Agro-silvo-pastoral systems in low rainfall areas

Challenge 2.1: Improving and managing rangeland systems resilience for delivering food and feed, biodiversity conservation with local communities and market linkages for livestock and dryland products

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Agro-sylvo-pastoral systems

Area: 873 million ha (42%)
Population: 0.22 billion people
Bio-physical environment of agro-silvo-pastoral systems

• **Arid and semi-arid:**
  - highly variable and unpredictable rainfall patterns, long dry seasons
  - unprecedented high frequency of extreme weather events
  - highly vulnerable to climate change
  - hot, high evaporation rates resulting in high moisture deficits
  - grasslands represent largest land use

• **Often on poor, shallow soils, prone to erosion:**
  - depleted soil organic carbon in overused landscapes

• **Natural vegetation well adapted to these conditions:**
  - fragile vegetation types: dominated by annual species and therefore low biomass productivity
  - system is prone to invasive/unpalatable plant species
  - significant seasonal feed shortages

Mountainous drylands in Ethiopia

Rangelands in Tunisia
Challenges related to the fragile environment

**Water scarcity:** triggered by low rainfall (coupled with low surface and/or groundwater influx) exacerbated by erratic occurrence
- inability to exploit scarce rainwater sources efficiently and/or high risk of crop failure

**Soils depleted of SOC:** with reduced infiltration (e.g. surface crust, compaction, ...) and low ability to store moisture (poor soil structure, porosity, connectivity, soil depths, ...)
- surface runoff and soil erosion lead to formation of surface rills and gullies changing the dryland’s hydrology, draining water from the agro-pastoral watersheds, and gullies interrupting pathways for human, livestock and agricultural machinery.

**Severe land degradation (declining vegetation and erosion):** due to unsustainable grazing strategies, mismanagement and encroaching cultivation, e.g. of depressions
- evaporation from bare soil surface, unprotected from erosive forces of water and wind accelerating physical degradation
- unavailability of well adapted range and forage seeds (seed system)
Research questions addressing the biophysical challenges

• **How to** restore landscapes and soil health?
  - Design of integrated watershed management (incl. fitting crops/varieties, adaptive management)?
  - Restore vegetative cover (resting, reseeding, shrub/tree plantation)?
  - Restore soil health to better infiltrate, store and release water (enhancement of soil water characteristics/capabilities through soil cover and rebuilding SOM)?
  - Develop an adaptive way to revitalize the landscapes with species diversification and enriched native biodiversity?

• **How to design and implement** sustainable utilization of rehabilitated rangelands and watersheds?
  - Livestock management for enhanced productivity and income (grazing, water points, herd management, mitigation strategies for animal feed shortages and disease outbreaks, improved marketing strategies)
  - Enhanced governance mechanisms (see challenge 2.2): Identification of pathways for enhancing rangeland governance under constraining land tenure systems
Research questions addressing the biophysical challenges

• **How to** address climate risk (erratic rainfall and droughts)
  - Water harvesting and storage options?
  - Digital Advisories and Early Warning Systems (DAEWS) that address the needs of the research community and user segments and are easily accessible?
  - Insurance solutions for crops and livestock for smallholders (e.g. index-based insurance)?
  - More diverse livelihood options through value addition in crop, range and livestock value chains (researchers’ role)?

• **At what scale/level** are interventions most effective?
  - Rehabilitation measures at watershed level versus community-based approaches?
  - Mediation between upstream and downstream rehabilitation?
  - How to mediate between sedentary and commuting actors (landscape connectivity)?
Higher level research questions

• How much and what modeling and monitoring is needed (versus investment in development/scaling)?
  o Downscaling climate to higher spatial resolution for various climate change scenarios?
  o Mapping and monitoring ecosystem carbon dynamics and water regimes?
  o Biophysical modeling of soil, water and vegetation dynamics?
  o Valuation and pricing of ecosystem services? ...

• What are critical success factors for adoption and sustainability?
  o What are the critical parts of the system (strong leverage points and/or high return on investments)?
  o How do we develop adaptive capacity of all stakeholders incl. researchers?
  o What are incentives for behavioral change of the different actors?
  o How do we foster knowledge, learning, campaigning and self-organization to build resilience?

• Scalability
  o How to scale very context specific pilot projects?
  o Do we have tools to target interventions or do we need more research on suitability mapping/assessment?
  o What are the minimum requirements for an enabling governance/institutional setting before embarking into a rehabilitation program?