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Grazing with trees

A silvopastoral approach to managing and restoring drylands



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Grazing with trees

A silvopastoral approach to managing and restoring drylands

by

Fidaa F. Haddad, Pedro M.Herrera and Badi Besbes

Case study	Authors
Silvopastoral systems and sustainability of Sahelian socioecosystems in Senegal	Alexandre Ickowicz, El Hadji Traore, Assouma Habibou, Paulo Salgado, Abdrahmane Wane, Ibra Touré, Simon Taugourdeau, Christian, Corniaux Tamsir Mbaye, Jean-Daniel Cesaro, Etienne Delay, Amy Bakhoun Morgane Dendoncker and Caroline Vincke, Cirad, France, ISRA, Senegal, Cirad-Cirades Burkina Faso, Cirad-ISRA, Senegal, Cirad-ILRI, Côte d'Ivoire, UCAD, Senegal, Université Catholique de Louvain, Belgium.
Forest owners and livestock farmers determine the success of silvopastoralism in northeastern Spain	Elsa Varela, Ana Olaizola, Marc Taüll and Antonio Lecegui, Forest Science and Technology Centre of Catalonia (CTFC), University of Zaragoza, Catalan Institute of Agrifood Research and Technology.
Rangeland forests and silvopastoralism in Uzbekistan's cold deserts	Nariman Nishanov, FAO, National Coordinator of the CADI project in Uzbekistan.
Rational grazing on bocage perimeter in Burkina Faso	Aubin Ouedraogo, Seydou Kabore and Henri Girard, Terre Verte.
Conserve native flora through ecological restoration in the Royal Botanic Garden of Jordan	Mustafa Al-Shudiefat and Hana Kambay, The Royal Botanic Garden of Jordan.
Characterizing grazing livestock systems for tailored adaptation support in Fatick, Senegal	Ernest Habanabakize, Awa Mbodj and Maïdie Sinitambirivoutin, with the collaboration of Ndèye Yacine Ndour, Elsa Vasseur and Patrick Cortbaoui. McGill University, FAO.
Community movements for ecosystem and livelihood resilience in Iran	Mina Esteghamat, Siavash Aghakhani, Amir Zand and Mahmoud Moradi, Center for Conservation and Development of Sustainable Ecosystems (ZIPAK NGO).
Traditional agrosilvopastoral system in Meridional Espinhaço range (Minas Gerais State/Brazil)	Fernanda Testa and Claudenir Fávero, Monteiro São Paulo University, Federal University of Jequitinhonha and Mucuri Valleys.
Participatory rangeland management-an enabling process for improving silvopastoral management and governance	Fiona Flintan, CGIAR Livestock, Climate and System Resilience initiative, International Livestock Research Institute (ILRI).
Updates on legal silvopastoralism instruments in Lebanon	Zeina Tamim, Department of Rangelands and Public Gardens Ministry of Agriculture, Lebanon.
Silvopastoral strategy for Morocco	Said Moukrim, Water and Forestry Department; Mohammed-V University, Morocco.

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Commissariat of Agricultural Development of Zaghouan (represented by the forest service and the water and soils conservation service), the Higher School of Agriculture of Mateur, the National Institute for Research in Rural Engineering, Water and Forests, the CBO and the communities and farmers was a key factor in the success of the project and its sustainability.

The great potential recognized so far at this pilot site has boosted the aim to outscale this system to other areas within Tunisia in order to improve the livelihoods of smallholder farmers. As such, this pilot site would be an example for other places within Tunisia and in the Near East region.

For more information

Project final report (Louhaichi *et al.*, 2019).

Using native drought-tolerant forage species for enhanced dryland pasture restoration (Blog) by Mounir Louaichi (2021).

Assessment of soil surface scarification and reseeding with sulla (*Hedysarum coronarium* L.) of degraded Mediterranean semiarid rangelands (Slim *et al.*, 2021).

Managing rangelands: promoting sustainable legume species: *Hedysarum coronarium* L.: a biennial herbaceous legume used for forage in the Mediterranean basin (Louhaichi, Slim and Gouider, 2018).

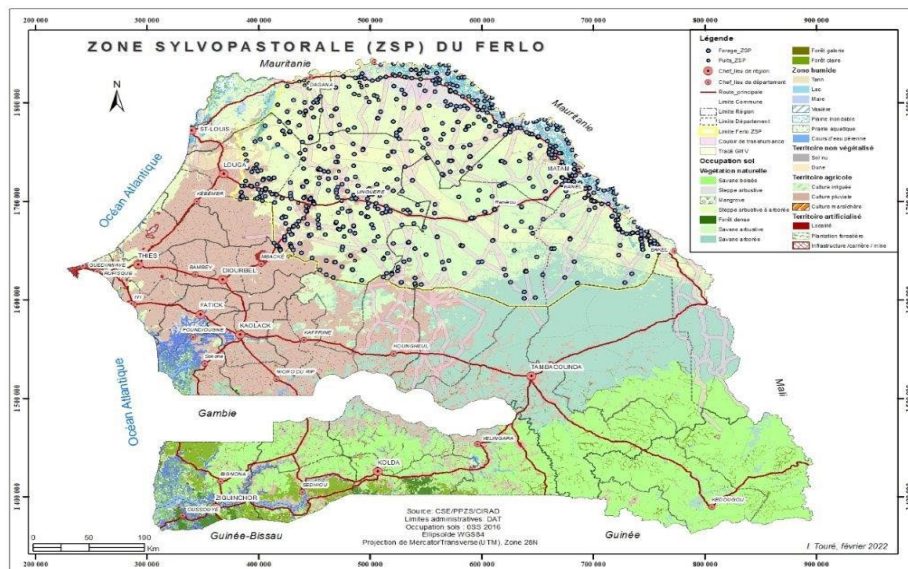
CASE STUDY 7: SILVOPASTORAL SYSTEMS AND SUSTAINABILITY OF SAHELIAN SOCIOECOSYSTEMS IN SENEGAL

The area of Northern Senegal known as the Ferlo, which is dominated by semiarid open rangelands with mainly annual grass and open tree-shrub covers, with a mean annual rainfall ranging from 400 mm/y to 200 mm/y, hosts a large part of the domestic ruminant population (54 percent of cattle (over 3 668 000), 59 percent of sheep (upwards of 7 152 000), and 56 percent of goats (over 6 052 000). Livestock is managed through traditional silvopastoral mobile livestock systems.

Grazing livestock, forests and trees in the Ferlo in Senegal

Landscape in the Ferlo region is composed of undulating smooth sandy dunes in the western part and a ferruginous plateau in the eastern part. The vegetation is characterized by semiarid open tree and shrub steppes dominated by annual grasses (*Aristida* spp., *Cenchrus* spp., *Schoenefeldia gracilis* Kunth., *Panicum* spp., *Brachiaria* spp., etc.) (Figure 10). Dominant tree and shrub species are *Balanites aegyptiaca*, *Boscia senegalensis*, *Senegalia senegal* (L.) Britton, *Vachellia tortilis*, *Vachellia nilotica* (L.) P.J.H.Hurter and Mabb., *Pterocarpus lucens* Lepr. ex Guill. and Perr., *Adansonia digitata* L., *Sclerocarya birrea*, and so on. The average tree and shrub cover is around 15 percent. Due to low and unpredictable rainfall, cropping activities are not dominant in the southern part of the region and are almost absent in the northern part. Silvopastoral systems are the dominant land use, consisting of communal land owned by the government and managed by the local population through the status and regulations of “pastoral units”.

FIGURE 10
Silvopastoral zones in the Ferlo, Senegal



Source: PPZS/CSE/CIRAD, I.Touré (2012)

The mobility of the herd and part of the family can vary from 5–10 km to 15–25 km per day in the rainy season, and a total distance of over 300 km during the dry season, depending on the livestock production system and the availability of annual pasture around watering points. In a normal year, cattle are often limited to the boreholes of the northern Ferlo, while small ruminants move increasingly south. Various studies conducted in the area have shown a significant increase in the domestic ruminant population over the past few decades (Touré *et al.*, 2012) and a decrease in the population of some woody species (Dendoncker and Vincke, 2020). Transhumant herders show a preference for routes that allow them to reach the host area as quickly as possible, under good feeding conditions for their livestock (presence and quality of pasture, availability of water, crop residues in agricultural areas) and considering the terms of trade practised in livestock markets (Garba *et al.* 2012). The transhumance movements are thus made up of a series of stages carefully chosen based on information collected from informants and the personal experience of the herder.

There is no clear evidence of the impact of livestock on woody vegetation population numbers, despite the fact that tree and shrub leaves and fruits may contribute to 20 and 80 percent of cattle and small ruminant diet, respectively, during the hot dry season when grasses are dry and rare. Among the 27 woody species mentioned by herders as used for food, fodder, firewood, construction, medicine and veterinary support, ten were cited as a source of fodder (Dendoncker, Ngom and Vincke, 2015). As another example, results from a field inventory carried at varying distances from boreholes do not show a significant influence of livestock on woody vegetation density, cover and species composition (Dendoncker and

Vincke, 2020). Many attempts to improve and restore the woody population have been conducted in the area for decades with some positive results. The Great Green Wall for the Sahara and Sahel Initiative (GGW) has been operative in the area (around 10 000 hectares of afforestation since 2011), with FAO supporting processes related to the resilience of rural communities in the implementation of land restoration through the GGW programme between 2015 and 2019 (Sacande, Parfondry and Ciciatello, 2020). More than 200 plant species have been identified as useful to communities, including at least 86 tree species, mainly for human consumption (food, medicine, etc.) and fodder (Sacande and Parfondry, 2018). After a first phase when the population was not so much involved in restoration actions, the new strategy for the coming decades offers the opportunity for local stakeholders to participate in planning and operating restoration activities. Another important issue in the Ferlo is the recent development (starting 15 years ago) of local dairy value chains based on the small dairy industry collecting milk from silvopastoral livestock systems and selling products to urban centres (Corniaux, Duteurtre and Broutin, 2014; Bourgouin *et al.*, 2019). This dynamic has the triple impact of improving income and livelihoods for pastoralists (Wane, Cadilhon and Yauck, 2017), offering local products to consumers versus imported dairy products (e.g. full milk powder) and stimulating silvopastoral ecosystem management and valuing through multistakeholder process and planning.

The Ferlo in Senegal: Protected areas managed by pastoralist associations

The Ferlo comprises seven silvopastoral protected areas with old boreholes managed by pastoralist associations to provide water to livestock and human populations (Cesaro, Magrin and Ninot, 2010; Touré *et al.*, 2012). The government has developed several public policies to promote the sustainable management of these protected areas and support livestock mobility. For many decades, numerous development and research projects conducted in this area through collaboration between the Government, CSOs (such as the *Association pour la Promotion de l'Élevage au Sahel* or the *Réseau Billital Maroobè*) and national and international research organizations pointed to an abundance of positive interactions between livestock activities and woody population management (ecosystem maintenance, feeding ruminants, biodiversity management, nutrient cycling, carbon balance, etc.) (Ickowicz and Mbaye 2001; Assouma *et al.*, 2019; Bakhoum *et al.*, 2020).

Most recent results and synthesis of these past and present projects show that there is no clear evidence of the overarching impact of anthropogenic factors over climatic factors on tree and shrub population decrease and ecosystem degradation (Diouf 2002; Diouf *et al.*, 2005; Assouma *et al.*, 2019). While a decline in tree density was observed between 1965 and 2008 (14.8 trees/ha to 11.9 trees/ha; shrubs not taken into account), the following decade was marked by stabilization (12.2 trees/ha in 2018). Over the same initial period, species composition shifted, with a decrease of some tree species (e.g. *Sclerocarya birrea* (A.Rich.) Hochst. *Combretum glutinosum* Perr. ex DC.) and an increase or stabilization of shrub

species and/or drought-resistant species (e.g. *Vachellia tortilis* (Forssk.) Galasso and Banfi, *Boscia senegalensis* Lam., *Balanites aegyptiaca* (L.) Delile). As a result, the shrub-to-tree ratio increased (Dendoncker *et al.*, 2020). A recent study on the carbon balance in silvopastoral ecosystems in the Ferlo showed that these systems are neutral, compensating emissions with storage, mainly due to positive interactions between ligneous plant species, soils and livestock (Assouma *et al.*, 2019). This shows that Sahelian silvopastoral systems are well adapted to their environment and can contribute to sustainable development and food systems when relevant public policies and sustainable rural practices are adopted.

Baseline data is crucial to strengthen the monitoring systems

The project: “Carbon sequestration and greenhouse gas emissions in (agro) silvopastoral ecosystems in the Sahelian CILSS States (CaSSECS)” which spans from 2020 to 2023 aims at improving the assessment of the carbon footprint of Sahelian agrosilvopastoral ecosystems to better quantify their impacts on climate change for the development of livestock policies adapted to the Sahel.

At the end of the second year of implementation, the project already mobilized numerous devices that allow for the acquisition of reference data that will, thereafter, offer the possibility of establishing a carbon footprint adapted to Sahelian silvopastoral zones. At the animal level, use of: (i) green feed to measure methane emissions during ingestion; (ii) experimentation in fields and on stations to evaluate the level of ingestion of ruminants; (iii) near-infrared spectrometers to estimate the chemical composition of animal feces, feeds and forages, using specific prediction equations; and (iv) GPS tags and collars to follow the demography of the herds and their mobility.

For herbaceous vegetation, biomass evaluation is conducted at the plot level, followed by the calibration of drones for a larger-scale evaluation of grass growth.

At the woody vegetation level, use of: (i) root and trunk growth monitoring system to assess the carbon accumulation and intra-annual variation; (ii) canopies growth and dynamics of trees monitored using drones but also terrestrial Lidar calibrated imagery; and (iii) experimentation in the field to study the dynamics of woody communities and their dendrometric characteristics.

For soil and gas exchange: (i) two GHG flux towers measure daily GHG fluxes; (ii) coupled climatological towers monitor weather conditions (data available for the past few years); (iii) automatic and manual chambers calculate soil gas exchange on bare or covered soil, under trees or in open areas; and (iv) soil samples, collected from different territories and according to various grazing management, are analysed in the laboratory to estimate their carbon stock.

In order to fully meet the objectives of the project and to incorporate target people, studies were conducted to understand the choices and practices of pastoralists but also the dynamics of the territories around silvopastoral systems. At the territorial level, the role of trees is linked to ES provision. A study conducted in CaSSECS is based on a better understanding of the socioeconomic importance of tree resources for pastoral households (human food, fruit marketing, animal

feed, construction, energy, local medicine, etc.). The issue ahead is whether the increase in tree density (a GGW objective), possibly with multispecies composition close to natural distribution, is compatible with pastoral livestock farming or whether a compromise must be found between the two activities. The idea is to co-conceive new livestock practices to increase ES and livelihoods while promoting an adaptation of grazing systems to climate change.

Finally, training on using the different devices and methods was provided during these first two years. This training aimed to strengthen the capacities of the project's technicians, researchers and Ph.D. students to facilitate the creation of references. For the next two years, training sessions will be organized for pastoralists and farmers' organizations, as well as for technicians and agents of the ministries, to make the references and tools designed accessible to those who need them.

Management is crucial to managing the positive and negative interaction between grazing livestock and restoring woodland

The analysis of this case, based on the conceptual framework (Figure 3) and the proposed criteria (Table 3), shows that the Ferlo region is quite representative of the general context all over the Sahelian region. CaSSECS has already promoted the acquisition of reference data that will, thereafter, offer the possibility of establishing a carbon footprint adapted to Sahelian silvopastoral zones. The methods used in CaSSECS focus mainly on producing evidence and reliable figures on the impact of the silvopastoral system on climate change and carbon balance. Initial assessment and studies through predictive models and field studies showed that Sahelian silvopastoral systems are significantly under the initial estimates of UNCCC and closer to a neutral GHG balance. This is due mainly to carbon storage in soils and trees and to lower GHG emissions by ruminants with a low annual average intake rate. But pathways to an ecological intensification of silvopastoral production maintaining a neutral carbon balance require a number of preconditions, including: innovative and fine-tuned agricultural practices with real measurement of carbon storage and GHG emissions (ruminant feeding, herd management, etc.); support from governments through appropriate regulations (land-use, proper carbon balance assessment system; import taxes; local value chain support; and investments (communication, rural infrastructure, etc.).

The focus on positive environmental interactions between livestock and silvopastoral ecosystems, without neglecting economic and social aspects and looking at management and policy support and strategy, offers the opportunity to foster multistakeholder discussions on the sustainable development of silvopastoral landscapes and to innovate towards relevant sustainable practices. Co-building and the promotion of innovative practices, regulations and policies that allow positive interactions to be supported between livestock and forestry activities in the Sahel to meet the Sustainable Development Goals (SDGs), while avoiding the negatives, are among the main objectives of CaSSECS project in the Ferlo, together with many other projects taking place in this area.

Livestock, trees and shrubs, grasses, soils and pastoralists are part of the Sahelian silvopastoral socioecosystem which for centuries has demonstrated its capacity to adapt to changes (climatic, social, and economic) in a relatively sustainable way, albeit with negative impacts in specific contexts. Recent studies on ecosystem maintenance, feeding ruminants, biodiversity management, nutrient cycling, Carbon balance (Ickowicz et Mbaye 2001, Danthu et al. 1996, Manlay et al. 2004, Chirat et al. 2014, Traore et al. 2016, Assouma et al. 2019, Bakhoun et al. 2020, Traore 2021) have described more accurately how positive and negative interactions can occur between these components. They showed also that to adapt better to a changing environment and remain in line with SDGs, the project needs to promote practices, regulations and policies that take into account all the components together and to have a holistic, multidisciplinary and multisectoral approach to elaborating new and innovative sustainable solutions and options. Livestock and forestry stakeholders, who are the main actors in this environment, must then collaborate and be open to other actors to design the operational context. Accordingly, the institutional and political environment for the sustainable management of the Sahelian region would be strengthened to take action against desertification impacts.

For more information

www.cassecs.org

www.ppzs.org

CASE STUDY 8: FOREST OWNERS AND LIVESTOCK FARMERS DETERMINE THE SUCCESS OF SILVOPASTORALISM IN NORTHEASTERN SPAIN

Aragon (Guara Natural Park) and Catalonia (Lluçanès County) in the northeastern part of Spain display important differences arising from the forest property regimes. In Guara, 40 percent of the forest land is forest commons belonging to municipalities (regional government), while in Lluçanès, more than 90 percent of the forest belongs to private forest owners and 50 percent of the forest land, that is, around 24 000 ha, has a forest management plan. Around 400 of these private forests are bigger than 10 ha and around 200 forest owners hold forest states bigger than 50 ha. A shift from sheep to cattle farming has taken place in both areas. The overall stocking rate in forest land is low due to the reduced quality of forage in forest land. Supplementary feeding is provided by cattle farmers. In the absence of management optimization, this causes an irregular distribution of stocking rates with areas under high grazing pressure while others remain unexplored.

Silvopastoralism as an adaptation strategy for an integrated rural development

Extensive livestock farming and silviculture have experienced a significant decline in the rural areas in Spain, triggering unwanted effects on ecosystems and society. The reduction in forest management has resulted in an increase in biomass and