Remittances Review

October 2024

Volume: 9, No: 5, pp.284-303

ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

Received: 12 June 2024 ; Accepted: 27 October 2024
DOI: https://doi.org/10.47059/rr.vx9i2.16

BIOECONOMIC IMPACT OF THE DEFERRED GRAZING PROJECT IN THE STEPPE RANGELANDS OF THE DJELFA PROVINCE, ALGERIA

HOUARI Ahmed [1*], DJENANE Abdel-Madjid [2], RAHOUADJA Fatiha [3]

Abstract

In the province of Djelfa of Algeria, steppe rangelands are experiencing severe degradation. To address this issue, a twenty-year deferred grazing project was initiated. This study evaluates the project's impact on forage production, forage quality, and associated economic benefits. Data were collected during spring across four campaigns between 2017 and 2021, coinciding with the peak growth period of steppe species. A comparative methodology was employed to assess the floristic parameters of developed sites and nearby control areas. Additionally, economic indicators were developed using data from the developed perimeters (2001–2023).

The results demonstrate a significant improvement in developed areas compared to control sites: floristic diversity (104 vs 73 species), vegetation cover (72% vs 24%), phytomass (1.65 T DM/ha vs 0.52 T DM/ha), and forage production (174 FU/ha vs 33 FU/ha). Economic analysis confirms the project's viability and profitability, with a substantial reduction in the cost of forage production per unit.

Keywords: Algeria ; economic analysis ; forage production ; impact ; profitability.

1. Introduction

Algerian steppe areas are characterized by rangelands, namely, natural pastures extensively used for livestock feeding (Aidoud, 1994). This region serves as a vital space for over 7.2 million inhabitants,

[1] Department of Agronomic Sciences, Faculty of Nature and Life Sciences, Setif 1 University - Ferhat Abbas, El Bez Campus, Setif 19137, Algeria. E-mail: kebbiryas2006@yahoo.fr, Orcid : https://orcid.org/0000-0003-0367-9840

[2] Faculty of Economics, Business and Management Sciences. Sétif 1 University - Ferhat Abbas, El Bez Campus, Setif 19137, Algeria. E-mail: madjidjenane@univ-setif.dz

[3] Exploration and Valorization of Steppe Ecosystems Laboratory, Department of Agricultural and Veterinary Sciences, Faculty of Nature and Life Science, University of Djelfa, Po Box 3117, Djelfa17000, Algeria. E-mail: f.rahouadja@univ-djelfa.dz, Orcid: https://orcid.org/0000-0002-8865-0459

the majority of whom rely on livestock farming as their primary source of income. The livestock population grazing in these areas has seen a remarkable increase, rising from 7 million head in 1980 to over 20 million by 2001 (HCSD, 2022). According to Bedrani (1994), this rapid growth is primarily attributed to the high profitability of livestock farming in steppe environments. Consequently, the steppe plays a master role in sustaining sheep farming, which significantly contributes to reducing the national protein deficit.

However, the condition of steppe rangelands is increasingly concerning. Numerous studies have highlighted the growing degradation of these areas, emphasizing the fragility of the steppe ecosystem. This fragility is exacerbated by both natural constraints (such as climatic aridity and sand encroachment) and human activities (including overgrazing and land clearing), which place immense pressure on natural resources (Boutonnet, 1989).

Over the past few decades, this degradation has become particularly acute, manifesting as a dramatic decline in the extent and productivity of pastoral lands. This includes a reduction in both vegetation cover and forage potential. By 2001, the forage deficit was estimated at 47% of the annual requirements (HCSD, 2022), causing a significant challenge to meeting the needs of livestock. As a result of declining rangeland productivity, herders have been compelled to purchase concentrated forage—not only during transitional periods but sometimes throughout the year. Zirmi-Zembri and Kadi (2016) note that forage resources represent the most significant and costly inputs, accounting for 25% to 70% of total operational expenses. Rising input costs have also led to a substantial increase in livestock prices.

To address the degradation of steppe rangelands, reduce the forage deficit, and improve herder incomes, the High Commission for Steppe Development (HCSD), a public technical and scientific institution, implemented the deferred grazing project (DG_P). Numerous studies have shown that rangeland development and grazing control result in notable improvements in floristic richness and forage value in arid and semi-arid environments (Acherkouk, 2013; Amghar et al., 2016). However, these studies have not sufficiently addressed the economic aspects of the DG_P, even though such considerations are crucial for guiding rangeland management decisions. While opinions differ on the feasibility of this project, financial profitability remains a key indicator of its sustainability.

This study aimed to analyze the outcomes of the deferred grazing project. It evaluated the project's performance across various perimeters, focusing on its impact on floristic regeneration, vegetation cover, forage potential (in terms of dry matter and energy), and its contribution to overall vegetation coverage. Additionally, the economic impact of the project's implementation was assessed.

2. Materials and methods

2.1. Study area

Our study was conducted in several municipalities within the province of Djelfa, a choice prompted by the diversity of development techniques implemented in this region. Located in the central part of northern Algeria, beyond the southern foothills of the Tell Atlas when approaching from the north, the province of Djelfa is situated 300 km south of Algiers, the capital. It lies approximately in

Volume: 9, No: 5, pp.284-303

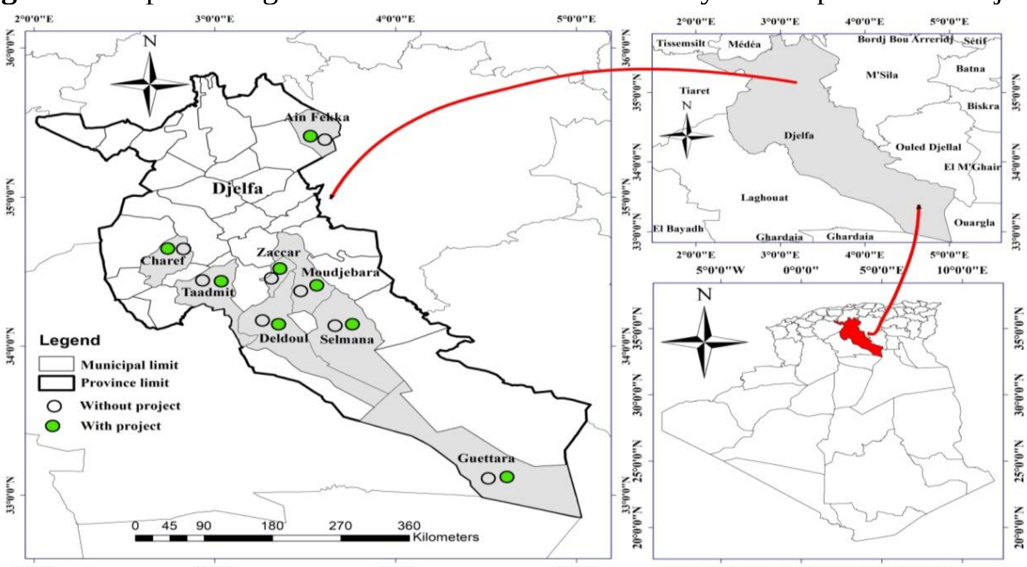
ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

300 km south of Algiers, the capital, and is situated between 2° and 5° East longitude and 33° and 35° North latitude (Figure 1).

The region's climate ranges from a lower cool semi-arid bioclimatic zone to an upper cool arid zone. The soils are characterized by limestone accumulations, low organic matter content, and high susceptibility to erosion and degradation (HCSD, 2022). In the north, the region is bordered by the 400-mm isohyet, marking the extent of rain-fed cereal farming, while the southern boundary is defined by the 100 mm isohyet, which delineates the southern limit of *Stipa tenacissima* (alfa grass) growth (Djebaili, 1984). Average annual rainfall recorded between 2001 and 2022 was 277 mm. Annual average temperatures are approximately 19°C, with minimums dropping as low as -4°C and maximums reaching an average of 36°C (ONM, 2023).

Rangelands dominate land use in this region, covering an area of 2 122 428 hectares, representing 66% of the province's total surface area. Along with alfa grasslands, these rangelands account for three-quarters of the region's land dedicated to agropastoral activities (DSA, 2022). Between 2001 and 2021, the sheep population in Djelfa experienced significant growth, increasing from over 2 million to more than 4 million head, accounting for approximately 12% of the national sheep population. Goats and cattle also play an important role in livestock farming, representing 11% and 1% of the total livestock, respectively, during the same period. Sheep farming, predominantly pastoral, remains the primary livestock activity in the region.

Figure 1. Map showing the distribution of floristic surveys in the province of Djelfa.



2.2. Deferred grazing project

Volume: 9, No: 5, pp.284-303

ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

This project aligns with ongoing efforts to preserve and protect steppe rangelands while combating the degradation of natural ecosystems. The establishment of protected areas is prioritized due to its proven effectiveness, the expertise acquired by rural and pastoral populations involved in participatory initiatives, and its significance in research, formation, and outreach. Additionally, it serves as a generator of employment in rural areas, where job opportunities are often scarce or nonexistent.

In regions where rangeland degradation is moderate—characterized by perennial vegetation coverage between 20% and 40%—the HCSD employs a combined approach of protected area establishment and controlled grazing. This strategy safeguards a territory or parcel from inappropriate human or animal exploitation.

Once designated as protected areas, these zones are placed under surveillance for a period of three to five years. Boundaries are marked by visible mounds, and protection is ensured by guards (HCSD, 2022).

The implementation, monitoring, and management costs of the project are primarily distributed as follows:

- Setup: Selection of sites, transportation, fuel, installation of boundary markers, etc.
- Guard salaries;
- Legal expenses and miscellaneous;
- Technical supervising and monitoring.

3. Methodology

3.1. Biological aspect

Field data collection was conducted during spring over four campaigns (2018, 2019, 2020, and 2021), corresponding to the peak growth period for most steppe species. These campaigns were carried out approximately 17 to 20 years after the initiation of the project.

A comparative method was employed to analyze floristic parameters between developed sites (32 floristic surveys conducted in fenced protection areas, referred to as SWP – Situation with Project) and their respective control sites located nearby (32 surveys conducted in freely grazed plots, referred to as SWOP – Situation Without Project). These surveys were carried out in eight stations within the province of Djelfa.

The selection of stations was based on the homogeneity of vegetation physiognomy, ensuring representativeness while avoiding transition zones within each station. After describing the vegetation, a specific record was prepared for each floristic survey. Finally, a summary table consolidating data from various stations was developed.

Using appropriate tools (measuring tape, pruning shears, plastic bags, stakes to delimit plots, etc.), surveys were conducted following the linear sampling method (Daget and Poissonet, 1971). A line of 100 points, spaced 10 cm apart, was drawn randomly, and vegetation readings were taken along this line.

Remittances Review

October 2024

Volume: 9, No: 5, pp.284-303

ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

Collected species were coded and placed in bags for later identification using the flora guide by Quézel and Santa (1962). In the steppe environment, the minimum studied surface area ranged between 64 and 132 m².

For natural species, phytomass was measured by cutting vegetation at ground level within a designated area: 10 m² for perennial species and 1 m² for annual species. Perennials were sorted by species and weighed on-site, while annuals were also weighed on-site before being dried in an oven at 105°C for five hours to obtain their dry weight.

- Specific frequency (Sfi)

The frequency of a species is determined by the number of times it is observed in the surveyed (n) plots, expressed as a percentage. The specific frequency corresponds to the percentage presence (Ni) of species (i) relative to the total number (N) of reading points:

$$\mathrm{Sfi} = \frac{\mathrm{Ni}}{\mathrm{N}} \times 100$$

- Vegetation cover

The degree of canopy cover is determined by the projection of the above-ground parts of plants onto the ground. The method for calculating canopy cover varies depending on the morphology of each plant:

- For a circular projection :

$$\mathrm{Vc} = \pi \, \mathrm{X} \, \frac{\mathrm{d}^2}{2}$$

- For a rectangular projection :

$$\mathrm{Vc} = \mathrm{a} \, \mathrm{X} \, \mathrm{b}$$

- Phytomass

The assessment of pastoral resources relies on measuring the phytomass of the plant communities in grazing areas. The method used is semi-destructive: one-quarter of the plant tuft is cut, and the weight is multiplied by four to estimate the total weight of the tuft. This weight is expressed in dry matter (DM) per unit area. Designed by FAO (1989), this technique minimizes species destruction.

- Dry matter

The dry matter content is calculated using the following formula:

$$\mathrm{DM}\ (\%) = \frac{\mathrm{X}}{\mathrm{Y}} \times 100$$

- X represents the weight of the sample after dehydration; Y represents the fresh weight of the sample.

- Specific contribution (Sci)

According to Daget and Poissonet (1971), the specific contribution of a species to the plant cover is calculated as follows:

$$\mathrm{Sci}\ (\%) = \frac{\mathrm{Sfi}}{\sum_{1}^{n} \mathrm{Sfi}} \times 100$$

- Sci is the specific contribution to the plant cover; Sfi is the specific frequency of species i.

Volume: 9, No: 5, pp.284-303

ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

- Pastoral value

Pastoral value is an indicator of the overall quality of grazing land. It considers three parameters: vegetation cover, the specific contribution of species to the plant cover, and the specific quality index (Djebaili, 1978). The formula is as follows:

$$Pv = 0.1 \sum_{i=1}^{n} Sci \times Isi$$

- Pv is the pastoral value; Isi the specific quality index, empirically evaluated on a scale of 0 to 10, where 0 indicates unpalatable or toxic species and 10 indicates highly palatable species.

- Pastoral productivity

According to Aidoud (1989), pastoral productivity is calculated as follows:

$$Pu = 6.74\ Pvu + 14.77$$

- Pu represents pastoral production; Pvu is the pastoral value of station u, expressed in FU/ha/year.

- Pastoral load

Pastoral load represents the grazing capacity of a land area, defined by the consumable production of the pasture and the average annual requirements of one animal (400 FU/year for a sheep). It is calculated as follows:

$$C = \frac{\text{Annual requirements of a sheep}}{\text{Pastoral production}}$$

- C is the pastoral load.

3.2. Economic aspect

The data for this analysis was collected from the HCSD. The sample includes 13 areas distributed across 9 municipalities within the province of Djelfa. Economic indicators were calculated based on actual raw data (HCSD) for the period from 2001 to 2023. Financial analysis was conducted to calculate profitability and determine the viability of the project.

The Net Present Value (NPV) of an investment project is defined as the discounted total cash flow projections for the implementation of the project (Chrissos and Gillet, 2008). For an investment to be considered profitable from a purely financial perspective, the NPV must be positive. To calculate the NPV, the financial cash flow schedule for DG_P follows a "Continuous Inputs - Continuous Outputs" investment model. According to Boughaba (2005), the formula is as follows:

$$NPV = \sum Rt(1+i)^{-t} - \sum Ij(1+i)^{-j}$$

- R represents revenues; I represent expenses; i is the discount rate, set at 10% in Algeria.

The Internal Rate of Return (IRR) is the discount rate at which the NPV equals zero (Boughaba, 2005). If the IRR exceeds the cost of capital, the project is deemed financially viable.

The Payback Period (PP) refers to the time required for cumulative cash flows to cover initial investments (Lasry, 2007).

Volume: 9, No: 5, pp.284-303
ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

The IRR and PP were calculated using the linear interpolation method.
The Profitability Index (PI) measures the NPV per unit of currency invested in a specific project (Chrissos and Gillet, 2008). In other words, it quantifies the return generated by each unit of currency invested in a project. The formula is as follows:

$$PI = \sum Rt(1+i)^{-t} / \sum Ij(1+i)^{-j}$$

3.3. Data analysis

For data analysis, the indicators listed in Table 1 (specific richness, annual plant richness, perennial plant richness, vegetation cover, pastoral value, phytomass, and pastoral productivity) and Figure 3 (land areas, recorded production, expenses, and revenues) were considered as variables. The collected data were encoded using Microsoft Office Excel 2010. The chi-square test was used to compare distributions between SWOP and SWP for the same variable. Hypothesis testing and descriptive analyses (mean, standard deviation, etc.) were conducted with SPSS v19 software.
The economic analysis, including the relative importance of costs, break-even price, income, net present value, internal rate of return, profitability index, and payback period, as well as the comparison of trends (value and sign) between the two situations for the same variable, was performed using Microsoft Excel. These analyses provided insights into the profitability and feasibility of the DG_P through a financial analysis approach.

4. Results

4.1. Biological aspect

- **Floristic diversity**

In the study area, 117 species were identified, comprising 74 therophytes (63.25%), 26 chamaephytes (22.22%), 12 hemicryptophytes (10.26%), 4 phanerophytes (3.42%), and 1 geophyte (0.85%). An increase in therophytes (44 to 66 species), chamaephytes (17 to 22 species), hemicryptophytes (8 to 11 species), and phanerophytes (3 to 4 species) was observed between SWOP and SWP. The number of geophytes remained constant at one species in both cases. The biological spectrum highlights the dominance of therophytes, which account for over 63% of the species. The vegetation structure can be summarized as follows: Th > Ch > He > Ge > Ph.
The SWOP includes fewer families (18) and exhibits a decline in pastoral flora compared to SWP, which encompasses 25 families with numerous important pastoral species. In both situations, cosmopolitan families such as Asteraceae and Poaceae are well-represented. The Asteraceae family includes 25 species (34%) in SWOP and 32 species (31%) in SWP, mainly annuals of the genera *Atractylis*, *Launaea*, and *Centaurea*. However, these species have limited pastoral value due to the prevalence of thorny varieties. The Poaceae family comprises 11 species (15%) in SWOP and 16 species (15%) in SWP, primarily perennial grasses such as *Stipa tenacissima*, *Lygeum spartum*, and *Aristida pungens*.
The Fabaceae family, known for its forage value, is prevalent in all areas, ranking third with 5 species (7%) in SWOP and 12 species (12%) in SWP. The Brassicaceae family contains 5 species (7%) in SWOP and 6 species (6%) in SWP, followed by Lamiaceae (5%) and Chenopodiaceae and Cistaceae

(4% each) in SWP. Among the 18 families recorded in SWOP, 5 are represented by a single species, while in SWP, 13 families out of 25 are represented by one species each. Families absent in SWOP, such as Apiaceae, Campanulaceae, Cleomaceae, Geraniaceae, Malvaceae, Papaveraceae, and Polygonaceae, appear in SWP.

Floristic surveys reveal a specific richness of 73 species in SWOP, significantly lower than the 104 species recorded in SWP, representing an average variation of +42%. SWOP is dominated by annual species such as *Bromus tectorum*, *Centaurea microcarpa*, *Dactyloctenium aegyptium*, *Euphorbia bupleuroïdes*, *Marrubium vulgare*, and *Sonchus oleraceus*. Conversely, SWP is dominated by annuals like *Cotula cinerea*, *Launea glomerata*, *Paronychia arabica*, *Plantago ovata*, *Stipa capensis*, and *Stipa retorta*.

The floristic analysis identified 60 species common to both environments, along with 13 species exclusive to SWOP and 44 ones exclusive to SWP. Among the exclusive SWOP species are indicators of environmental degradation, such as *Echinaria capitata*, *Herniaria hirsuta*, *Paronychia argentea*, and *Thymelaea tartonraira*, which lack pastoral value. In contrast, the 44 SWP-exclusive species include valuable pastoral plants such as *Argyrolobium uniflorum*, *Cynodon dactylon*, *Hordeum murinum*, and *Medicago laciniata*. Total specific richness differs significantly between SWOP and SWP ($p < 0.001$). In SWP, the richness of annual species increased from 18 to 39 (+123%), while the richness of perennial species increased from 10 to 13 (+29%, not significant).

- **Vegetation cover**

Spatially, Table 1 highlights a significant difference in vegetation cover between SWOP and SWP, with an average variation rate of +200%. In SWOP, vegetation cover ranges from 15% to 40%, averaging around 24%, which is significantly lower than in the managed areas. In comparison, SWP vegetation cover varies from 55% to 85%, averaging approximately 72%, three times more than the one of SWOP.

Floristic surveys also reveal compositional differences: annual species account for 68% in SWOP compared to 76% in SWP, while perennials represent 32% in SWOP and 24% in SWP. Figure 2 illustrates these differences, showcasing the spatial distribution of green biomass and increased vegetative activity in managed areas.

- Forage potential

A comparison between SWOP and SWP reveals a significant difference in phytomass ($p < 0.001$) (Table 1). The maximum phytomass under SWP ranges from 0.89 to 2.60 T/ha. At the regional scale, dry matter production in SWP far exceeds that of SWOP, averaging 1.65 T DM/ha compared to 0.52 T DM/ha—a mean variation rate of +217%. This difference is attributed to the higher vegetative biomass observed in SWP.

In terms of pastoral production, specific quality indices (ranging from 1 to 10) highlight a markedly higher pastoral value in managed areas. The pastoral value demonstrates a clear and highly significant hierarchy, with substantially higher values in protected perimeters (average of 23.55) and a mean variation rate reaching +757%. Within the studied perimeters, the pastoral value ranges from 1.66

Remittances Review

October 2024

Volume: 9, No: 5, pp.284-303

ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

to 4.50 for SWOP and from 12 to 37 for SWP, reflecting an average increase of more than eightfold. The average pastoral productivity of managed sites is significantly greater than that of control sites ($p < 0.001$), with a mean variation rate of +757%.

For SWOP, pastoral productivity ranges from 26 to 45 FU/ha/year, with an average of 33.28 FU/ha/year. In contrast, SWP exhibits an energy equivalent ranging from 96 to 264 FU/ha/year, averaging 173.50 FU/ha/year—more than five times higher than SWOP. This discrepancy is logically explained by the difference in pastoral values observed between the two situations (Figure 2).

Protected plots are distinguished by a trajectory characterized by high species richness, superior pastoral value, and increased forage production.

Table 1. Impacts of the Deferred Grazing Project on Vegetation Parameters in the Province of Djelfa.

Variables	SWOP (n = 32)	SWP (n = 32)	Variation Rate (%)	Chi-Square	Sig.
Specific richness	73 (2.98)	104 (6.31)	+ 42	674	***
Annual richness per 100	18 (4.45)	39 (5.71)	+ 123	1 128	***
Perennial richness per 100	10 (2.17)	13 (2.14)	+ 29	40	ns
Vegetation cover (%)	24 (6.85)	72 (8.76)	+ 200	3 746	***
Pastoral value per 100	2.75 (0.77)	23.55 (7.06)	+ 757	6 163	***
Phytomass (T DM/ha)	0.52 (0.09)	1.65 (0.47)	+ 217	96	***
Pastoral productivity (FU/ha)	33.28 (5.21)	173.50 (47.58)	+ 421	21 776	***

- SWOP: situation without project; SWP: situation with project; values in parentheses represent standard deviations; sig.: significantly; ***: $p < 0.001$, ns: not significant; the differences are tested by the non-parametric test of (khi-2).

Figure 2. Comparative photos of the two situations (without and with deferred grazing project) in the province of Djelfa.

Remittances Review

October 2024

Volume: 9, No: 5, pp.284-303

ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

a) SWOP

b) SWP (First Year)

c) SWP (Third Year)

d) SWP (Fourth Year)

4.2. Economic aspect

We adopted a simplifying assumption that inflation affects both expenses and revenues in the same manner.

- Expenses

The DG_P is entirely funded by public resources and implemented by the State agency HCSD, which is exempt from income tax and does not rely on loans. A 20-year timeline was adopted to prepare an investment schedule, encompassing expenses such as salaries, procurement of equipment, and service costs. Financial data are based on the actual commitments made by HCSD.

Volume: 9, No: 5, pp.284-303

ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

The implementation of the project involved several stages, including land selection, installation of boundary markers, technical support, and supervision. The analysis of production factors for each perimeter reveals uniformity in the utilized resources, including human, material, and financial resources.

Staff remuneration, particularly for security staff, constitutes the largest share of costs, accounting for 77.32% of total expenditures. Setup-related expenses represent 13.52%, followed by fuel and travel costs at 3.84% and 3.60%, respectively. Since the land is leased at a symbolic rate, its cost is negligible (0%). The average cost per hectare is estimated at 238.71 DZD/ha.

The formula for calculating annual expenditures is as follows:

Expenses (I) 1 in DZD/year = Surface area achieved (ha/year) × Average unit cost (DZD/ha)

1: Figure 3.

- Income

The DG_P generates income exclusively from forage sales. A marketing strategy was developed based on selling the production as standing forage. Income estimates assumed that technical standards would meet market demands and that all production would be sold.

A pastoral evaluation, combined with estimates of standing forage production, enabled income calculations based on barley market prices. The forage production potential (as shown in Figure 3) indicates a significant increase in regional food availability due to the project. The average annual production is approximately 34 million FU, with an average annual growth of 1.37 million FU. By the end of the analysis period, the average productivity is projected at 203 FU/ha/year, a remarkable improvement from the initial 30 FU/ha/year. The average sheep load capacity increased from nearly 0 head/ha under SWOP to approximately 0.5 head/ha under SWP.

The formula for calculating annual income is as follows:

Income (I) 1 in DZD/year = Production (FU/year) × Barley equivalent sale price (DZD/FU)

1: Figure 3.

- Profitability and viability analysis

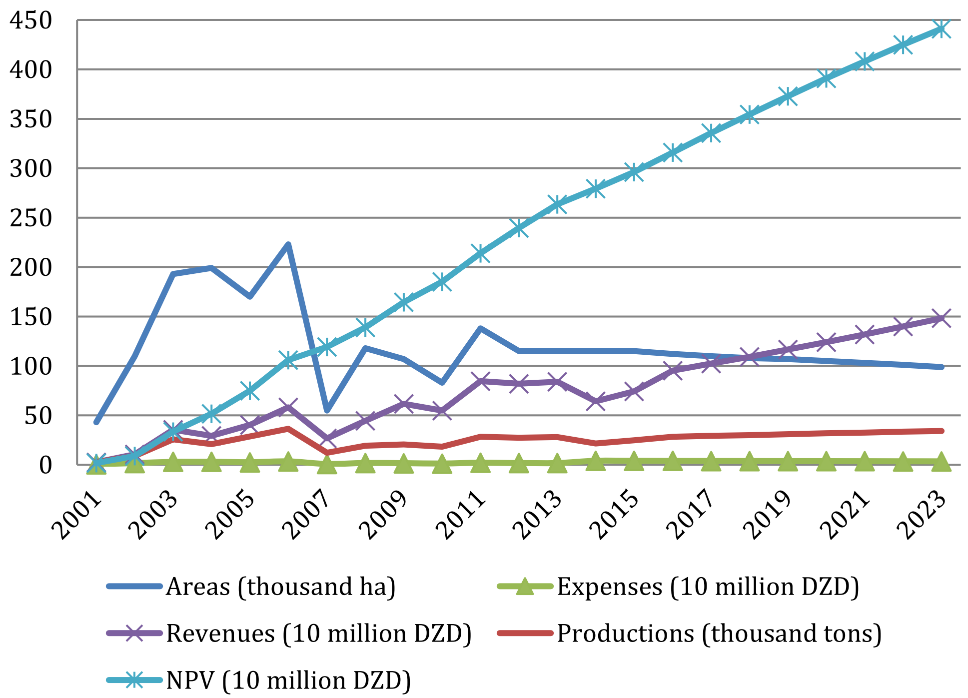
The DG_P is characterized by its straightforward implementation and high success rate. With an average production cost of 238.71 DZD/ha, the project is considered cost-effective. The unit cost of forage (FU) production is 0.37 DZD.

Each invested dinar generates a gross income of 20.70 DZD by the end of the project, demonstrating its profitability. The net present value (NPV) is positive from the first year and continues to improve, reaching a substantial 4,408,042,514.22 DZD. The internal rate of return (IRR) significantly exceeds the discount rate, indicating exceptional profitability.

The payback period for the capital invested is less than one year, which is extremely short. By the project's end, the profitability index (PI) reaches 21.70, confirming its strong economic viability (Figure 3 and Table 2).

Remittances Review
October 2024
Volume: 9, No: 5, pp.284-303
ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

Figure 3. Estimation of forage production and calculation of the Net Present Value of DG_P



- Productions at estimated figures; DZD: Algerian Dinar; Average exchange rate (2001–2023): 1 DZD = 0.0115 USD, source: http://fxtop.com/fr/historique-taux-change.php.

Table 2. Comparative Analysis of Financial Indicators of the Deferred Grazing Project in the Province of Djelfa.

Bio-financial indicators	SWTP	SWP
Average productivity (FU/ha/year)	Between 20 and 40	203
Relative share of average production costs	/	Guarding: 77.32%
Cost price (DZD/Ha)	/	238.71
Cost price (DZD/FU)	/	0.37

Volume: 9, No: 5, pp.284-303

ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

Gross income generated per 1 invested Dinar (DZD)	/	20.7
Net Present Value - NPV (DZD)	Nearly zero	4 408 042 514.22
Internal Rate of Return - IRR (%)	/	Very high
Profitability Index - PI	/	21.7
Payback Period - PP	/	Less than one year

- SWTP: situation without project; SWP: situation with project; DZD: Algerian Dinar.

5. Discussion

5.1. Biological aspect

- Floristic diversity

The evaluation of floral diversity was conducted using Raunkiaer's method (1934), which classifies biological types based on their adaptive strategies to environmental conditions. The analysis reveals a predominance of therophytes—annual plants that complete their life cycle within a single season (Daget and Poissonet, 1997). These plants are well-adapted to the dry season in the province of Djelfa, surviving as seeds during the summer. The SWP promotes floristic enrichment by stabilizing soils and encouraging the development of annual plants, leading to a marked trend of therophytization within the vegetation.

Floral diversity in an ecosystem serves as a critical indicator of its health. In heavily grazed areas, advanced stages of degradation are observed, characterized by the proliferation of species with low pastoral value. Grazing intensity emerges as the primary driver of floristic composition depletion, leading to significant ecological changes. Studies consistently show that grazing disrupts the ecological balance of rangelands, reducing soil moisture, hindering infiltration, increasing runoff, and intensifying both water and wind erosion (Quinton et al., 1989). Early grazing of young shoots prevents plants from storing reserves, weakens root systems, and can ultimately lead to plant extinction.

In this context, low floral diversity is exacerbated by the dominance of *Peganum harmala*, a species indicative of degraded environments with limited forage value. Nedjraoui and Bedrani (2009) observe that the presence of this species indicates the influence of anthropogenic and zoogenic factors on these areas. Concurrently, species such as *Centaurea parviflora*, *Herniaria hirsuta*, *Echinaria capitata*, and *Thymelaea tartonraira* exhibit trends toward rarity and potential disappearance.

The DG_P appears to offer a favorable solution for improving floral diversity in developed areas compared to unprotected ones. The study highlights an uneven distribution of taxa across botanical families in grazed areas versus protected zones. This disparity is attributed to competition between perennial grasses and annual plants, with annuals being particularly dense in protected zones.

Remittances Review

October 2024

Volume: 9, No: 5, pp.284-303

ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

Dominant families such as Asteraceae and Poaceae play a central role in Algeria's flora. Their adaptability to various biotopes and widespread distribution contribute to their prevalence. Aidoud (1989) emphasizes that floristic richness in arid environments heavily depends on annual species, influenced by factors such as climate, soil conditions, land use, and human impact.

Protection measures significantly enhance the abundance of annual species in the SWP, facilitating the return of original species within the floristic assemblage. These zones provide a conducive environment for the growth of mature species capable of producing seeds, ensuring population sustainability. Additionally, this approach encourages the emergence of infiltrating species within heavily grazed areas.

By safeguarding the growth and maturation phases of plants, protection measures create a favorable microclimate while preserving germinated seeds and seedlings from drought effects. This dynamic contributes to the biological resurgence of endemic pastoral species, fostering partial regeneration of the flora. The observed floristic enrichment primarily results from seed germination following precipitation, coupled with their ability to grow and flower rapidly. Thus, deferred grazing plays a pivotal role in ecosystem restoration, particularly through the reappearance of species with high pastoral value.

- Vegetation cover

The coverage rate is a reliable indicator of vegetation health, soil protection against erosion, and efforts to fight desertification. A high coverage rate ensures better soil protection from wind, rainfall, runoff, and the direct effects of the sun, such as heating and drying. However, in the SWOP, the coverage rate remains the lowest compared to developed sites. This spatial variability is typical of arid environments, where vegetation is naturally sparse. The reduction in vegetation cover is primarily attributed to increasing human pressure, particularly overgrazing. Vegetation constantly exploited by livestock lacks the opportunity to recover, leaving only unpalatable or less desirable species to persist.

In contrast, the high coverage rate observed in the SWP is attributed to the cessation of grazing, allowing robust and large plants to thrive. Additionally, species with prolific seed production rapidly colonize open spaces, bolstered by biological enhancement processes. This coverage predominantly consists of ephemeral species, whose development depends heavily on annual rainfall and human activity. Differences between these situations can be linked to the management systems employed. Managed grazing in controlled sites allows for the regeneration and development of critical plant species between grazing periods (Acherkouk, 2013). Vegetative rest periods also favor the establishment of young perennial plants and the germination of annual species (Yahefdhou et al., 2002). Furthermore, the introduction of development techniques influences species dominance and, consequently, their coverage rate.

Remittances Review
October 2024
Volume: 9, No: 5, pp.284-303
ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

- Forage potential

In developed areas, the forage potential achieves a success rate of 60% to 85% (HCSD, 2022). Zones with an 85% success rate exhibit particularly high total phytomass. However, climatic conditions and grazing impact have significantly reduced phytomass in control sites. Grazing has led to a decline in high-value forage species, replaced by less desirable ones. This phenomenon, characteristic of North African steppes subjected to continuous grazing, limits average production to 0.2 tons of dry matter per hectare (Le Houérou, 1995). Overgrazing and the clearing of pastoral lands are the primary causes of this low productivity, with overgrazing often considered the leading factor of degradation (Carrière and Toutain, 1995). This degradation is marked by reduced species richness, soil deterioration, and a decrease in the area occupied by quality pastoral species, ultimately lowering pastoral productivity.

In the SWP, the phytomass of perennial species is influenced by deferred grazing and the timing of sampling (April), when Alfa grass reaches its peak development. Vegetative cover is dense due to rational grazing management, alternating between open and closed periods. This approach promotes plant regeneration, biomass production, and soil conditions conducive to the restoration of a diverse flora. Relatively high annual rainfall (272 mm on average from 2018 to 2021) has also played a crucial role.

Ephemeral species have significantly contributed to improved vegetative cover and phytomass production. Aidoud and Touffet (1996) confirm that in the absence of grazing, resources prioritize maintaining standing biomass over production. Some stations demonstrate an increase in pastoral value, despite reduced vegetative cover, thanks to high-value pastoral species such as Vicia monantha, Plantago albicans, and Cynodon dactylon.

The observed disparity in average pastoral value between the two situations stems mainly from the specific contribution of low-quality species with no economic value, ignored by livestock in overgrazed areas. This phenomenon reflects livestock selectivity, a relevant indicator of rangeland degradation processes. This dynamic leads to the rarity or complete disappearance of some pastoral species of interest. Conversely, areas protected by deferred grazing benefit from a strong contribution of high-quality species, highly valued by livestock. This abundance of qualitative species results in a notable improvement in pastoral value.

Additionally, the abundant presence of annual grasses in protected areas further explains differences in forage value between the two situations. Although some low-quality species are included, their contribution to overall floristic richness enhances pastoral value.

The annual dietary requirements for an ewe raising a lamb are estimated at 400 forage units, necessitating a pastoral load expressed in hectares. The calculated pastoral load for the SWP is approximately one head per two hectares, which remains low despite the benefits of deferred grazing. This low figure reflects the advanced degradation of rangelands and the fragility of the ecosystem. In comparison, the Ministry of Agriculture recommends a pastoral load of one head per four hectares. This discrepancy directly results from the protection strategy implemented by the HCSD,

Remittances Review

October 2024

Volume: 9, No: 5, pp.284-303

ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

aimed at limiting irrational exploitation of steppe lands but leading to a growing imbalance between rangeland capacity and the needs of an expanding sheep flock.

The deferred grazing project has demonstrated the superiority of protected sites, with a pastoral load reaching 0.5 sheep per hectare compared to zero in degraded areas. This initiative supports rangeland regeneration through controlled grazing, involving rational management of species and livestock numbers, appropriate timing, and strict control of grazing duration.

Finally, analyzing the spatial distribution of biomass and vegetative activity in developed areas highlights the effectiveness of these techniques in restoring steppes, particularly in the province of Djelfa. Deferred grazing emerges as a key tool for protecting pastoral lands, enhancing their resilience, and ensuring a reserve of standing forage during drought periods.

5.2. Economic aspect

The HCSD intervened in severely degraded areas characterized by virtually nonexistent pastoral productivity in SWOP, resulting in zero income. However, the implementation of the DG_P led to a significant increase in forage unit (FU) production. The average sheep carrying capacity in SWP was estimated at approximately 0.5 heads/ha.

For the rational exploitation of protected perimeters, strict control of livestock density is essential, along with tailored management of grazing periods. This must account for the vegetation's potential, particularly during March, April, and September. The introduction of a rotational grazing system is also necessary to manage vegetation development while reducing seasonal fluctuations in its nutritional value (Granier and Gilibert, 1974).

The increased production, coupled with reduced production costs, will enable the project to achieve economies of scale. It will yield positive outcomes, including a significant net present value and a positive internal rate of return (IRR), confirming its profitability and economic viability. This project generates substantial wealth, as evidenced by the gap between the discount rate (10%) and the IRR. This significant margin serves as a safety buffer to accommodate potential additional expenses, such as recruitment needs based on labor demands.

The investment recovery period is less than a year, a notably short duration that ensures a quick return for investors. This result highlights the attractiveness of such activities to investors seeking financial placements. This trend is common in agriculture, where capital value is more closely tied to production rather than simple financial investments.

The project, capable of covering its expenses within the first year of operation, is deemed viable. By the end of the analysis period, the cost of production was 0.37 DZD per FU, while the average market price for a kilogram of barley during the same period was 30.58 DZD, yielding a profit margin of 30.21 DZD. This substantial margin ensured the project’s financial stability and resilience against potential market disruptions or fluctuations in supply and demand.

In conclusion, the DG_P has demonstrated a significant financial impact on the developed perimeters, confirming its economic effectiveness and its contribution to the sustainability of rangelands.

6. Conclusion

This study, conducted in an Algerian steppe region, has identified the ecological and economic thresholds crucial for the development of rangelands. It also highlighted the impact of an introduced development project based on deferred grazing, which plays a pivotal role in rangeland management. The study quantified the project's effects on floristic composition, the horizontal structure of vegetation, and forage production within a protected area, compared to a neighboring free-range rangeland, while also evaluating the associated economic outcomes.

Our findings corroborate observations and results from similar studies. The deferred grazing project significantly enhances both the quantity and quality of floristic richness. It promotes the development of pastoral species, particularly therophytes, including ephemeral species of high pastoral value that have reemerged. Additionally, the project has improved vegetation cover, biomass, and pastoral productivity, with a notable increase in the number of forage units (FUs).

These results emphasize that the steppe development project based on land protection serves as a critical tool for diversifying both forage and financial resources. They also demonstrate that regenerating and restoring even moderately degraded steppe rangelands is feasible through such projects, combined with rational land management practices. Furthermore, the protection of specific rangeland areas proves to be an effective measure for combating degradation and slowing desertification processes.

This project offers a viable alternative for livestock farmers, especially by reducing the cost of producing FUs compared to their market acquisition price. The study also demonstrated the project's economic viability, highlighting its ability to enhance the profitability of steppe rangelands and achieve economies of scale. Economic analysis revealed highly positive and encouraging results, indicating that such projects can contribute to poverty alleviation by creating employment opportunities.

Given the generated financial benefits, a significant opportunity arises to invest further and consider horizontally expanding this project across the entire steppe territory. This could be achieved by fostering the integration of livestock and forage production systems and diversifying income sources for livestock farmers.

In light of the development prospects for livestock farming in Algeria and the challenges producers face in acquiring forage, it is essential to continue and strengthen this land protection approach. This effort should include increasing protected areas, implementing rotational grazing plans, controlling livestock density, and promoting the biological regeneration of native species most resilient to degradation.

The monitoring and evaluation of steppe rangelands could be undertaken on a broader scale using modern tools such as geographic information systems (GIS) and remote sensing. These technologies

Volume: 9, No: 5, pp.284-303

ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

would enable the creation and updating of desertification sensitivity maps and monitoring maps, essential for tracking steppe ecosystems and observing ecological changes. Finally, integrating this project into a national nutritional strategy aiming at addressing the decline in steppe pastoral resources would be particularly relevant.

Acknowledgments

We extend our heartfelt gratitude to the leadership and staff of the High Commission for Steppe Development (HCSD) in Djelfa, Algeria, for their exceptional support and collaboration. We also wish to express our sincere appreciation to all individuals who, either directly or indirectly, have contributed generously to the success of our scientific research endeavors. Your loyalty, dedication, and invaluable assistance have been instrumental in our work.

References

Acherkouk, M. (2013). Evaluation de l'impact des aménagements pastoraux sur la restauration des pâturages dégradés du couloir Taourirt-Taforalt (Maroc oriental). Thèse Doct. Université Mohammed Premier. Maroc. 211 p.

Aidoud, A. (1994). Écologie des steppes algériennes : diversité biologique et dynamique. Revue d'Écologie (Terre et Vie), 49(4), 323-334.

Aidoud, A. (1989). Contribution à l'étude des écosystèmes pâturés des hautes plaines steppiques algéro- oranaises. Fonctionnement, évolution des ressources végétales. Thèse Doct. USTHB. Alger. 256 p.

Aidoud, A., & Touffet, J. (1996). La régression de l'alfa (Stipa tenacissima L). Graminées pérennes, un indicateur de désertification des steppes algériennes. Sécheresse, p : 187-193.

Amghar, F., Langlois, E., Forey, E., & Margerie, P. (2016). La mise en défens et la plantation fourragère: deux modes de restauration pour améliorer la végétation, la fertilité et l'état de la surface du sol dans les parcours arides algériens. Biotechnol. Agron.Soc. Environ.*Volume* 20 (3), 386-396.

Bedrani, S. (1994). Une recherche d'action en zone steppique (objectif-méthode et premiers résultats).Les cahiers du C.R.E.A.D. (Centre de Recherche en Economie Appliquée pour le Développement) n°31/32, 3ème et 4ème trimestres ; 23 p.

Boughaba, A. (2005). Analyse et évaluation des projets. Edition Berti, Alger.

Boutonnet, J-P. (1989). La spéculation ovine en Algérie, un produit clé de la céréaliculture. INRA-ENSAM Montpellier, série notes et documents n°90, 50p ;

Carrière, M., & Toutain, B. (1995). Utilisation des terres de parcours par l'élevage et interactions avec l'environnement : outils d'évaluation et indicateurs. Centre de Coopération Internationale en Recherche Agronomique pour le Développement, France.

Chrissos, J., & Gillet, R. (2008). Décision d'investissement, Edition Dareios et Pearson Education, 2ème Edition. France.

Daget, Ph., & Poissonet, J. (1997). Biodiversité et végétation pastorale. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 50 (2) : 141-144 ;

Daget, Ph., & Poissonet J. (1971). Une méthode d'analyse phytoécologique des prairies, critère d'application. Am. agron 22 (1), 541.

Direction des services agricoles, DSA, (2022). Statistiques Agricoles de la wilaya de Djelfa. DSA-Djelfa. Algérie.

Djebaili, S. (1984). Steppe algérienne, phytosociologie et écologie. O.P.U, Alger P.159.

Djebaili, S. (1978). Recherches phytosociologiques et écologiques sur la végétation des hautes plaines steppiques et de l'Atlas Saharien algérien. Thèse Doct., Univ. Sc. Tech. Languedoc, Montpellier, 229 p.

FAO, (1989). Bilan préliminaire de 30 ans de pastoralisme, technique de développement pastoral. Vol. 3 Plantations d'arbustes fourragers, Organisation des Nations Unies pour l'alimentation et l'agriculture, Rome.

Granier, P., & Gilibert, J. (1974). Contribution à l'étude de l'exploitation par rotation des pâturages de savane soudanienne Techniques et résultats. Rev. Elev. Méd. Vét. Pays trop., 1974, 27 (2): 223-233

Haut Commissariat au Développement de la Steppe, HCDS, (2022). Bilan des réalisations du HCDS (1994 au 2021). HCDS- Djelfa. Algérie.

Lasry, J-M. (2007). Evaluation et financement de projet ; la collection de l'étudiant ; édition Dar el Othmania. Alger, 104p.

Le Houérou, H-N. (1995). Dégradation, régénération et mise en valeur des terres sèches d'Afrique., In : Pontanier R, M'Hiri A, Akrimi N, Aronson J, Le Floc'H. L'homme peut-il refaire ce qu'il a défait ? Paris. Edits. 65-102.

Nedjraoui, D., & Bedrani S. (2009). La désertification dans les steppes algériennes: causes, impacts et actions de lutte, *Vertigo*. Revue électronique : Vertigo. Sc. Env., Vol. 8 Numéro 1. http://vertigo.revues.org/5375

Office National Météorologiques, ONM, (2023). Données climatiques de la station de Djelfa. ONM-Djelfa, Algérie.

Volume: 9, No: 5, pp.284-303

ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

Quézel, P., & Santa, S. (1962). Nouvelle flore de l'Algérie et des régions désertiques méridionales. CNRS. Paris. Tome 1. 565 p., Tome 2. 605 p.

Quinton, D-A., Malak, W., & Hall, J-W. (1989). The effect of cattle grazing on the growth and miserotoxin content of Columbia milkveth. J. Range Manage. pp. 368-372.

Raunkiaer, C. (1934). The life form of plants and statistical plant geography. Collected papers, Clarendon Press, Oxford, 632 p.

Yahefdhou, O-S-M, Neffati, M., & Henchi, B. (2002). Effet du mode de gestion des phytocénosessur leur dynamique en Tunisie présaharienne: cas du parc national de Sidi Touil et de ses environs. Science et Changements Planétaires/Sécheresse 13(3): 195-203.

Zirmi-Zembri, N., & Kadi, S-A. (2016). Valeur nutritive des principales ressources fourragères utilisées en Algérie. 1- Les fourrages naturels herbacés. Livestock Research for Rural Development. Volume 28, Article #145. http://www.lrrd.org/lrrd28/8/zemb28145.html