INTEGRATED FERTILIZATION AND OVERSEEDING IMPROVE PERMANENT GRASSLAND PRODUCTIVITY AND FORAGE QUALITY IN THE MOLDAVIAN PLATEAU

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Abstract

This study evaluated four permanent-grassland management variants in the Moldavian Plateau during 2026: an unfertilized control, organo-mineral fertilization, intensive organic fertilization, and moderate organic fertilization combined with overseeding. Botanical composition was assessed by geobotanical relevés, pastoral value by species cover and forage-quality indices, green-mass yield by repeated cuts, and proximate composition by standardized methods. The integrated treatment produced the highest pastoral value (83.00), green-mass yield (10,073 kg ha−1), dry-matter yield (2.015 t ha−1), and crude protein concentration (16.20% DM), while crude fibre declined to 24.80% DM. Relative to the control, green-mass yield increased by 70.41%. Fertilization alone improved the sward, but combining manure with overseeding delivered the most balanced gains in botanical structure, productivity, and forage quality.

Key words: *permanent grassland, overseeding, manure, pastoral value, forage quality*

INTRODUCTION

Permanent grasslands support ruminant production while contributing to carbon storage, erosion control, water regulation, biodiversity and cultural landscapes. Their multifunctionality, however, declines when land-use change, intensification, abandonment or unsuitable grazing alters plant communities and soil processes [1]. In livestock systems, degradation is expressed not only as lower herbage production, but also as the replacement of valuable grasses and legumes by low-value or invasive species, with consequences for feed intake and nutrient supply.

Grassland improvement therefore requires a compromise between agronomic performance and the conservation of ecosystem functions. Fertilization, the introduction of valuable forage species and adapted grazing are established means of increasing productivity, whereas disruptive renovation can increase carbon and nitrogen losses [2]. Overseeding is a less disruptive option because desired grasses and legumes are introduced into the existing sward. Recent assessments indicate that it can improve grass production and other ecosystem services when site conditions and management permit successful establishment [3].

The response of permanent grassland depends on nutrient source, botanical composition, weather and the persistence of introduced species. Nitrogen commonly increases yield and crude protein, but the effects on fibre fractions and digestibility vary [4]. Diverse, legume-containing swards can maintain forage productivity with lower mineral nitrogen inputs, although management strongly affects legume persistence [5]. Consequently, productivity, botanical composition and feed value should be evaluated together rather than inferred from biomass alone.

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Permanent grasslands are an important feed resource for sheep farms in the Moldavian Plateau, yet many stands are affected by weed encroachment and a low proportion of valuable Poaceae and Fabaceae. The present study evaluated four management variants during the third vegetation year. The objective was to determine whether fertilization alone, or fertilization combined with overseeding, improved botanical structure, pastoral value, seasonal biomass production and proximate composition compared with an unfertilized control.

MATERIAL AND METHOD

The experiment was conducted on permanent grassland in the Moldavian Plateau, Romania, within project ADER 15.2.3. Four management variants were compared in 2026. Lot 1 was an unfertilized control. Lot 2 received an organo-mineral treatment consisting of 7.5 t ha−1 fermented manure and N80P50K50. Lot 3 received 25 t ha−1 fermented manure. Lot 4 received 15 t ha−1 fermented manure and was overseeded with productive grasses and legumes adapted to local conditions. The 2026 observations describe the residual and cumulative response in the third vegetation year. Routine maintenance on the improved lots included stone and residue removal, manual weed control and surface cleaning.

Botanical composition was determined by the geobotanical relevé method. Three to five square sampling areas were positioned along plot diagonals in floristically uniform locations. Species were identified and grouped as grasses, legumes or other botanical families; abundance-dominance, frequency and phenological stage were recorded. Percentage contribution (PC) was combined with a species forage-quality index (IC, 0–5) to calculate pastoral value: $VP = \Sigma[PC \times IC]/5$. The resulting 0–100 score was interpreted as degraded (0–5), very poor (5–15), poor (15–25), medium (25–50), good (50–75) or very good (75–100).

Green-mass production was estimated by repeated cutting. At each monthly production cycle, five 10 m² quadrats were harvested along the diagonal of each lot. Harvested biomass was weighed, expressed per square metre and converted to kg ha−1. Total production was the sum of the April–July cycles. Dry-matter yield was estimated from green mass using the 5:1 conversion applied in the project protocol.

Samples collected in May 2026 were analysed for dry matter, crude protein, crude fat, crude fibre and crude ash. Dry matter, crude protein, crude fat, crude fibre and ash were determined according to the procedures specified in Commission Regulation (EC) No 152/2009 and the corresponding ISO methods cited in the project protocol [6]. Nitrogen-free extract was calculated by difference. Results were summarized descriptively because the phase report provided treatment aggregates rather than plot-level replicate measurements; therefore, no inferential significance is claimed.

RESULTS

Botanical composition differed markedly among variants (Table 1). The control was dominated by species from other botanical families (85.30%), while grasses and legumes together accounted for only 14.70%. Organo-mineral fertilization increased their combined share to 38.60%. Intensive organic fertilization increased grass cover to 52.80%, making Lot 3 the best non-overseeded variant.

The integrated treatment in Lot 4 produced a sward containing 84.60% grasses and 6.10% legumes, while other families declined to 9.30%.

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Table 1 Botanical composition and pastoral value of the experimental grasslands

Indicator	Lot 1	Lot 2	Lot 3	Lot 4
Grasses (%)	12.60	27.40	52.80	84.60
Legumes (%)	2.10	11.20	6.80	6.10
Other families (%)	85.30	61.40	40.40	9.30
Grasses + legumes (%)	14.70	38.60	59.60	90.70
Pastoral value	20.26	48.64	62.66	83.00
Classification	Poor	Medium	Good	Very good

Note: Lot 1, unfertilized control; Lot 2, organo-mineral fertilization; Lot 3, 25 t ha−1 manure; Lot 4, 15 t ha−1 manure plus overseeding.

Pastoral value followed the improvement gradient (Fig. 1), increasing from 20.26 in the control to 48.64, 62.66 and 83.00 in Lots 2, 3 and 4, respectively. In Lot 4, Lolium perenne (36.20%) and Festuca arundinacea (21.00%) were dominant, accompanied by Lolium multiflorum, Festuca rubra, Phleum pratense, Trifolium pratense and Medicago sativa. By contrast, the control contained high proportions of Artemisia absinthium, Cardaria draba, Rubus caesius and Chenopodium album, species assigned little or no forage value in the scoring system.



Fig. 1 Pastoral value of the four management variants

Total green-mass yield ranged from 5,911 kg ha−1 in the control to 10,073 kg ha−1 in Lot 4 (Table 2; Fig. 2). The organo-mineral treatment yielded 9,220 kg ha−1, 55.98% above the control, whereas intensive organic fertilization yielded 7,615 kg ha−1, a 28.83% increase. Lot 4 exceeded the control by 4,162 kg ha−1 or 70.41%. Across variants, May and June contributed approximately 60% of the April–July total, while July production declined as temperatures increased and soil water availability decreased.

Table 2 Monthly and total green-mass production in 2026

Variant	April	May	June	July	Total	Relative
Lot 1	1,182	1,885	1,651	1,193	5,911	100.00
Lot 2	1,854	2,952	2,605	1,809	9,220	155.98
Lot 3	1,501	2,454	2,153	1,507	7,615	128.83
Lot 4	2,056	3,208	2,907	1,902	10,073	170.41

Note: Monthly and total production in kg ha−1; relative production expressed as percentage of Lot 1.

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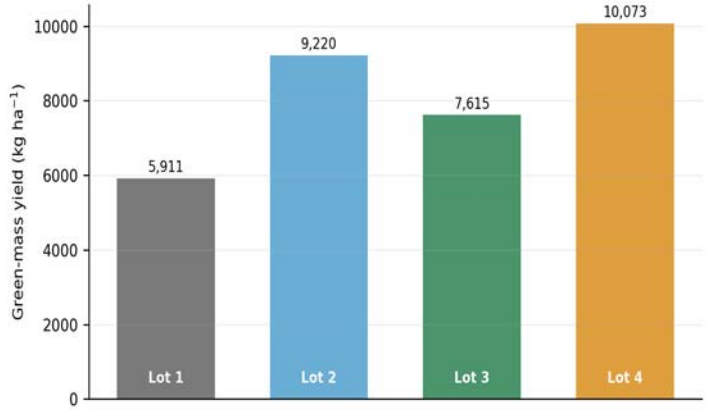


Fig. 2 Total green-mass yield of the four management variants

Estimated dry-matter yield confirmed the same ranking: 1.182 t ha−1 in Lot 1, 1.844 t ha−1 in Lot 2, 1.523 t ha−1 in Lot 3 and 2.015 t ha−1 in Lot 4. Thus, the integrated treatment combined the highest forage-quality score with the greatest amount of harvestable biomass.

Forage chemical composition also improved in the managed variants (Table 3). The control had the highest dry-matter concentration (25.20%) but the lowest crude protein (10.20% DM) and the highest crude fibre (30.80% DM). Lot 4 had lower dry matter, consistent with a younger, more succulent canopy, but reached 16.20% crude protein and only 24.80% crude fibre. Lots 2 and 3 were intermediate. Crude ash was highest in Lot 2 (10.20% DM), whereas nitrogen-free extract varied within a narrow range of 44.60–47.40% DM.

Table 3 Chemical composition of green forage harvested in May 2026

Variant	DM (% fresh)	CP (% DM)	Fat (% DM)	CF (% DM)	NFE (% DM)	Ash (% DM)
Lot 1	25.20	10.20	2.40	30.80	47.10	9.50
Lot 2	22.40	14.80	2.80	27.60	44.60	10.20
Lot 3	23.10	13.90	2.70	28.20	45.80	9.40
Lot 4	21.60	16.20	3.00	24.80	47.40	8.60

Note: DM, dry matter; CP, crude protein; CF, crude fibre; NFE, nitrogen-free extract.

DISCUSSIONS

The results show that fertilizer quantity alone did not determine grassland performance. Lot 3 received the largest manure dose and developed the best botanical structure among the naturally regenerated lots, yet Lot 4 achieved higher pastoral value, biomass yield and crude protein with a lower manure dose combined with overseeding. The main explanation is compositional: introduced high-value grasses established a productive canopy, while legumes and weed suppression contributed to a more favourable feed resource. This agrees with the general principle that renovation benefits arise through changes in sward composition, but that the magnitude and persistence of the response depend on site and management [2].

The strong response of Lot 4 is also consistent with evidence that overseeding can increase the proportion of desired species without complete destruction of the original

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sward [3]. Decision thresholds for sod-seeding should account for existing sward composition and expected yield response so that seed and field operations are targeted to stands likely to benefit [7]. Avoiding full inversion is relevant because intensive renewal may increase short-term yield and quality while also increasing the risk of carbon and nitrogen release [2]. Nevertheless, the persistence of the introduced species should be monitored. Sown species may decline several years after establishment if nutrient supply, defoliation frequency, soil moisture or competition are not managed appropriately [3].

The organo-mineral variant produced more green mass than the high-manure variant, although its pastoral value was lower. Mineral nitrogen provides a rapidly available nutrient supply, while manure mineralizes gradually and may generate a slower residual response. Studies on permanent grassland likewise report higher biomass after manure or mineral nitrogen than under unfertilized management, although effects on chemical composition can be less consistent than effects on yield [4]. In the present study, both fertilized, non-overseeded variants increased crude protein and reduced crude fibre relative to the control, indicating a combined nutrient and botanical response.

The lower dry-matter concentration in Lot 4 should not be interpreted as inferior forage. Its higher protein and lower fibre indicate a leafy, less mature stand at sampling. Forage maturity and botanical composition are major determinants of structural carbohydrate accumulation and nutrient availability. The result also illustrates why green-mass production alone is an incomplete indicator: the control contained more dry matter in fresh forage but delivered the lowest dry-matter yield per hectare and the least favourable protein–fibre balance.

Recent research shows that plant diversity can affect forage quality, yield and farm revenues [8], while grass–legume mixtures provide a robust nitrogen-yield advantage across a broad range of legume proportions and environments [9]. On-farm evidence further indicates that multispecies grasslands containing legumes can maintain yield and forage quality at lower nitrogen inputs than highly fertilized grass-dominated swards [5]. Although the present experiment did not quantify biological nitrogen fixation or species richness, the favourable performance of the grass–legume mixture in Lot 4 supports continued evaluation of diversified swards under Moldavian Plateau conditions. European-scale evidence warns that intensification and land-use change can reduce grassland multifunctionality [1]; therefore, future work should combine agronomic indicators with soil carbon, nutrient-use efficiency, plant diversity and animal performance.

The principal limitation of this phase analysis is the absence of plot-level replicated data in the available dataset. The reported differences are agronomically large, but causal attribution and statistical significance cannot be established from treatment aggregates alone. Future experiments should use replicated randomized plots, record soil and weather covariates, determine NDF, ADF and digestibility, and follow the persistence of overseeded species over multiple years. These additions would distinguish treatment effects from spatial and annual variability and support robust recommendations for sheep farms.

CONCLUSIONS

Integrated management combining 15 t ha−1 fermented manure with overseeding was the most effective variant under the conditions of the study. It transformed the sward from one dominated by low-value species to one containing 90.70% grasses and legumes, increased pastoral value to 83.00, raised green-mass yield by 70.41% relative to the unfertilized control, and

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produced the best crude-protein and crude-fibre profile. Fertilization without overseeding also improved productivity and forage quality, with the organo-mineral treatment favouring short-term biomass production and the high-manure treatment supporting progressive improvement of the natural sward. For practical use in the Moldavian Plateau, fertilization should be integrated with weed control and targeted introduction of adapted forage species, followed by monitoring of stand persistence and soil nutrient balance.

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