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Science for resilient livelihoods in dry areas

CGIAR Research Program on Livestock Agri-Food Systems

Livestock and the Environment Flagship

Capacity Development Report

On-the-job training Rangeland Assessment and Monitoring

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2020

CGIAR RESEARCH PROGRAM ON Livestock

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Introduction

Rangelands are the dominant land use in southern Tunisia under arid and desert climates. These lands, however, have suffered decades of severe degradation due to profound socioeconomic changes, expressed in the emergence of agro-pastoral societies in place of the former pastoral ones (Hudson et al., 2014). Rangelands are highly susceptible to the impacts of climate change in response to limited water availability and higher air and soil temperatures (Ouled Belgacem and Louhaichi, 2013). To assess rangeland condition, ecological indicators are used as a surrogate to explain complex ecological processes and methodology such as concept of Rangeland Health Assessment (Briske et al., 2005; Teague et al., 2008). It is crucial to evaluate the vegetation dynamics in order to predict if the current management is leading toward desired restoration objective.

In arid areas, temporary grazing exclusion is cost-effective and feasible depending on the climate conditions. Therefore, the Office of Livestock and Pasture (OEP) continues its efforts to improve rangeland conditions through the use of a resting system (Gdel) across large areas of private and communal rangelands annually. Among these rangelands are *Haloxylon schmittianum* and *Rhanterium suaveolens* steppes in Ben Guerdane and *Stipa tenacissima* steppe in the region of Beni Khedache in Medenine.

Under the CRP Livestock (LE flagship), ICARDA in collaboration with national partners developed key indicators for sustainable grazing management especially in favorable years. These indicators were very much welcomed by the development projects operating in Southern Tunisia (national and international). In particular OEP immediately took action to adopt this innovative procedure to decide first whether to allow/open grazing and second to estimate carrying capacity. An official request was sent from the DG of OEP to ICARDA (Annex 1).

In order to implement properly these set of indicators special training is needed for the technical field staff. In this regards, two group training sessions were conducted earlier (December 2018 and February 2019) on rangelands plant terminology and basic plant identification. At least 60 participants representing several national institutions including technical staff from the Office de l'Elevage de des Pâturages (OEP), graduat students from the Ecole Supérieure d'Agriculture de Mateur (ESA Mateur), Commissariat Régional de Développement Agricole (CRDA), Direction Générale de la Pêche et de l'Aquaculture (DGPA) and La Banque Nationale des Gènes (BNG).

In addition to these theoretical trainings, specialized on the job training were needed to sharpen the skills and enhance the knowledge as practical aspects is the best way to reinforce learning. Thus, the rangeland ecology and forages at ICARDA offered a joint field mission consisting of a rangeland scientist from ICARDA and technical staff from OEP Medenine and Tataouine.

In total three consecutive sessions of on-the-job training were offered to the selected participants from Medenine (Southern Tunisia). The first session was carried out in March 2019, the second in May 2020 and the last one in October 2020. All trainees received necessary information spread over ten field days. Since the same trainees were involved in these exercises, it was clear that over time they started to become familiar and confident to undertake this task with minimum supervision and even on their own.

Objectives

The main focus of this training was on rangeland inventorying and monitoring and aimed to develop and improve the capabilities of engineers and technicians in the Office of Livestock and Pastures (OEP) of Medenine and Tataouine governorates.
Furthermore, the training presented an opportunity to evaluate and assess recovery potential of the natural vegetation following the adoption of controlled grazing management of restored sites.

Training of trainers (TOT)

Four participants attended the training: Mr. Ridha Yahia, Mr. Fakhri Sassi, Mr. Mohamed Salah Wadden from OEP Medenine, and Mr. Mohamed Abdelkader from OEP Tataouine (Annex 2, 3, 4).

Methodology

1. Sites description

This sampling was conducted at two different ecological sites located in the governorate of Medenine (southern Tunisia) and covering a total area of about 1,800 ha.

- **Site one** is located in the plain of Jeffara which belongs to Ben Guerdane county in the east of Medenine. The vegetation is mainly composed of sparse steppic plant communities on sandy soils. The dominant plant communities belong to the *Rhanterium suaveolens* and *Haloxylon schmittianum* found on the steppe and *Nitraria retusa, Atriplex halimus,* and *Tamarix gallica* found on saline landscape depressions. The mean annual rainfall is ~180 mm.
- **Site two** is located in the mountainous area of Beni Khedache county in the west of Medenine. The vegetation is dominated by *Stipa tenacissima* steppes found on calcareous soils. The mean annual rainfall is ~192 mm.

2. Tools needed

Rangelands monitoring and data collection require a set of tools and protocols to be respected to ensure uniformity (standard) and precision (Figure 1):

- Pencils, permanent markers, and a clipboard,
- Datasheets for recording measurements: it is very helpful to have an established protocol for the data collection,
- Depending on the target vegetation (annuals, shrubs, trees, etc.), a frame of a particular size and shape (square, rectangular or circular) is used to count plant density: For annual species, usually a square frame made of metal, wood, or PVC measuring $1m^2$ or 0.5 m^2 area
- A retractable measuring tape 50meters long
- A fine metal pin of about 1 meter long that is sharpened to indicate a point
- A high-resolution digital camera: the camera is used to take representative photos as well as videos to document vegetation changes over time; useful to document and save them as a reference or archival.

- A handheld Global Positioning System (GPS) unit: the GPS unit is used to record the exact location of the target site, the encountered plant communities, and any fixed object of interest during sampling exercise.

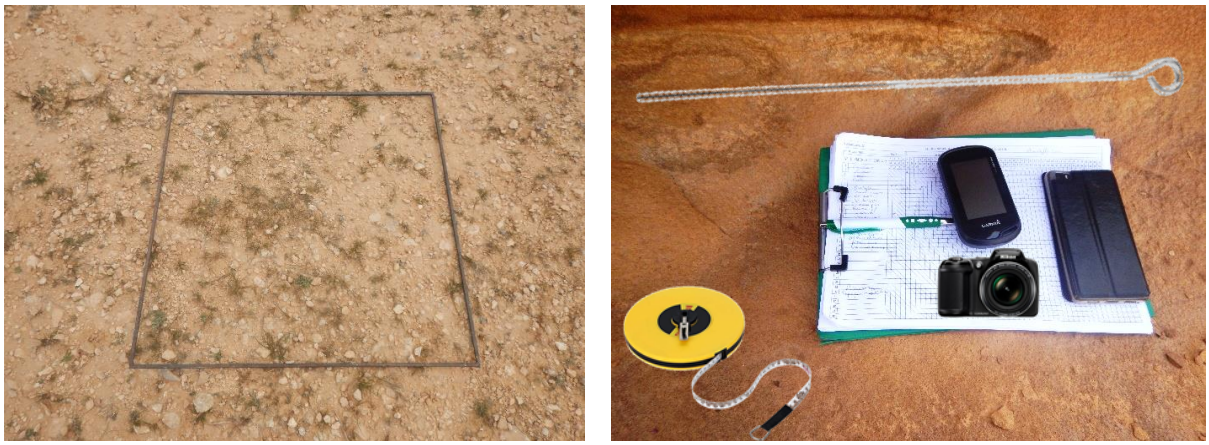

Figure 1. Some tools needed to rangeland assessment.

3. Appropriate indicators and methods

3.1. Estimation of plant cover and species diversity

A total of 45 transect lines were sampled during the spring season. These transects lines were selected in 2019 where 36 of them were conducted in rested sites (protected) and 9 transects in continuously grazed sites (control) (Figure 2). These transects were assessed using the point quadrat method as defined by Daget and Poissonet (1971) and Floret (1988). A fine pin was descended to the ground every 50 cm along the transect. Each of the 100 hits per transect was recorded according to the plant species or type of ground touched (stones, wind veil, crust, or litter). The specific frequency of taxon i, is the proportion (ni/N) of individuals of one particular species found (ni) divided by the total number of individuals found (N).

$$SFi = \frac{ni}{N}$$

This proportion is frequently used to calculate the Shannon-Weaver diversity index and Hill's diversity numbers.

$$H' = -\sum_{i=1}^{s}(SF_i \times \log_2 SF_i) = -\sum_{i=1}^{s}(\frac{ni}{N} \text{Log}_2 \frac{ni}{N})$$

Specific contribution (SC*i*) of a species *i* defines its participation in plant cover. It is equal to the quotient of the taxon's centesimal specific frequency (CSF*i*) divided by the sum of the centesimal specific frequencies of all the taxa detected along the line.

This Specific contribution is frequently used to calculate the pastoral value of rangeland.

$$CSFi\ \% = \frac{ni \times 100}{N}$$

$$SCi\% = \frac{CSFi \times 100}{\sum CSFi}$$

$$SCi\% = \frac{ni}{\sum ni}\ x\ 100$$

Species richness is the total number of species within a defined region. It was calculated by simply counting the number of each species in this community, and it does not take into account the abundances of the species or their relative abundance distributions.

Figure 2. Field monitoring measurement

3.2. Measuring plant density

Species density provides a good ecological indicator of grazing intensity on rangelands. For example, high grazing pressure may be identified when the density of palatable species is decreasing while invasive and non-palatable species are increasing compared to palatable species. During favorable years the density of annual plants, which generally are therophytes is so high. In order to estimate their density, it is recommended to use a 1 m^2 quadrat (Figure 3). For the perennial plants, the density is estimated using a larger area of a rectangle 50 m^2 aligned with the line intercept used to cover measurements (Figure 4). The number of replications is determined depending on the site

homogeneity. When the site is heterogenous then the number of samples should increase to minimize variability. In general, under arid environments, five sampling units for annual species and three sampling units for perennial species are usually recommended.

Figure 3. Participants competed to identify common rangeland plants and measuring vegetation attributes

Figure 4. Frame of 1m^2 for annual plants density measurement

Figure 5. Frame of 50m^2 for perennial plants density measurement

3.3. Biomass production and carrying capacity

In order to estimate biomass production, we used the specific contribution of each species to total cover, the total plant cover, and the palatability class or acceptability index according to the following formula (INRA 1978):

$$P = 1.5 \sum_{i=n}^{n} SCi \text{ x } PIi \text{ x } TPC/100$$

Where P is total rangeland production in forage Units (FU)/ha/year, SCi is cover of species *i* (%), PI*i* is palatability index of species *i*, and TPC is total plant cover (%).

Forage production will allow us to know the number of forage units needed for estimating the carrying capacity (number of animals allowed to graze per area during a fixed period) (see appendix).

Rangeland production was estimated under each plant community type to obtain accurate results of carrying capacity for the duration of the grazing period.
The carrying capacity was determined as the ratio of total biomass production to the annual needs of an animal unit which is estimated to 400 FU/year.
However, the utilization of natural arid rangeland should not exceed 60% of available biomass in order to ensure regeneration and adequate forage production in the following years.

$$\text{Carrying capacity} = \frac{\text{Total forage production can be used}}{\text{FU required/year}} = \text{heads/year}$$

Applications and intended uses

Setting up a proper grazing system in arid rangelands should be based on profound understanding of vegetation dynamics which takes into account certain ecological indicators. Based on science-based evidence, ICARDA has recently identified three essential indicators that should be respected when deciding whether grazing is to take place or not (Louhaichi et al. 2019):

1. Seasonal rainfall: the minimum rainfall amount should be at least 80 mm during the period September to December in Medenine/Tataouine and 60 mm for Ramada.
2. Plant cover (%): should be higher than 40%.
3. Plant composition: at least 30 % of species richness are palatable species and each vegetation will be classified according to the most dominant species.

Furthermore, as a general rule of thumb it is recommended to take 60% of the total vegetation (grazing) and to leave 40% for easy regeneration. This is important to ensure vegetation resilience and to allow for regrowth of the forage and sustainability of preferred plant species (Figures 5 and 6).

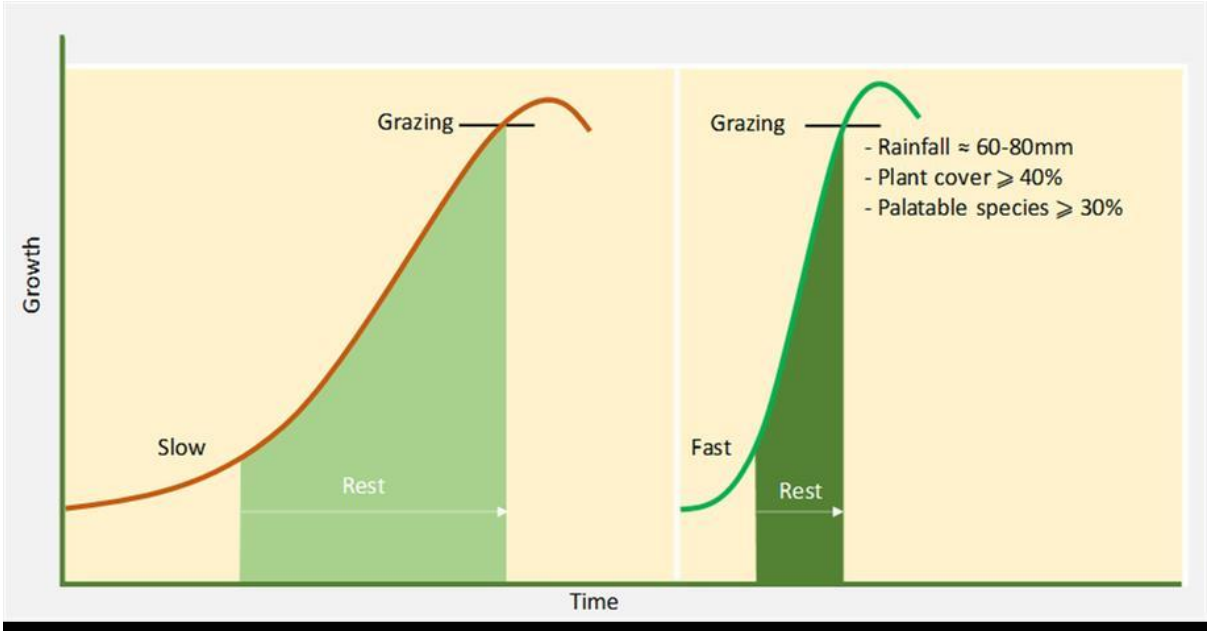

Figure 6. Adequate forage production and suggested grazing system.

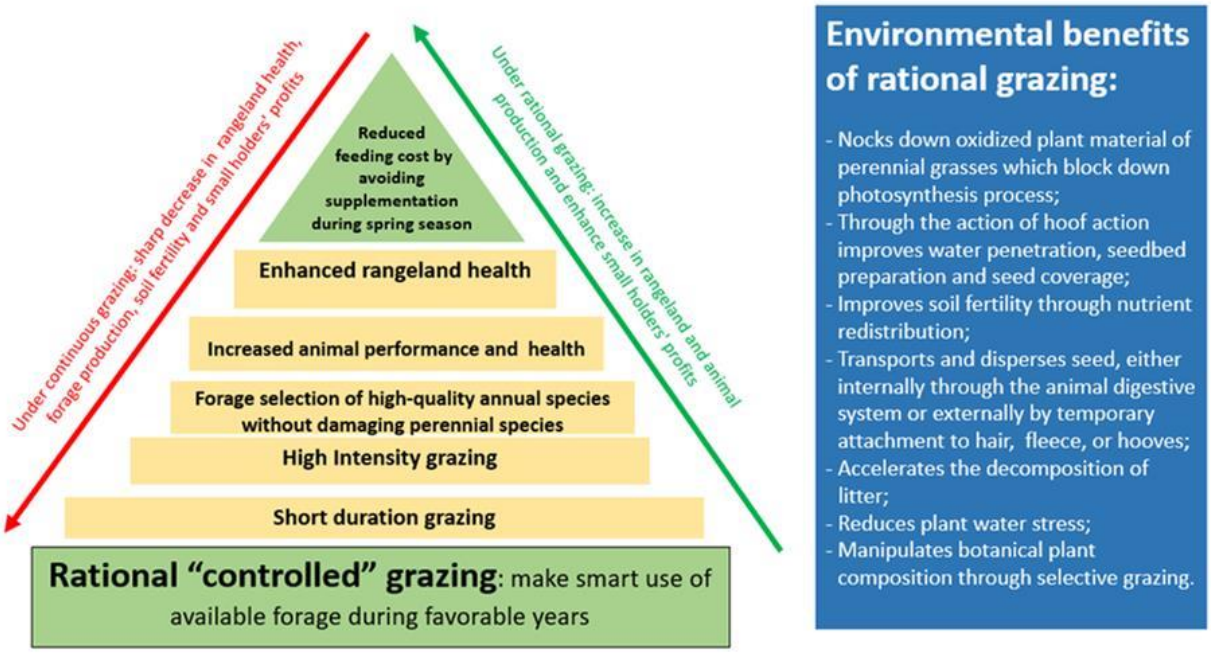

Figure 7. Benefits of rotational grazing.

Figure 8. The photo on the left before grazing, the photo on the right after controlled grazing: an opportunity for flash grazing targeting annual species and skipping woody and perennial species.

Figure 9. The rangeland on the right is under controlled grazing. The rangeland on the left is not, it is the natural reserve of Sidi Toui.

Figure 10. Photos showing the incorporation of litter into the soil and prevention of soil crusting by hoof action.

Figure 11. Increased degradation at livestock watering points in the arid rangelands of southern Tunisia.

Figure 12. Photos showing the effect of heavy grazing on palatable species.

Figure 13. Continuous grazing had a strong effect on highly palatable species (Echiochilon fruticosum on the left) and low palatable species (Deverra tortuosa on the right).

Figure 14. Photos showing rangeland encroachment by invasive species, such as Adonis dentata an unpalatable and toxic plant to livestock.

Figure 15. Understanding carrying capacity is essential for sustainable rangeland management.

Figure 16. Is there enough forage and biomass? Balancing forage supply and demand is crucial: Assessment is needed to determine if there is enough forage to support livestock while also leaving enough residual vegetation for regeneration.

Figure 17. Stipa tenacissima plant showing "dead center" which reflects growth pattern of the plant due to drought, not a decline in vigour due to grazing. The plant shown occurs on a protected area. This is likely due to the way Stipa tenacissima produce new leaves and tillers on the outside of the "bunch" while old tillers in the center die out, which leads to splitting up of the bunch and creation of several distinct "new" plants.

Conclusion

Flexible management take into account the results of rangeland monitoring and assessment to estimate proper carrying capacity. Changes are made in grazing management when climatic variation is encountered or when changes in ground cover or the plant community are desired. There are different approaches for monitoring and assessing rangeland conditions. However, development of any rapid assessment requires good understanding of past disturbances in order to identify environmental, social and technical drivers that led to the current status. Using simple and robust indicators (environmental and biological) present a reliable and viable option toward achieving sustainable rangeland restoration. The methodology presented here is rapid, ease to use and cost-effective for obtaining valuable information that can be used along with other indicators to achieve desired restoration objectives. Therefore, this methodology has great potential for adoption by development agencies as illustrated in this document through the embracement of the office of livestock and pastures.

Acknowledgment

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Annex 1: Official request for ICARDA REF team to support OEP_IFAD project in Tunisia

REPUBLIQUE TUNISIENNE
MINISTERE DE L'AGRICULTURE
DES RESSOURCES HYDRAULIQUES
ET DE LA PECHE

الجمهورية التونسية
وزارة الفلاحة و الموارد المائية
و الصيد البحري

ديوان تربية الماشية وتوفير المرعى
OFFICE DE L'ELEVAGE ET DES PATURAGES

عـــــدد/إ.م.ع.ر

تونس في، ....14 أكتوبر 2020

إلى السيد
المنسق الجهوي لمنظمة إيكاردا

الموضوع: حول انجاز القياسات الرعوية في نطاق تنفيذ مخطط استغلال المراعي المرتحة في نطاق مشروع PRODEFIL

في إطار مواصلة تنفيذ أمثلة التصرف في المراعي الخاصة المرتحة في نطاق مشروع التنمية الزراعية والرعوية وتطوير منظومات الإنتاج (PRODEFIL)، وعلى إثر انقضاء الفترة الأولى من الاستغلال، الرجاء السماح للسيد المولدي قمعون (خبير مراعي بايكاردا–ICARDA) لمعاضدة الفريق الجهوي لانجاز القياسات الرعوية باعتماد المؤشرات التى تم التوصل إليها فى نطاق البحث التنموى الممول من طرف (CRP Livestock). هذا العمل سيتم إنجازه بمعتمدية بني خداش على مستوى القطع المستغلة والقطع التي سيشرع في استغلالها بمنطقتي المرداسية والعوجاء والتي ستخضع للترتيح من جديد بمنطقتي شعبة النعاج وشعبة الحرايق وذلك يومي21 و22 أكتوبر 2020. و السلام.

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Annex 2: List of Participnats: On the Job training of Rangelands Inventorying and monitoring (26 February – 21 March 2019)

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CGIAR RESEARCH PROGRAM ON Livestock

On the Job Training
Rangelands Inventorying and Monitoring
Southern Tunisia
26 February - 21 March 2019
List of participants

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7					☐

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Annex 3: List of Particpnats: On the Job training of Rangelands Inventorying and monitoring (May 2020)

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Science for resilient livelihoods in dry areas

CGIAR RESEARCH PROGRAM ON Livestock

On the Job Training
Rangelands Inventorying and Monitoring
Southern Tunisia
May 2020

List of participants

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3	Wadder Mabsaleh	OEP	Salih6872@live.fr		☒
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5					☐
6					☐
7					☐

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Annex 4: List of Participnats: On the Job training of Rangelands Inventorying and monitoring (21-22 October 2020)

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Science for resilient livelihoods in dry areas

CGIAR RESEARCH PROGRAM ON Livestock

On the Job Training
Rangeland Assessment and Monitoring
Southern Tunisia
21-22 October 2020
List of participants

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3	Yahia Ridha	OEP Mednine	admmg@hotmail.fr		☒
4	Mouldi Gamoun	ICARDA	m.gamoun@cgiar.org		☑
5					☐
6					☐
7					☐

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