



AI-HERBAGE : Artificial Intelligence for the Holistic Efficiency of Rangeland in terms of Breeding Animals and Grassland Exploitation

PEPR AgroEcoNum Axis 4

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Summary

AI-Herbage in a nutshell

The consortium

Expected outcomes

AI approaches

Data description



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AI-HERBAGE in words

PEPR AgroEcoNum Axis 4: Developing digital tools and methods for agriculture data processing and modelling, for agricultural equipment, and for decision support.

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PEPR AgroEcoNum Axis 4: Developing digital tools and methods for agriculture data processing and modelling, for agricultural equipment, and for decision support.

- ▶ **Title** : Artificial Intelligence for the Holistic Efficiency of Rangeland in terms of Breeding Animals and Grassland Exploitation
- ▶ **Titre** : Intelligence artificielle pour l'efficacité holistique des surfaces herbacées en termes d'élevage d'animaux et d'exploitation des prairies.
- ▶ **Keywords**: digital; modeling; algorithms; machine/deep learning; remote sensing; decision support; welfare; livestock; low-tech; grassland monitoring.
- ▶ **Objective**: improve grassland (pastures and meadows) management and associated farming practices by developing a full pipeline including monitoring, data analysis and tools for decision making

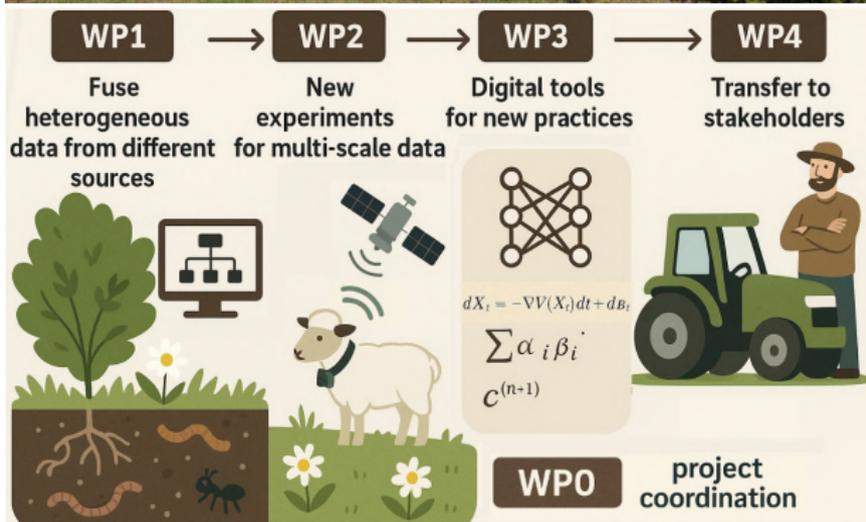


AI-HERBAGE in words

- ▶ **Objective:** improve grassland (pastures and meadows) management and associated farming practices by developing a full pipeline including monitoring, data analysis and tools for decision making
 1. Develop numerical methods to exploit a large set of data: **aerial acquisitions** (satellite, drone, etc.), **data from animal sensors** (location, weighing, etc.) and **field data** (plants, invertebrates, etc). Focus on **data quality enhancement** and **data fusion**.
 2. Develop concrete **decision-support tools** (e.g., information-enriched maps, sensor-based early warning systems as well as best-practice guidelines for landscape and resource management) for stakeholders (shepherds, meadow managers...).
- ▶ **Impact:** Contribute to agro-ecological transition: reduce inputs in grazing management, improve vegetation quality, monitor and favour biodiversity, improved and more informed management of grasslands and herds.



AI-HERBAGE : working plan



AI-HERBAGE in numbers

- ▶ **Consortium:**
 - ▶ **38 permanent staff members** (267 person.months)
13 AI-HERBAGE personnel: 6 PhD + 2 Post-doc + 5 engineers
+ internships
 - ▶ **9 research and 1 experimental units,**
based in Montpellier, Grenoble and Clermont-Ferrand
 - ▶ **3 experimental sites** (Aveyron, Alps, French Guiana)
 - ▶ **15 training and research institutions**
INRAE, Institut Agro, AgroParisTech, CIRAD, CNRS, EPF, Inria,
VetAgro Sup, IRD, ENSM S-E, CA INP, UCA, Grenoble
INP-UGA, CNRS, UGA
- ▶ **Project duration:** 60 months
- ▶ **Budget:** 2 999 704 € requested funding / 7 645 685 € full cost



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Involved teams

- ▶ Mistea - Montpellier - INRAE / IAM - Numerics
- ▶ GIPSA-lab - Grenoble - CNRS / INP / UGA/ INRIA - Numerics
- ▶ Selmet - Montpellier - CIRAD/ INRAE / IAM - Livestock
- ▶ Herbivores - Clermont-F. - INRAE/VetAgro Sup - Livestock
- ▶ LESSEM -Grenoble - INRAE - Ecology
- ▶ Eco&Sol - Montpellier - CIRAD/IRD/INRAE/IAM - Ecology
- ▶ LaFage - Aveyron - INRAE - Livestock
- ▶ TETIS - Montpellier - INRAE/APT/CIRAD/CNRS - Numerics
- ▶ LIMOS - Clermont-F. - ENSM S-E/INP/CNRS/UCA - Numerics
- ▶ THOTH - Grenoble - Inria - Numerics



Experimental site: INRAE La Fage



About us Experimental setup Projects Work with us



Welcome to LaFage Experimental Unit!

Mesures Comportementales

- Suivi comportemental individuel & collectif
- Collier de suivi GPS et d'activités
- Mesures de bien-être animal
- Comportement de la berline à la table



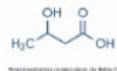
Mesures Zootechniques

- Poids animalier – kg
- Ratio Eau Corporel – Smeur / S
- Poids vif à l'abattage des mâles – kg de MV
- Valeurs alimentaires des fourrages – kg de MS
- Contrôle de l'ingestion par lit – kg de MS
- Coprologies
- Suivi production laitière – L
- Contrôle laitière :
 - Taux Butyrique – g/kg
 - Taux Protéique – g/kg
 - Célulose Saccharosés – celluloseL
 - Uvite – mg/L
- Echographie du gras dorsal



Mesures Métaboliques

- Dosages hormonaux
- Glucoséries
- Dosages métaboliques



Mesures Environnementales

- Données météorologiques
- Suivi de la biomasse
- Biomasse bactérienne
- Jurdances des bâtiments

Le réseau météorologique enregistre des données (température, précipitations) depuis plus de 30 ans



MS = Matière Sèche

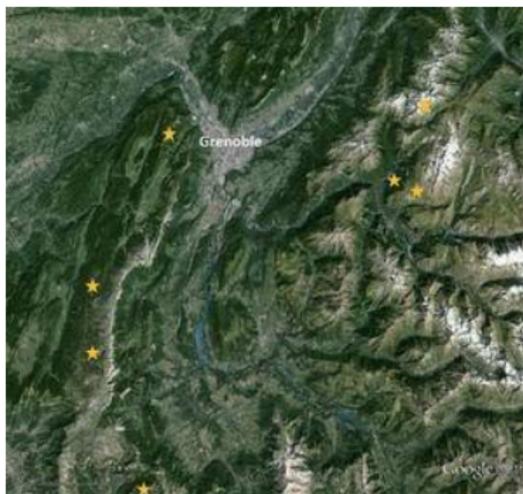
MV = Matière Vive

L = Litre

<https://uef.isc.inrae.fr/dispositif-experimental/mesures-experimentales>



Experimental site: French Alps



<https://lessem.lyon-grenoble.hub.inrae.fr/le-lessem/infrastructures-et-plateformes/sites-experimentaux/>

Experimental site: French Guyana



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Expected outcomes

- ▶ **Decision-support tools** (estimate the quality of pastoral and grassland resources, livestock behavioural early warning systems, advice for choosing transhumance routes, data acquisition strategies, optimization of resources...) [WP3]
- ▶ Curated and annotated **multi-sensor, multi-scale datasets** (soil, plants, animals) on **three different sites** [WP1]
- ▶ **Web applications** providing **decision-support tools** and access to **data** for three experimental areas [WP2, WP4]
- ▶ **Open design modular drone** platforms for agro-ecological monitoring [WP4]
- ▶ **Guidelines** and **best practices** for optimizing grazing, herd monitoring and management [WP4]



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AI approaches

- ▶ **Deep Neural Networks (DNNs)**: in particular, Physics-informed neural networks, Neural ODE... (T1.1 for data assimilation, T1.2.2 for machine vision + supervised learning). For example, for buried scanners: unsupervised pre-training to learn representations from unlabeled data, detection based on image differences in the representation space, supervised classification through fine-tuning of foundation models.
- ▶ **Unsupervised learning**: change-point detection (T3.2) for early warning system using sensors or graph clustering (T3.1.3).
- ▶ **Mechanistic/systemic modeling** (ODE/PDE/Markov processes), coupled or not with deep neural networks (T3.1, T3.3)
- ▶ **Control algorithms** (hybrid control) with or without DNNs (T3.3)

Strong expertise in maths, engineering and computer science. Developed algorithms can be applied even beyond the project scope.



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Type of data

Agro-ecology variables and [data sources]:

▶ Terrain

- ▶ relief, orientation, shadow areas... [geographical archive maps]
- ▶ land cover type (grass/shrubs/trees) [aerial remote sensing]

▶ Soil

- ▶ C, N, P, K concentration [NIR spectroscopy]
- ▶ bio-diversity of invertebrates [underground scanners]

▶ Grassland

- ▶ floral species diversity and characterization (growth state, chlorophyll level...) [remote sensing]
- ▶ plants fiber composition, proteins... [NIR spectroscopy]

▶ Animals

- ▶ geo-localization and movement tracking of individuals [collars with GNSS and accelerometer sensors]
- ▶ socio-sexual interactions [sexual overlap sensors]
- ▶ animal growth [self-weighing platform]
- ▶ environment interaction [lux-meter]



Source of data

Data sources:

- ▶ **Public archives**
 - ▶ **Geographic and weather** (National geographic institute (IGN), MeteoFrance)
 - ▶ **Remote sensing** imagery (Sentinel-2, SPOT 6/7...)
- ▶ **Available data** from the consortium
 - ▶ **Remote sensing** imagery (PlanetScope, Pleiades)
 - ▶ **Drone navigation** (PIA ROBOTEX2.0, ANR STRAD, DarkNav, MuteSwarm)
 - ▶ **Animal data** (Auvergne CAP2025, CLOChète, P@stor-all, Cowview database, UE TechCare, Digi4live, SMARTER)
 - ▶ Images from **underground scanners** (Eudaphobase, ADEME DESCEN/CASCA , ANR GlobNets, INRAE BISE, EU COST)
 - ▶ In-situ **NIR spectroscopy** data(dopredict database, Deschamps PhD, ANR C-cos2)
 - ▶ **Floral biodiversity inventories** (INRAE PraidirE)
- ▶ **AI-HERBAGE acquisitions** [WP2]
 1. **INRAE La Fage** experimental site (380 hectares, 1000 ewes) [grassland, sheep herds]
 2. **French Alps** (65 plots) [meadows]
 3. **French Guiana** (2 cattle farms) [pastures and cattle livestock]
 4. Additional tests in partner private farms, agricultural colleges or other experimental stations



Thanks for your attention!

