'approche de l'indice de nutriment (<i>PRFU</i>)	Dr.LARIBI Abdelkader

5. Activity Report of team 4

5.1.Presentation of team 4 :

Team Title : Soil Typology and Behavior of Agricultural Soils
Team Leader : Dr.Hadj Miloud Samir (samir.hadjmiloud@edu.ensa.dz)

5.2.Scientific outputs

Year	Article	Journal	Cat.	Link
2025	Impact of Land Use On Soil Organic Matter Fractions and Physical Quality Under Sub-humid Climate in Algeria	African Journal Of Biological Sciences	B	https://doi.org/10.48047/AFJBS.7.5.2025.554-565
2025	Neural networks for the prediction of soil water retention in the upper Cheliff watershed, Algeria	Science Soil Annual	B	https://www.soilsa.com/Neural-networks-for-the-prediction-of-soil-water-retention-in-the-upper-Cheliff-watershed,204387,0,2.html
2025	Application of Artificial Neural Networks to Predict Solonchaks Index Derived from Fuzzy Logic: A Case Study in North Algeria"	Sustaibility	A	https://doi.org/10.3390/su17177798
2024	Assessment and mapping of soil calcium carbonate content using electromagnetic induction sensor	African Journal Of Biological Sciences	B	https://doi.org/10.33472/AFJBS.6.5.2024.6519-6532
2024	Comparative Study of Three Land Evaluation Systems in a North African region: case of Algeria	African Journal Of Biological Sciences	B	https://doi.org/10.33472/AFJBS.6.5.2024.7962-7975
2024	Mapping the Petrogypsic Horizon Occurrence Probability in the Sahara Desert Using Predictive Models	Eurasian Soil Science	A	https://link.springer.com/article/10.1134/S1064229323601920

5.3. Doctoral Theses Defended (2022–2025)

- **Dilmi Amal (2023).**
Soil Formation and Evolution under Forest Ecosystems in a Mediterranean Climate.
PhD dissertation, National Higher School of Agronomy (ENSA), defended in October 2023.
- **Degui Nouar (2024).**
Dynamics and Speciation of Trace Elements in Saline Soils of Arid Environments in Algeria.
PhD dissertation, National Higher School of Agronomy (ENSA), defended in May 2024.
- **Laoufi Hadjer (2025).**
Contribution to the Pedological and Geochemical Study of Saline Soils in the Endorheic Setifian Eco-Complex.
PhD dissertation, National Higher School of Agronomy (ENSA), defended in May 2025.

6. General Discussion: Scientific Production and Doctoral Training (2022–2025)

6.1. Dynamics of Doctoral Training

Between 2022 and 2025, LMEA recorded eight PhD defenses, reflecting sustained research-based training activity. The defenses were particularly concentrated in 2023 and 2024, a period during which the laboratory restructured its major scientific axes and human resources.

The official launch of a doctoral training program within LMEA in 2025, with the recruitment of three new doctoral candidates, represents a structuring milestone for the laboratory. It ensures the continuity of research activities, the renewal of scientific skills, and the strengthening of LMEA's academic visibility at the national level.

6.2. Quantitative and Qualitative Analysis of Scientific Production

The laboratory's scientific output over the recent period is characterized by a strong orientation toward high-level international journals. The majority of the publications fall within Category A, attesting to the scientific quality of the research and its international recognition.

- **Dominance of Category A journals:** Several articles have been published in journals such as *Scientific Reports*, *Agricultural Water Management*, *Sustainability*, *Plants*, and *Soil Systems*.
- **Complementarity of research teams:**
 - **Team 2 (Agricultural Machinery and Agro-Equipment Technology)** stands out for the volume and diversity of its publications, covering agricultural

machinery, cropping systems, precision agriculture, and the impact of climate change on cereal yields.

- **Team 1 (Water Resources and Environmental Degradation)** exhibits strong international visibility, with research focused on wastewater reuse, irrigation management, and socio-technical innovation in arid environments.
- **Teams 3 and 4** contribute in a targeted and high-quality manner in the fields of soil mapping, remote sensing, environmental modeling, and soil typology and behavior.

This thematic complementarity strengthens the overall scientific coherence of the laboratory and enables comprehensive coverage of the “**water – soil – plant – machinery**” continuum.

6.3. Knowledge Transfer, Innovation, and Strategic Positioning

Beyond scientific publications, LMEA stands out for its ability to generate results with high operational and applied value.

- **Genetics:** Development of wheat and barley varieties (PRFU 2019–2022).
- **Engineering:** Design of tillage implements and spraying systems, often developed through self-funding or logistical partnerships (ENPMA, MAGI), demonstrating the resilience and innovation capacity of the research teams.
- **PRIMA projects:** Active participation in major international research projects, particularly PRIMA initiatives, positioning the laboratory as a recognized Mediterranean research actor. The strong involvement of certain members, notably Prof. Hartani Tarik, in several international projects (three PRIMA projects), including as project coordinator, illustrates the scientific maturity of LMEA and its ability to integrate sustainably into competitive international research networks.

7. Conclusion and Perspectives

The 2024–2025 period confirms LMEA’s strategic role in scientific knowledge production and high-level training in the fields of water resources, soil science, agricultural machinery, and innovative agricultural technologies.

The laboratory’s future perspectives focus on:

- Strengthening publications in high-impact (Category A) journals,
- Consolidating doctoral training,
- Expanding international partnerships, particularly through PRIMA and Horizon Europe research projects,
- Supporting public policies related to food security and climate change adaptation.