



REPORT

Training of Trainers in Rangeland Monitoring & Assessment: Integrating LandPKS, VegMeasure, and Traditional Methods

May 2023

Mounir Louhaichi & Sawsan Hassan
The International Center for Agricultural Research in the
Dry Areas. Tunis, Tunisia



INITIATIVE ON
Livestock and Climate



Introduction

Effective monitoring and assessment of natural resources form the base of successful rangeland management. These processes yield invaluable insights into the structure and functioning of ecosystems, enabling land managers to align their actions with specific management goals and objectives. To harness the full potential of monitoring data, it is imperative to employ standardized methods consistently across both time and space, ensuring data quality suitable for a wide range of applications. Achieving this level of successful rangeland monitoring necessitates a significant investment in time and human resources, including comprehensive training in the monitoring process.

Proficiency in collecting, managing, and utilizing monitoring data for rangeland management is not limited to professionals alone. Academics at universities and colleges must also be equipped with these skills as part of their role in educating students, with a specific focus on rangeland monitoring. Consequently, the assessment and sharing of information and techniques within academics and professional monitoring capacity development are pivotal. In addition to rangeland-focused training, other fields like ecology may necessitate or recommend complementary training in monitoring methodologies. Unfortunately, the standardization of training methodologies often falls short, necessitating a broader approach that encompasses both traditional and new technologies, with an emphasis on keeping methods updated and relevant. The data collection and analytical skills acquired through capacity development can be highly beneficial for professionals engaged in research projects.



Professional training in rangeland monitoring is usually organized according to specific monitoring programs or methods, often under the auspices of international organizations. These events are tailored to address particular job duties within the context of rangeland management.

The International Center for Agricultural Research in the Dry Areas (ICARDA) plays a pivotal role in capacity development within this sphere. ICARDA designs and conducts a diverse range of training programs, workshops, and courses aimed at enhancing the technical and practical skills of individuals and organizations involved in rangeland management, particularly in arid and semi-arid regions. These initiatives span topics such as sustainable land management and climate change adaptation. Collaborative efforts with local and international research institutions, universities, and government agencies promote knowledge exchange, joint research projects, and the sharing of best practices, ultimately boosting the research capabilities of partner institutions.

ICARDA contributes to capacity development by organizing workshops, training courses, and on-the-job training events that facilitate knowledge sharing and stimulate discussions on critical agricultural and environmental matters. These events provide a platform for exchanging ideas and experiences. However, reaching all professionals from various stakeholders and organizations involved in rangeland management can be challenging. Therefore, training of professional trainers in rangeland monitoring serves as the foundation for professionals to conduct employer training opportunities, with a specific focus on assessing rangeland ecosystem structure and function within their job roles. These training of trainers events typically cater to officers of government agencies, employees from development organizations, and university personnel. In situations where comprehensive training resources are limited, well-designed and executed rangeland monitoring methods can be highly valuable for professionals. Consequently, trainers must develop their skills independently and be self-motivated to enhance their professional abilities, ultimately contributing to the capacity development of staff in their institutions.



Objective

The primary aim of these events is to enhance trainers' capacity in rangeland monitoring, assessment, and data collection, enabling effective knowledge transfer and strengthening institutional capacity. This, in turn, supports local institutes in providing informed recommendations to decision-makers, contributing to national development.

Target Trainees

The event aimed to benefit professionals from the Office d'élevage et des paturages and the Direction Générale des Forêts in Tunisia, as well as academics from the Ecole Supérieure d'Agriculture de Mateur and the Higher Institute of Arts and Crafts of Tataouine (ISAMT).

Training Methodology:

The training of trainers incorporates a diverse range of methodologies aimed at equipping individuals with the knowledge and skills essential for effective rangeland management and monitoring. These methodologies not only encompass traditional techniques but also integrate the latest technological advancements. Throughout the training, participants acquire proficiency in documenting site conditions both before and after implementing various treatments on representative rangeland sites. This training is carefully designed to enable them to assess the effectiveness of these treatments in mitigating threats related to climate change and mismanagement. Additionally, trainees develop expertise in the quantitative monitoring of changes in rangeland health, a crucial aspect of long-term ecosystem management and sustainability.

Emerging Technologies in Rangeland Monitoring

The integration of cutting-edge technologies has significantly advanced rangeland management, allowing for real-time monitoring and collaborative data sharing among researchers, land managers, and stakeholders. This training program encompasses two pivotal applications: the Land-Potential Knowledge System (LandPKS) and Vegmeasure Digital Vegetation Charting Technique. These methods offer efficient and rapid approaches for



covering extensive areas and assessing rangeland vegetation cover with a remarkable level of accuracy. Disseminating this knowledge through training programs ensures the continuity and preservation of knowledge systems related to rangeland monitoring and assessment. Furthermore, it serves as a bridge, connecting professionals with these new technologies, fostering collaboration with national partners, and facilitating the widespread adoption of advanced tools in rangeland management.

This comprehensive approach equips individuals with the skills needed to navigate modern rangeland management while respecting time-tested practices.

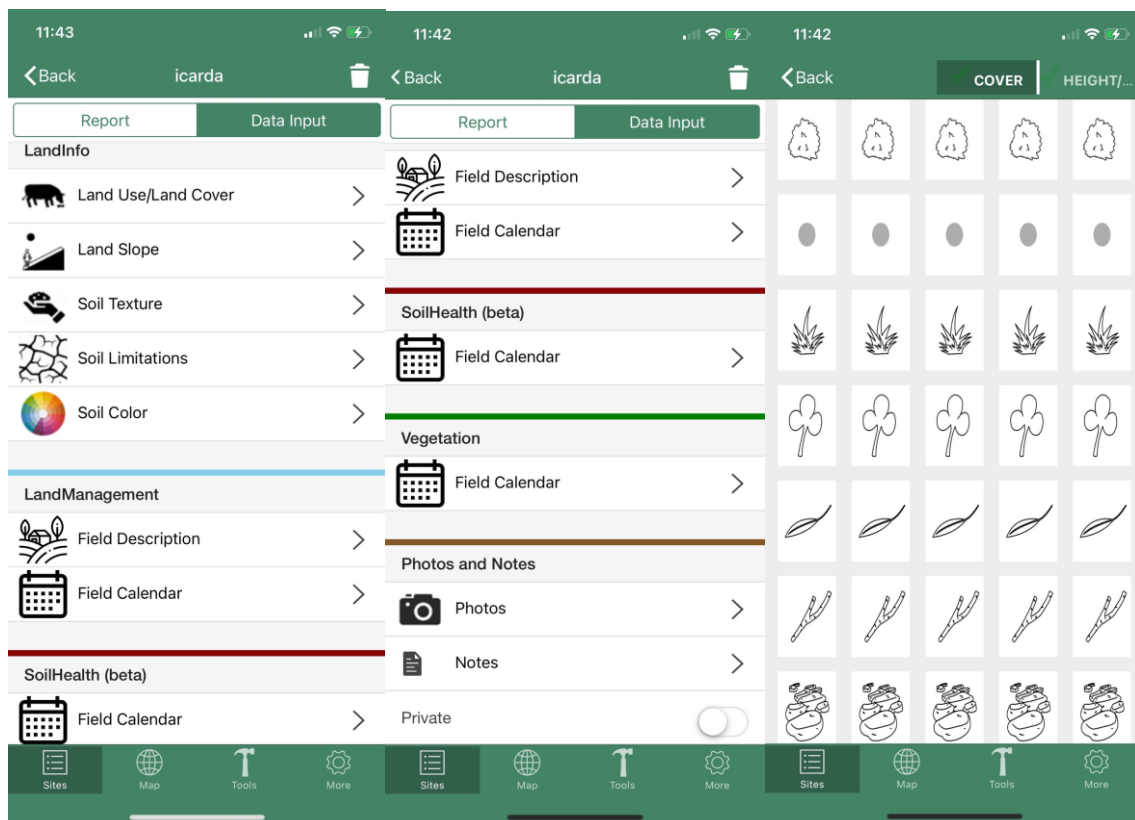
Land-Potential Knowledge System (LandPKS) application

Within this training program, participants explored the LandPKS application and its role in rangeland monitoring. LandPKS represents a transformative approach to redefining land potential assessment, dynamically adapting it to the ever-changing soil and climate conditions. Acting as a conduit between local wisdom and scientific knowledge on sustainable land management, LandPKS harnesses the capabilities of mobile technologies and cloud computing while embracing crowdsourcing. Leveraging recent advancements in cloud computing, digital soil and cover mapping, GPS-enabled mobile phones, and dedicated mobile applications, LandPKS empowers users to collect on-site soil and land cover data through mobile apps. This data is subsequently uploaded to the cloud and integrated with global databases, facilitating the generation of site-specific land potential assessments. LandPKS offers user-friendly mobile interfaces as well as sophisticated web tools, granting individual land managers the capacity to address sustainable land management queries at the field scale. Policymakers can aggregate data over larger areas, considering factors such as the presence of small yet highly productive or biodiverse sites within regions. Extension workers access the latest information, allowing them to interpret it within local contexts and values. Additionally, scientists benefit from a global georeferenced database for remote sensing and hypothesis testing. Furthermore, LandPKS serves as a social networking platform, fostering connections among producers facing similar challenges on comparable land types. This collaborative environment enhances the exchange of knowledge and experiences, ultimately contributing to more informed and effective land management practices.

Upon installing the application, trainees were introduced to its features, enabling them to add new sites and make effective use of its diverse functions. The application facilitates the identification of land cover types, including tree cover, shrublands, and grasslands, enabling



customized land management strategies. It also aids in distinguishing between grazed and non-grazed land uses, assisting in the assessment of land degradation risks linked to various animal species. Furthermore, the app offers slope and slope shape analysis to assess susceptibility to soil erosion, highlighting soil conditions like deep cracks and salt accumulation that indicate potential growth constraints for plant species. Additionally, the assessment of soil layers, encompassing texture and rock content, informs decisions related to water infiltration, holding capacity, and erosion risk. Collectively, these functions empower land managers to make informed, sustainable choices, ultimately enhancing land health.



Landpkd application

Trainers guided trainees in filling data for these features. The training focused on vegetation cover, including aspects like cover, structure, and utilization. Trainees learned to utilize the LandPKS Vegetation Module, enabling rapid data collection and monitoring of various vegetation attributes, including composition, cover, height, basal/canopy gaps, and species density. The module simplifies vegetation cover assessment with a 1-meter stick and a point-intercept method, presenting cover trend graphs over time for user-friendly interpretation.





VegMeasure

VegMeasure is a sophisticated software designed for precise vegetation measurement and monitoring across various landscapes, including rangelands, agronomic fields, and more. Its primary objective is to map vegetation on the ground by capturing vertically downward photographs. This innovative tool was developed to provide accurate representations of plant positions, areas, and conditions. Traditionally, assessing vegetation cover in the field, relied on time-consuming and labor-intensive methods like the quadrat technique. VegMeasure significantly streamlines this process while standardizing measurements, ensuring more consistent and representative assessments of vegetation conditions.

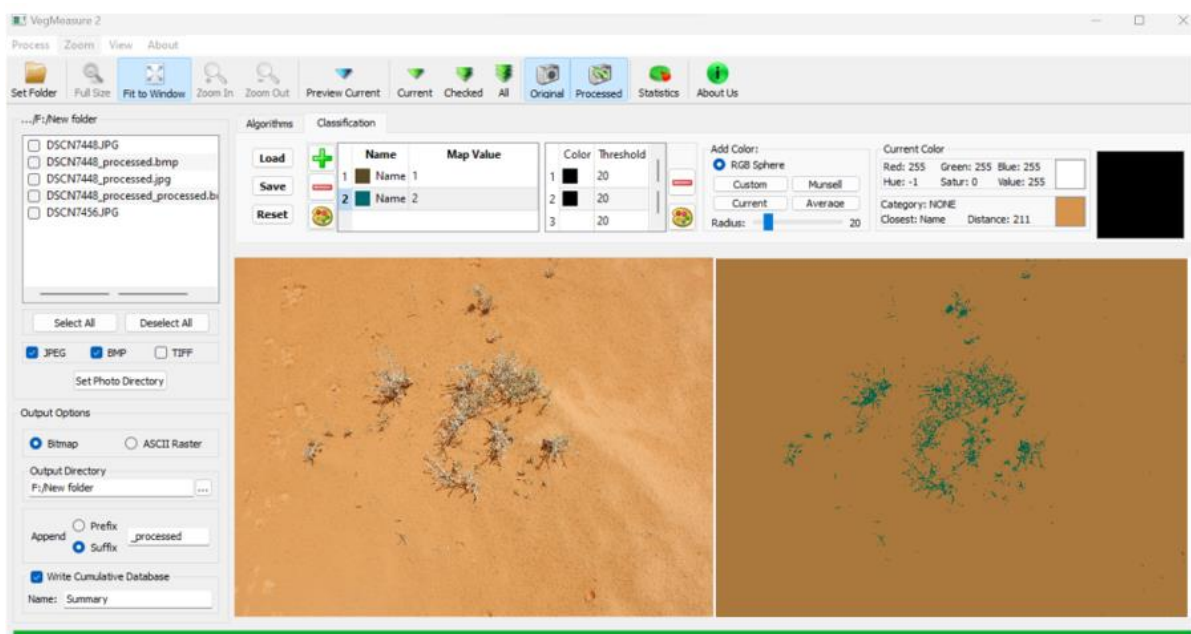
VegMeasure extends its functionality. It has been effectively employed to assess plant cover using vertically downward photos captured from ground level, relying on distinct plant colors. The software incorporates specific algorithms to support these applications. Additionally, VegMeasure enables the tracking of temporal changes, such as springtime plant growth or reductions in leaf area due to grazing. It serves as a versatile tool for quantifying alterations in particular plant cover, facilitating the measurement of their growth. Moreover, it can evaluate the individual persistence and behavior of plants within vegetative communities.

In our training program, participants received comprehensive instruction on data collection techniques using digital cameras equipped with GPS capabilities, allowing them to precisely



tag the location for each image, adjust the monopod's height for optimal results, avoid shadows, and capture reference images for each site and treatment.

Following data collection, trainees were expertly guided through the image analysis process using the VegMeasure software, which was installed on their laptops. This software offers multiple analysis methods, allowing users to choose between supervised and unsupervised approaches. VegMeasure efficiently classifies images into distinct categories and presents the results on the screen for user evaluation. Additionally, it features a K-means algorithm, dividing images into several classes to facilitate the identification of unique vegetation elements within each image, thereby streamlining data processing in the laboratory.



Vegmeasure Software

After the image analysis, participants learned how to generate comprehensive reports that detail the percentage of each class within individual images and across all images. This reporting process is straightforward and user-friendly, making it a valuable tool for vegetation assessment and monitoring.

Incorporating the LandPKS and Vegmeasure applications into the training equips trainers with rapid and efficient methods for assessing extensive areas and evaluating rangeland vegetation cover with a high degree of accuracy. By imparting this knowledge to national partners, the continuity and preservation of rangeland monitoring and assessment systems are assured. Furthermore, the training of trainers serves as a bridge, connecting professionals



and students with these innovative technologies and bolstering the capabilities of national partners. This, in turn, paves the way for the widespread adoption of advanced tools in rangeland management.

Traditional Methodologies in Rangeland Monitoring

Traditional rangeland monitoring methodologies have long relied on hands-on fieldwork, manual data collection, and observations grounded in ecological principles. While these methods may be time-consuming and occasionally have the potential to impact rangeland productivity, they remain important for effective rangeland monitoring, providing a robust foundation for comprehending the essential aspects of rangeland ecosystems, often enriched by indigenous knowledge passed down through generations.

Participants were first trained on how to diligently record observations to describe and document the current site conditions. They also learned how to record species richness, which encompasses the diversity of species within a specific site. Trainers provided comprehensive guidance to enable trainees to effectively observe, identify, and record all encountered species within the monitored sites. To equip trainers with the requisite skills and expertise for precise and accurate assessments of vegetation, our training approach emphasizes quantitative data collection. Although this traditional method demands time and effort, it confers the ability to discern subtle modifications in vegetation cover and composition. Therefore, these trainees have acquired the essential expertise required for the quantitative monitoring of changes in rangeland conditions, including:

Line-Point Intercept

Central to this training is the implementation of the Line-Point Intercept (LPI) method, renowned for its rapid and precise quantification of ground cover, encompassing vegetation, litter, rocks, and biotic crusts. Proficiency in these measurements is pivotal for evaluating the site. It is worth noting that Line-Point Intercept differs from Line Intercept (also known as Gap Intercept), which primarily focuses on identifying the proportion of the line covered by significant gaps between plants.

The following materials are indispensable for conducting this method: Transect Tape, 2 Pins, stakes, Data Sheet, and Clipboard. This process unfolds as follows:



- Selection of Representative Location: Trainees were tasked with identifying a representative site within the designated treatment area.
- Establishment of Permanent Marker: A stake was securely placed into the ground to mark the origin. The coordinates of this origin were meticulously recorded on the provided Field Sheet, and a waypoint was saved for future reference.
- Transect Line Setup: The transect tape was stretched taut, as close to the ground as possible, commencing at the "0" end of the tape. Measurements were systematically taken at regular intervals, typically every 50 cm along a 50 m tape, resulting in a total of 100 data points.
- Data Collection: Trainees strategically positioned themselves on one side of the line, leaning over to read the pin drop on the other side, ensuring minimal disturbance to the vegetation during measurements. Each encountered plant species, from the top to the soil surface, was diligently recorded using the pin. To prevent duplications, each plant species was meticulously documented only once. In instances of uncertainty regarding a particular species, trainees took note of the functional group or provided a brief description, such as annual forb, perennial forb, annual grass, perennial grass, shrub, or tree.
- Distinguishing Live and Dead Foliage: Trainees finely tuned their ability to distinguish between live and dead foliage, recognizing the significance of this distinction for specific objectives.
- Basal and Soil Surface Hits: Following canopy hits, trainees diligently documented basal or soil surface hits. In the case of a plant base hit, the species was promptly recorded. For soil surface hits, trainees specified the surface type, including bare soil, litter, or rocks (> 5 cm in diameter).



Plant Density

Plant density, representing the concentration of individuals within specific species or across various species in a defined area, plays a pivotal role in monitoring population responses to different treatments and ecological changes. This tool proves invaluable for assessing the effectiveness of weed control measures, tracking the success of seeding efforts over time, and implementing strategies to enhance key species within ecosystems. The trainees underwent comprehensive training to equip them with the skills needed to accurately record data related to age or size classes, especially for woody plants or perennials.

It is essential to understand that density measurements can vary significantly based on ecological site, state, phase, plant size, and population size structure. Consequently, the trainees were taught the importance of considering density measurements in conjunction with other vegetation metrics.

Trainees were equipped to differentiate among three spatial scales, each tailored to specific plant types and scenarios for measuring plant density:

- **Small-scale Assessment:** This method is most suitable for small plants and common seedlings. It entails counting the number of plants within a 1 × 1 m plot established at each designated location.
- **Quadrat Sampling:** When dealing with herbaceous species, density is commonly recorded within quadrats. The size of the quadrat can be adjusted to align with the size and spacing of the plants under investigation. Larger plants can be enumerated within larger quadrats on longer transects, while smaller plants can be assessed in smaller quadrats on shorter transects. Field forms should meticulously capture the dimensions of the quadrat in meter (m), with allowances made for variations related to different items and size classes.
- **Belt Transects:** For shrubs, especially those with an average diameter of 1 m or less, belt transects are the preferred approach. These transects consist of a belt width of 20 x 1 m. In the case of larger shrubs, with an average diameter of 1 m, a belt width 20 x 2 m is more appropriate. The length and width of the belt transect can be adapted to accommodate the varying sizes and densities of shrubs and trees. Longer and wider transects are well-suited for larger or sparsely distributed vegetation, while shorter and narrower transects are more applicable to smaller and denser vegetation.





Biomass Estimation

Throughout the training sessions, trainers comprehensively covered various methodologies for estimating biomass production in rangeland ecosystems. The estimation of biomass in rangelands holds a pivotal role in obtaining a holistic understanding of ecosystem health, productivity, and enabling well-informed decision-making. Several techniques can be deployed to estimate biomass in these dynamic environments, with the selection of the method contingent upon factors such as vegetation type, available resources, and research objectives. Among the most frequently employed approaches is the harvesting and weighing method, often referred to as the Direct Method. This technique entails physically harvesting plants from predetermined sample plots, subjecting them to drying processes to eliminate moisture, and subsequently weighing them to determine their biomass. While this method yields highly precise results, it is noteworthy that it can be labor-intensive, thus making it particularly well-suited for smaller-scale assessments.





Conclusion

In conclusion, effective rangeland management hinges upon precise monitoring and the assessment of natural resources. This is accomplished through the application of standardized methods and comprehensive training. Proficiency in data collection and its strategic use is imperative, benefiting both professionals and academics by fostering knowledge exchange. ICARDA plays a pivotal role in this capacity development, orchestrating a diverse array of training programs.

Our training approach seamlessly integrates traditional and advanced methodologies, such as LandPKS and VegMeasure, which provide real-time monitoring capabilities. This holistic training equips individuals to adeptly navigate contemporary rangeland management while preserving invaluable indigenous knowledge. It encompasses in-depth instruction on data collection and meticulous analysis. By incorporating LandPKS and VegMeasure, assessments are expedited and conducted with precision.

It is crucial to emphasize the enduring significance of traditional methodologies like Line-Point Intercept, plant density assessment, and biomass estimation, as they form the foundation of rangeland monitoring and decision-making. Furthermore, our training program specifically includes the training of trainers. This extension empowers professionals not only to understand the intricacies of rangeland monitoring across diverse systems and management contexts but also to effectively disseminate this knowledge among their colleagues. Ultimately, this holistic understanding instills enhanced confidence in their abilities, resulting in heightened satisfaction and productivity, both within their institutions and among their fellow colleagues.



List of participants



INITIATIVE ON
Livestock and Climate

Training of Trainers in Rangeland Monitoring & Assessment: Integrating LandPKS, VegMeasure, & Traditional Methods Tunisia

25 March - 10 April 2023

No	Name/الاسم	Institution	Phone number	Signature/التوقيع	*
1	صباح الكرازي	غابات			*
2	الحنا كساب	غابات			*
3	المولاي لقوة	ساحل			x
4	محمد عبد القادر	ديوان تربية الخيل			x
5	سوسن من	إيكاردا			x
6	حسام التفاضل	الدراسة العليا للفلاحة بآمر			x
7					
8					
9					
10					

*بتحديد المربع، أمتح المركز الدولي للبحوث الزراعية في المناطق الجافة (إيكاردا) الحق باستخدام وإعادة الاستخدام والنشرو/أو إعادة النشر بشكل كلي أو جزئي في أية وسيلة (بما في ذلك موقع إيكاردا على الانترنت ووسائل التواصل الاجتماعي، ووسائل النشر الأخرى) لكافة المعلومات الشخصية الموجودة بما في ذلك الصور الخاصة بي بشكلي إفرادي أو في أي مجموعة أنا موجود فيها) التي تم التقاطها خلال هذا النشاط دون قيود فيما يتعلق بالتغييرات أو التعديل، على أن يتم استخدامها بالتوافق مع تمثيل المركز والترويج له. أقر بأنني أفهم أن جميع التسجيلات والوثائق، بأي وسيلة كانت، ستبقى ملكاً لإيكاردا فقط و لن يكون لي أي حق أو مصلحة فيها. كما أنني أسمح لإيكاردا ووكلائها المعتمدين باستخدام صورتي أو إسمي أو عنوان عملي حيث يتم استخدامها بالإقترا مع تمثيل إيكاردا و الترويج لها.



The **CGIAR Research Initiative on Livestock and Climate** is designed to address the challenges that climate change poses to livestock production, providing livestock-keeping communities with the support they need without accelerating greenhouse gas emissions or degrading land, water, and biodiversity.

It forms part of CGIAR's new Research Portfolio, delivering science and innovation to transform food, land, and water systems in a climate crisis.

This report was produced as part of the CGIAR Research Initiative on Livestock and Climate which is supported by contributors to the [CGIAR Trust Fund](https://www.cgiar.org/funders). [cgiar.org/funders](https://www.cgiar.org/funders)



This document is licensed for use under the Creative Commons Attribution 4.0 International Licence. May 2023

