STUDY ON THE STORAGE INFRASTRUCTURE OF CEREALS AND TECHNICAL PLANTS IN SOUTHWEST OLTENIA 2016–2023

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Abstract

This study provides a comprehensive analysis of the evolution of cereal and industrial crop storage infrastructure in the South-West Oltenia region during the period 2016–2023. The research adopts a dual perspective, examining both the quantitative expansion of storage capacity and the qualitative improvement of storage conditions. Drawing on statistical data from Submeasure 4.2 of the PNDR 2014–2020, the study evaluates storage density per hectare, the number and geographical distribution of facilities, as well as the allocation of eligible and public investments. At the same time, it investigates how different construction materials—wood, reinforced concrete, metal, and polyethylene (silo bags)—influence the technological performance of storage systems by affecting durability, microclimatic stability, operational flexibility, and overall economic feasibilityThe results point to a visible intensification of investments, with total storage capacity increasing by 12% in 2023 and the number of facilities rising by 6%. Nevertheless, important territorial asymmetries remain evident, as counties such as Dolj and Olt continue to attract the majority of projects, while other areas remain underserved. Material-based analysis reveals that wooden structures are still present in small-scale contexts, reinforced concrete provides durability but limited adaptability, metal silos deliver superior long-term quality control, and silo bags represent a cost-effective and flexible short-term option.The discussion underscores that reducing post-harvest losses and achieving regional food security depend not only on expanding infrastructure but also on enhancing the technological and material quality of storage facilities.
Keywords: *grain storage, post-harvest losses, rural development policy, EU funding*

INTRODUCTION

The storage of agricultural production represents a decisive link in the agri-food chain, positioned at the intersection of agriculture, the food industry, and logistics. Beyond its technical role of safeguarding harvests until marketing, storage facilities determine the final quality of products, the extent of post-harvest losses, and farmers' ability to optimize sales in line with market dynamics. Adequate storage enables producers to delay commercialization until favorable prices emerge, thereby avoiding seasonal saturation and increasing economic resilience. At the same time, it shields crops from climatic variability, pests, and deterioration, ensuring both quality preservation and food security. The historical evolution of storage—from rudimentary cribs and traditional wooden shelters to reinforced concrete silos, fully automated metal silos, and flexible silo bags—illustrates technological progress and organizational

shifts within agriculture. Operationally, two paradigms can be distinguished: horizontal solutions (platforms, sheds, warehouses), emphasizing flexibility, and vertical solutions (silos), maximizing space efficiency and enabling advanced microclimatic control. The adoption of silo bags further complements this picture, offering rapid deployability and cost-effective short-term conservation based on anaerobic principles. At the European scale, cereal production is concentrated in a limited number of countries, underscoring the strategic importance of storage infrastructure not only for food security but also for maintaining trade balances. Climate variability amplifies this challenge, heightening the need for resilient systems. Against this backdrop, the South-West Oltenia region (Dolj, Olt, Vâlcea, Mehedinți, Gorj) constitutes a representative case study. The region combines significant arable potential with uneven infrastructural development, where targeted investment programs—especially Submeasure 4.2 of PNDR 2014–2020 By integrating statistical analysis of capacities, facility distribution, and material choices, this research highlights how strategic investments in storage infrastructure can reduce losses, strengthen competitiveness, and ensure a more sustainable valorization of agricultural production.

MATERIALS AND METHODS

The empirical analysis is based on three complementary datasets that allow both structural and dynamic assessments of storage infrastructure in the South-West Oltenia region. The first dataset consists of county-level records for 2023, comprising the number of storage facilities, their cumulative storage capacity (expressed in tons), and the extent of arable land (hectares). This provides the essential basis for evaluating the quantitative adequacy of storage infrastructure relative to agricultural potential.The second dataset captures the financial dimension of investment support schemes. It includes annual series (2016–2023) of eligible project values and public contributions, disaggregated at the county level. These data make it possible to trace the trajectory of policy-driven investment flows over nearly a decade, thereby situating recent developments within a longer-term context.The third projections, incorporating eligible amounts, public contributions, the share financed by the European Agricultural Fund for Rural Development (FEADR), and cumulative public totals.

Together, these data enable an integrated perspective on infrastructure development, combining physical capacity, agricultural resource endowment, and financial support mechanisms. Quantitative analysis was complemented by qualitative information derived from a synthesis of constructive and functional typologies of storage spaces, including traditional solutions (cribs, platforms, sheds, warehouses) and modern systems (concrete and metal silos, silo bags). This dual approach provides not only a statistical picture of infrastructure levels, but also an interpretative framework regarding technological diversity and functional adequacy. Several indicators were calculated to enhance comparability and allow a more precise interpretation of the relationship between storage capacity and agricultural resources. These include: storage capacity density, ratio of total capacity (tons) to arable land (ha), expressed as t/ha; infrastructure density,

measured both as facilities per hectare and as the arable land equivalent per facility (ha/facility); growth dynamics, interannual growth rates, computed separately for the number of facilities and total storage capacity; regional and county contributions: aggregation of values at regional level and calculation of each county's share in total storage and investment indicators; investment synthesis,total eligible and public. All calculations were strictly based on reported data; no exogenous adjustments, imputation, or rescaling procedures were applied. This ensures full traceability of results to the primary datasets.

RESULTS AND DISCUSSIONS

The evolution of grain storage infrastructure in South-West Oltenia between 2015 and 2023 highlights a dynamic process of both quantitative expansion and qualitative restructuring. In 2015, the region had a total of 395 authorized storage facilities with an overall capacity of 1.13 million tons. By 2023, the number of facilities had increased to 534 (+43%), while total authorized capacity reached 3.23 million tons (+185%). This growth clearly demonstrates a structural modernization of the storage sector.County-level patterns reveal significant asymmetries. Dolj and Olt stand out as the agricultural poles of the region. Dolj more than tripled its capacity, from 478,872 tons in 2015 to over 1.48 million tons in 2023, with the number of facilities rising from 198 to 262. Similarly, Olt advanced from 364,933 tons to over 1.12 million tons, while its facilities expanded from 110 to 166. Mehedinți registered moderate but consistent growth, increasing capacity from 143,595 tons to 259,788 tons over the same period. Vâlcea experienced an almost stationary situation (66,273 tons vs. 86,709 tons). In contrast, Gorj displayed stagnation, with capacity actually declining from 79,850 tons in 2015 to only 26,620 tons in 2023, despite maintaining a similar number of facilities.At the regional level, the average capacity per facility nearly doubled, from 2,870 tons in 2015 to approximately 5,710 tons in 2023.

Table 1

The numerical and quantitative evolution of storage capacities in the South-West Oltenia Region

(Source: Own calculations based on afir.ro data)

County \ Year	2015		2017		2023	
	Number of storage spaces	Total authorized capacity (t)	Number of storage spaces	Total authorized capacity (t)	Number of storage spaces	Total authorized capacity (t)
Dolj	198	478872	224	1173433	262	1484474
Gorj	23	79850	26	35700	21	26620
Mehedinti	39	143595	51	152338	69	259788
Olt	110	364933	124	714636	166	1024851
Vâlcea	25	66273	18	64090	16	86709
TOTAL	395	1133523	443	2140197	534	2882442

This shift reflects not only the numerical increase in infrastructure but also the adoption of larger, technologically improved storage solutions. Statistical correlations confirm that counties with greater arable land—such as Dolj (488,560 ha) and Olt (390,336 ha)—are also those concentrating most of the investments and infrastructure, reinforcing their central role in regional

agricultural production.The financial dimension complements this picture. Data from Submeasure 4.2 of PNDR 2014–2020 show that eligible and public investments intensified substantially between 2017 and 2023. Peaks were reached in 2022–2023, when Olt attracted more than €22 million in eligible funding and Dolj exceeded €12 million.

Table 2

Public and eligible project values by county funded through Submeasure 4.2 (Source: Own calculations based on afir.ro data)

An	Componentă	REGIUNE								Total valoareeligibilă - euro	Total valoareapublică-euro
		N-E	S-E	S.M	S-Vo	V	N-V	C	B-IF		
2015	E	6211636	833879	1559351	0	0	1360000	0	0	9964866	0
	P	6211636	416939	779675	0	0	680000	0	0	0	8088250
2016	E	4649242	833879	0	0	0	1360000	0	0	6843121	0
	P	2324621	416939	0	0	0	680000	0	0	0	3421560
2017	E	3179997	12692179	5319454	6507593	14975101	11159286	2123465	0	55957075	0
	P	1589998	6346088	2326694	3253795	12580815	5117737	1061732	0	0	32276859
2018	E	9610765	14518962	7587013	7180970	11461900	15998509	7098727	4962457	78419303	0
	P	4805381	7259479	3418706	3590484	5386188	7504955	3350747	2481228	0	37797168
2019	E	6795959	9020407	45766982	8995193	12312634	36754077	4445082	0	124090334	0
	P	3989560	5959215	8923112	6069336	6611950	23752287	2824784	0	0	58130244
2020	E	0	15803584	2477378	6095536	4574574	5995989	3737009	0	38684070	0
	P	0	1151732	1271135	2497097	2287286	1998994	1826771	0	0	11033015
2021	E	0	0	0	0	0	0	0	0	0	0
	P	0	0	0	0	0	0	0	0	0	0
2022	E	6553257	18114281	25475144	14988119	26580632	30857860	7767801	1199986	131537080	0
	P	4347302	11043386	15501434	10454463	16299070	21161911	5128195	599993	0	84535754
2023	E	0	0	0	4165554	1396696	0	0	0	5562250	0
	P	0	0	0	1786211	977687	0	0	0	0	2763898
Total	E	37000856	71817171	88185322	47932965	71301537	103485721	25172084	6162443	451058099	0
	P	23268498	32593778	32220756	27651386	44142996	60895884	14192229	3081221	0	238046748

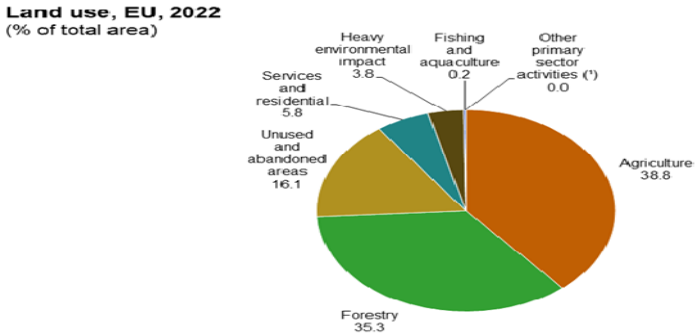

Figure 1. Public and eligible project values by county funded through Submeasure 4.2
(Source:https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Land_use,_EU,_2022_(%25_of_total_area).png)

Beyond the quantitative results, the quality of storage materials and technologies has played a decisive role in shaping outcomes. Traditional wooden cribs and sheds, although historically important, are increasingly inadequate due to their vulnerability to pests, humidity, and limited capacity. Reinforced concrete warehouses and silos ensure durability and thermal inertia, enabling stable preservation of large volumes, though they involve high construction costs and limited flexibility. Metal silos, particularly galvanized steel models, represent the technological benchmark, combining vertical efficiency with advanced systems for aeration, thermometry, and automation, thereby reducing post-harvest losses to minimal levels and allowing long-term storage of up to 20 years. Silo bags, introduced more recently, complement the system by providing temporary, low-cost solutions for seasonal surpluses. They rely on anaerobic conservation, which inhibits pests and mold, but their storage duration is limited to 6–12 months, and they remain vulnerable to mechanical damage.

Table 3

Metal silo vs. Silo bag

Characteristic	Metal silo	Silo bag
Structure	**Vertical cylinder made of galvanized metal panels, with conical roof and flat/conical base**	**Tubular polyethylene triple-layer bag (white exterior, black interior)**
Typical dimensions	**Diameter: 4–32 m**	**Length: 60–75 m**
	Height: 10–30 m	**Diameter: 2–3 m**
Storage capacity	**500 – 10,000 tons/silo (depending on size)**	**200 – 250 tons/bag**
Occupied area	**Relatively small (vertical storage)**	**160–180 m² per bag (for 60 m length, Ø 2.7 m)**
Storage duration	**5–20 years (long-term)**	**6–12 months (temporary)**
Control systems	**Ventilation, temperature and humidity sensors, automation**	**No active systems; preservation through anaerobiosis**
Allowed grain moisture	**Up to 15–16% (with ventilation)**	**12–14% (before storage)**
Filling	**Elevators, augers, conveyors**	**Silo-bagger equipment**
Emptying	**Gravity (conical base) or mechanized (augers)**	**Auger extractor, flow 80–100 t/h**
Initial investment	**High (construction and equipment cost)**	**Low (bag cost + bagger/extractor equipment)**
Lifetime	**30–40 years (with maintenance)**	**1 usage cycle (non-reusable film, but recyclable)**
Flexibility	**Fixed, cannot be moved**	**Very flexible, can be placed anywhere**

Taken together, the results emphasize that modernization has a dual dimension: expansion in capacity and improvement in quality. Dolj and Olt embody this convergence, with both the largest increases in storage infrastructure and the adoption of more advanced storage technologies. Vâlcea illustrates the potential of recovery through targeted funding and hybrid solutions, while Mehedinți demonstrates steady but moderate development. Gorj, by contrast, highlights the persistence of structural gaps in agricultural infrastructure, limited access to financing, and insufficient adoption of new technologies.From a broader perspective, these findings align with European patterns, where storage infrastructure is closely correlated with land use, productivity, and access to funding. However, the South-West Oltenia case also reveals intra-regional disparities that risk deepening if investments continue to concentrate in already dominant counties. Policy responses should therefore promote a balanced portfolio of storage technologies, combining metal silos for long-term reserves, reinforced concrete facilities for medium-scale storage, and silo bags for seasonal surpluses, adapted to farm typologies and regional agro-climatic contexts.

CONCLUSIONS

The analysis of grain storage infrastructure in South-West Oltenia during the period 2015–2023 highlights a process of accelerated modernization, strongly influenced by both European funding instruments (Submeasure 4.2 of PNDR 2014–2020) and the structural characteristics of regional agriculture. Overall, the number of storage facilities increased by more than 40%, while total authorized capacity almost has doubled, rising from 1.13 million tons in 2015 to over 2.88 million tons in 2023. These dynamics underline the fact that storage has become a central element of agricultural competitiveness, allowing for greater flexibility in marketing and more effective preservation of production quality.At the territorial level, the results confirm the polarization of investments. Dolj and Olt concentrate the majority of facilities, capacities, and funds, reflecting their vast arable areas and stronger institutional capacity to absorb financing. Mehedinți and Vâlcea show moderate growth, the latter achieving a notable recovery through targeted investments. Gorj, however, remains structurally marginal, with very limited capacity and weak dynamics, suggesting the need for corrective policies to reduce intra-regional disparities.From a technological perspective, modernization is not only quantitative but also qualitative. The transition from wooden cribs and traditional sheds toward reinforced concrete warehouses, metal silos, and silo bags demonstrates an evolution in storage philosophy. Metal silos represent the technological benchmark, offering long-term preservation and advanced monitoring systems. Reinforced concrete structures ensure durability and resilience, but they lack flexibility and require high construction costs. Silo bags emerge as a complementary, low-cost solution for seasonal surpluses, while wooden structures are increasingly obsolete in the context of modern agri-food chains.In conclusion, the modernization of storage infrastructure in South-West Oltenia requires a balanced approach that combines capacity expansion with technological upgrading.

For large-scale agricultural counties such as Dolj and Olt, continued investment in metal silos and digital monitoring systems is essential. For counties such as Mehedinți and Vâlcea, medium-scale reinforced concrete facilities combined with silo bags can provide efficient, cost-effective solutions. For structurally weaker areas such as Gorj, dedicated policy instruments and financial support mechanisms are needed to stimulate modernization and ensure a minimum level of storage resilience. At the strategic level, hybrid models that integrate permanent infrastructures (metal silos and warehouses) with flexible solutions (silo bags) should be promoted, alongside digitalization and smart monitoring of storage conditions. Such measures will not only secure the nutritional and sanitary quality of cereals but will also support food security, reduce post-harvest losses, and enhance the resilience of regional agriculture within the broader European context.

REFERENCES

Chira, Lenuta, Adrian Chira, Elena Delian, Ligia Ion, and Amalia Ionescu. "Research Regarding the Influence of the Harvesting Period Upon the Quality and Storage Capacity of Some Apple Varieties." *Scientific Papers-Series Management Economic Engineering in Agriculture and Rural Development* (Bucharest) 22, no. 1 (2022): 93–98.

Dumitriu, Iuliana Manuela, Cristina Stoica, Constanta Bacanu, Marius Nicula, and SilviusStanciu. "Research on Optimizing the Quality of the Lots of Grain Cereals Seeds for Sowing." In Education Excellence and Innovation Management Through Vision 2020, edited by K. S. Soliman. Int Business Information Management Assoc-Ibima, 2019.

Ivan, Elena Stefania, Maria-Narcisa Mocanu, Mariana Valentina Petre, and Oana Alina Nitu. "Research on the Incidence of Micromycetes on Wheat Seeds During Storage in View Damage Control." *Scientific Papers-Series a-Agronomy* (Bucharest) 64, no. 2 (2021): 406–10.

Medelete, Dragos Mihai, and Radu Lucian Panzaru. "Cereal Production of Dolj County in the Regional and National Context (2017-2021), Romania." *Scientific Papers-Series Management Economic Engineering in Agriculture and Rural Development* (Bucharest) 23, no. 4 (2023): 515–22.

Marin, Ancuta, Steliana Rodino, and Vili Dragomir. "Considerations Regarding the Storage of Agricultural Production in Romania." *Scientific Papers-Series Management Economic Engineering in Agriculture and Rural Development* (Bucharest) 24, no. 3 (2024): 551–58.

Medelete, Dragos Mihai, Radu Lucian Panzaru, Marius Vladu, and Gheorghe Matei. "Some Considerations Regarding the Primary Wheat Supply in Romania and Its Composition (2014 - 2016)." *Scientific Papers-Series Management Economic Engineering in Agriculture and Rural Development* (Bucharest)

18, no. 1 (2018): 245–52.

Panzaru, Radu Lucian, and Dragos Mihai Medelete. “Economic and Financial Aspects of Activity in S.c. ‘Al Theo & Dea’ S.r.l. - Salcia Common, Teleorman County (2011 - 2013).” *Scientific Papers-Series Management Economic Engineering in Agriculture and Rural Development* (Bucharest) 14, no. 3 (2014): 231–38.

Vladu, Marius, Radu Lucian Panzaru, and Cristina-EmanuelaVladu. “Studies on the Current Stage of the Investments Made, for the Development of Storage Capacities of Field Crops Production, Through the Sub-Measure 4.2 of the ‘National Program for Rural Development 2014-2020’, in the South-West Region Oltenia.” *Romanian Agricultural Research* (Fundulea) 36 (2019): 241–50.