SALAM-MED
sustainable approaches to land and water management in mediterranean drylands

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

The PRIMA programme is supported under Horizon 2020, the European Union's Framework Programme for Research and Innovation



# RECONCILE PASTORALISM AND CONSERVATION: The 'Agdal' System as a Model for Sustainable Management of the Argan Ecosystem

## KEY MESSAGES

- Threat of overgrazing: Intensive grazing is the main biotic threat to the argan tree, causing severe physiological stress and blocking natural regeneration.
- Proven oxidative stress: Trees subjected to intensive grazing suffer significant cellular damage, marked by excessive accumulation of hydrogen peroxide and malondialdehyde (MDA).
- Fall of physiology performance: Overexploitation drastically reduces photosynthetic efficiency and stomatal conductance, limiting the tree's ability to produce biomass and fruits.
- Soil degradation: Continuous grazing depletes the soil, resulting in a significant decrease in organic matter, total nitrogen and available phosphorus compared to protected areas.
- Efficiency of the Agdal system (moderate grazing): The traditional system of the Agdal (seasonal grazing management) allows the physiological state of trees to be maintained at a level comparable to that of ungrazed areas.
- Increased resilience: Trees under the Agdal system show better antioxidant enzymatic activity (catalase and peroxidase activity), demonstrating superior adaptability without depletion of reserves.
- Socio-Economic Trade-off: Unlike the total exclusion of livestock (difficult to apply socially), Agdal offers a viable balance between the economic needs of communities and the health of the forest.
- Biochemical quality: Moderate grazing preserves the proteins and photosynthetic pigments in leaves better than intensive grazing.
- Regulatory urgency: Without a transition to controlled grazing, irreversible soil degradation and dieback of mature trees will accelerate.
- Central recommendation: The generalization and institutionalization of Agdal practices are imperative for the sustainability of the Arganeraie Biosphere Reserve.

## SUMMARY

The argan tree (*Argania spinosa*), a species endemic to Morocco and a pillar of the Arganeraie Biosphere Reserve, plays a crucial ecological and socio-economic role. It constitutes a barrier against desertification and provides vital resources (oil, fodder, wood) to the local populations. However, this fragile ecosystem is now threatened by increasing anthropogenic pressure, notably overgrazing.

The practice of pastoralism is ancestral in the region, but the increase in herd size and settlement have transformed a precarious balance into destructive exploitation. Intensive grazing not only destroys young shoots, but also affects the health of mature trees and soil quality, compromising the long-term viability of the forest.

Faced with these challenges, two management models are often opposed: total exclusion (no grazing) and no exclusion (continuous grazing). A third way, rooted in the local traditional management, exists: the Agdal system. This is a seasonal ban, prohibiting access to the forest during critical periods (flowering, fruiting) and allowing it for the rest of the year.

This policy brief examines the real biological impact of these different management methods. It is based on recent scientific data comparing the physiological and biochemical responses of argan trees and edaphic (soil) traits under different grazing regimes. The objective is to provide decision-makers with tangible evidence to guide forestry pol-



November 2025

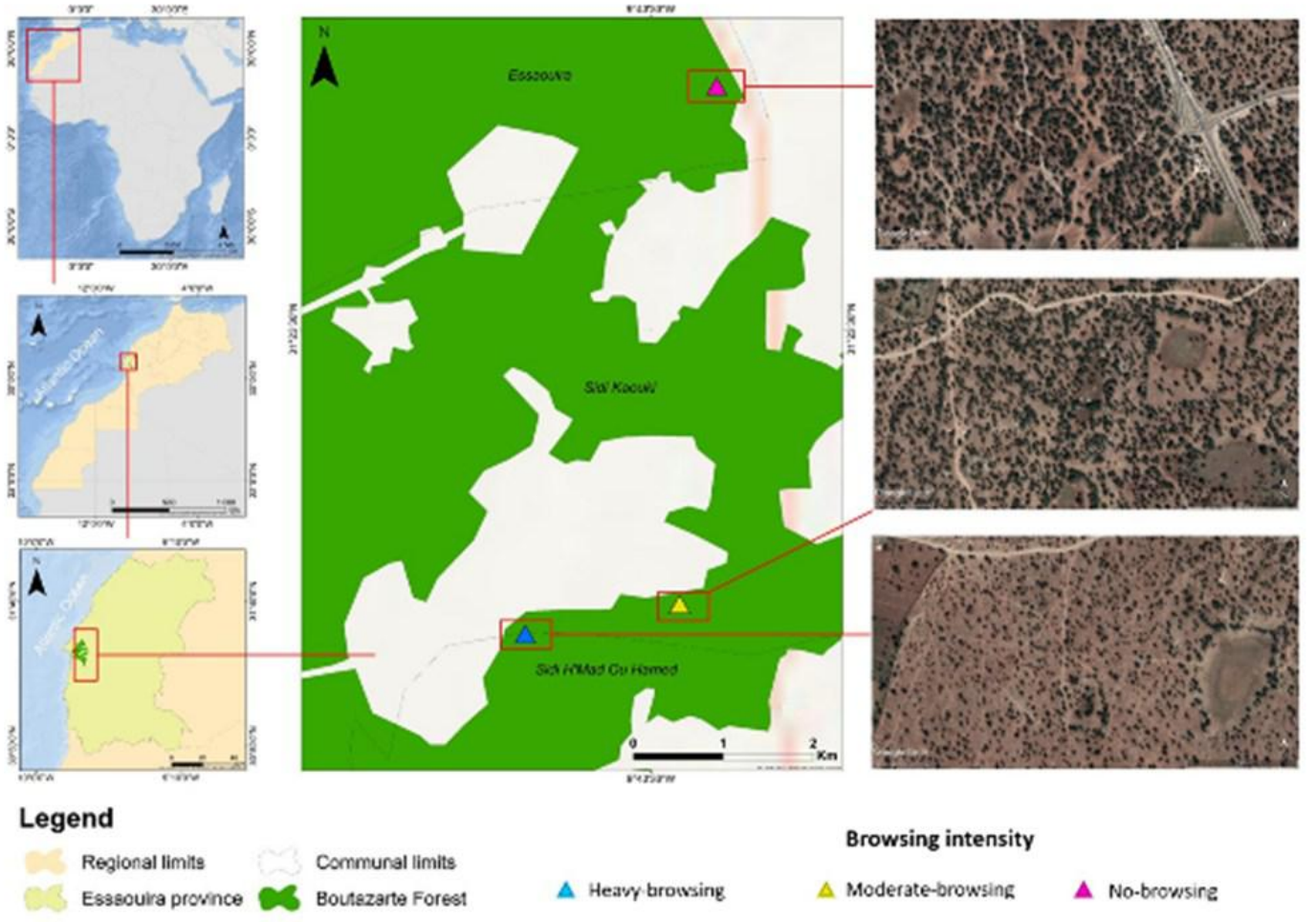
icies towards sustainable models that do not sacrifice either the forest or the income of farmers.

## RESEARCH AND RESULTS

The study was conducted in the Essaouira region (Boutazart area) on three distinct sites: a preserved site (no grazing), a site managed according to the Agdal system (moderate grazing) and a non-preserved site (intensive grazing).

**Physiological Impact**: The results show a clear alteration in overexploited trees. Photochemical efficiency (Fv/Fm) and leaf area index (LAI) significantly dropped in areas of intensive grazing, indicating a malfunction of the photosynthetic apparatus. Conversely, trees under the Agdal regime maintained physiological performances close to those of the ungrazed control site.

- **Biochemical Stress**: Overgrazing induces major oxidative stress. Foliar analyses reveal high levels of hydrogen peroxide and MDA in trees in intensive grazing, signifying irreversible damage to cell membranes. Although these trees are trying to compensate with increased activity of antioxidant enzymes (peroxidase and catalase activity), this defense is energetically expensive and insufficient in the long term.
- **Soil Quality**: Soils under intensive grazing have the lowest levels of organic matter, total nitrogen and available phosphorus. Excessive trampling and total consumption of biomass prevent the return of organic matter to the soil. The Agdal site, for its part, preserves an intermediate soil fertility, clearly superior to degraded areas, thus ensuring the nutrient cycle necessary for the survival of the ecosystem.



## RECOMMENDATIONS

To reverse the trend of degradation of the argan forest while maintaining the pastoral activity essential to the rural economy, the following measures are recommended:

**Institutionalize and Modernize the Agdal**: The Agdal system should no longer be considered as a simple local custom, but as a technical tool for forest management. Thereby a need

- **Action**: Integrate the Agdal management system into the Development Plans of the National Water and Forest Agency.
- **Implementation**: Define precise schedules for opening and closing the courses, based on the tree's phenological cycle (protect flowering and fruit maturation) and annual climatic conditions.

**Zoning and Rotation** of Pastures Continuous grazing on the same plots is the main cause of soil depletion.

- **Action**: Set up a plot rotation system to allow the soil and vegetation to regenerate.
- **Implementation**: Divide forest areas into pastoral management units. Alternate rest periods (minimum 1 to 2 years for very degraded areas) and operating periods.

**Pastoral Load Control**: The density of livestock in intensive grazing areas often exceeds the carrying capacity of the ecosystem.

- **Action**: Define livestock quotas per hectare adapted to the annual forage productivity of each area.
- **Implementation**: Create compensation or subsidy mechanisms for livestock farmers who meet quotas (payments for ecosystem services) to compensate for the shortfall in income in the short term.

**Monitoring the Health of Trees and Soils**: Management must be driven by scientific indicators and not only by forage demand.

- **Action**: Use the stress indicators identified by the study (Biochemical parameters of tree leaves) as monitoring tools.
- **Implementation**: Train forestry technicians to detect tree stress before the appearance of visual signs of dieback, allowing for a preventive closure of risk areas.

**Capacity Building** for Cooperatives and Associations: The success of Agdal is based on community membership.

- **Action**: Strengthen the management power of user associations (stakeholders).
- **Implementation**: Launch awareness programs explaining the direct link between soil health (proven by the study) and future range productivity, in order to transform farmers into conservation partners.

www.salam-med.org


MARRAKECH
جامعة القاضي عياض
UNIVERSITÉ CADI AYYAD

كلية العلوم السملالية - مراكش
FACULTÉ DES SCIENCES SEMLALIA - MARRAKECH

toxolt

*Contact Point*
**Nucleo Ricerca Desertificazione NRD**
**Università degli Studi di Sassari**
V.le Italia 39a - 07100 Sassari - Italia
Tel.: +39 079 213102/3 / Fax: +39 079 219394
E-mail: salam_med@uniss.it / nrd@uniss.it
*SALAM-MED Website* **www.salam-med.org**