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STORAGE OF CEREALS AND TECHNICAL PLANTS IN METAL CELLS, A VIABLE ALTERNATIVE FOR AGRICULTURAL PRODUCERS

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Abstract: The storage and preservation systems of agricultural products in the form of seeds are used to ensure the quality and viability of the seeds during storage. These systems involve the use of specific techniques and methods, aimed at extending the life of the seeds and preventing their damage. In seed storage, it is important to ensure optimal environmental conditions, such as controlled temperature and humidity. Temperature and humidity must be maintained at appropriate levels so that the seeds are not exposed to extreme variations that could affect their quality. Adequate ventilation of storage areas is also essential to avoid moisture build–up and mold growth. In addition, the seeds must be pre–prepared before storage by removing impurities and damaged or deformed seeds. This helps reduce the chances of contamination and maintains seed quality. To ensure the long–term viability of the seeds, special techniques such as the drying process and freezing of the seeds can also be used. Regarding the storage and preservation systems of agricultural products in the form of seeds, the most rational and economical system for Romania is that of dry storage.
Keywords: grain storage, food safety, ventilation, grain quality

1. INTRODUCTION

Agriculture represents one of the most important branches of the national economy, having a decisive role in ensuring the food security of the population, by offering agro–food products in sufficient quantities, at affordable prices, but especially of quality.

In order to achieve a modern agriculture in Romania, according to the European agricultural model, it is necessary to ensure some basic principles such as: preserving human health and safety, preserving animal health; ensuring farmers with incomes that guarantee the stability of holdings, etc. As a result, the regulation of the agricultural production valorization system is the most important and urgent problem of the rural economy.

The problem of keeping and storing grains can be approached from two perspectives: keeping and storing grains and technical plants within individual agricultural holdings; preservation and storage of cereals and technical plants within agricultural associations and commercial companies, [2].

At the Romanian level, the preservation and storage of cereals at small agricultural producers are deficient from the point of view of ensuring optimal storage conditions according to standards.

In most situations, producers in the first category practice subsistence agriculture in rural areas where the age limit is high.

The production being small due to the small areas, the harvests obtained are generally used for own consumption and the raising of animals necessary for the family, in the case of peasant households, in comparison with large agricultural holdings that have funds and have acquired storage systems of large and very large capacities from various companies from abroad, companies with headquarters or representation in Romania.

The small landowners are the most disadvantaged, finding year after year that the money obtained from the sold production does not cover the expenses made with the grain production, [3,4].

The delivery of products to the reception bases is not at all advantageous for small agricultural producers for several reasons: the delivered quantity is diminished by the high degree of impurities applied by those at the reception base; payment for the delivered quantity is made after 2–3 months in the best case.

All the problems that appear in the storage and preservation system are due to factors such as:

- the lack of an organized grain market and an interprofessional market regulation body;
- wheat quality; small farmers do not use, most of the time, for financial reasons, seeds of good quality, hence a quality that sends wheat to the feed category.
- the increasingly capricious weather of the last period, which periodically affected crops and their quality.
- the price, the most sensitive chapter in the discussions between producers and merchants or grain processors.

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All these reasons lead to the need for a concerted action in the matter of grain storage and preservation, an action that would cause grain producers to take into account a series of factors that contribute to a good preservation and conditioning of grain. The proper preservation of seeds can only be achieved in spaces that satisfy a wide range of the most different conditions, all competing to maintain their quality without quantitative and qualitative losses.

2. MATERIALS AND METHODS

In order to meet the optimal storage and storage conditions, the product harvested and transported to the storage base must follow the flow in fig. 1.

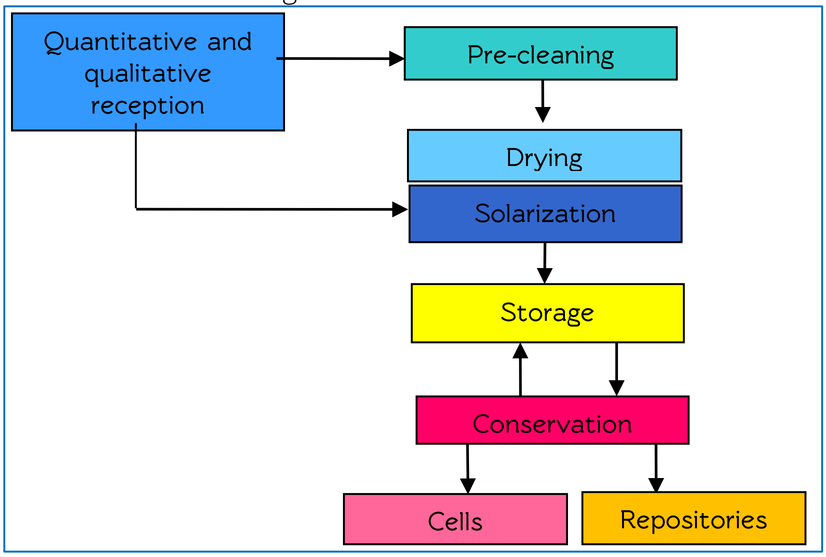


Figure 1 – Product storage technological flow

The technical storage conditions are in close correlation with the storage and preservation technologies of the bulk grain seeds, with the crop species, with their further destination and with the geographical area where they are located (the meteorological and vegetation conditions specific to the products reaching the humidity and the optimal storage temperature). Regarding the storage and conservation systems of agricultural products in the form of seeds, the most rational and economical system for Romania is that of dry storage. The problems that occur during the storage of agricultural products inevitably lead to quality deterioration (heating of the products, blackening, moldiness, rancidity, gnawed or empty grains, etc.) of the stored product and are classified according to the source that causes the problem, [9, 10].

In order to ensure optimal storage conditions, the respective spaces must ensure:

- proper storage of the seeds, to be clean and uninfested;
- location and implementation so that water of any origin does not enter the interior;
- the tightness of the access holes, so that birds or rodents do not enter inside;
- natural or artificial ventilation to avoid overheating.

The content of foreign bodies, this parameter determined by laboratory samples, is strictly monitored during storage, especially when the content of attacked seeds, moldy, spoiled (wheat) and stained attacked seeds (corn) has increased compared to the observed situation before storage.

Any storage of grains involves a biological decomposition of the substance. In addition, there is the risk of the development of harmful insects. Along with probing the products for the determination of moisture and foreign bodies, visible infestation is also analyzed.

The detection of the infestation must be done in the early phase for the measures taken to be effective. All these conditions can be ensured by using efficient storage facilities.

The installation for storing and preserving cereals, ISC 10, the Installation for storing and preserving cereals IDC 5 and the System for storing cereals SDC are installations made within INMA Bucharest, with the idea of helping agricultural producers of cereals and technical plants, [1, 2].

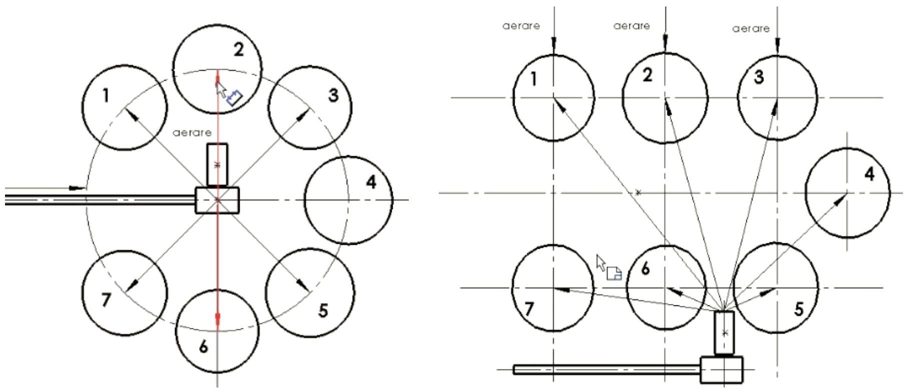
The ISC 10 grain storage and preservation facility is a complex, modern facility, intended for grass grains (wheat, barley, rye), corn, legumes and oilseeds, species with a large weight in the overall agricultural production made in small and medium–sized farms, facility that ensures grain pre–cleaning and aeration during storage. The storage and preservation facility, with a capacity of 10 tons, is composed of the following technical equipment: helical conveyor; cleaning group; cell; mobile pneumatic transport installation; mobile ventilation installation; power and control electrical installation.

The helical conveyor is inclined, mobile, with adjustable height, easy to move according to the required position within the technological flow (feeding pre–cleaning group or unloading cell).

The pre–cleaning group includes a cascade separator with its own fan, with a cyclone for decanting impurities and a sluice type product dispenser. Its functional role is to separate by suction, light impurities, ferromagnetic components and insects and to direct the pre–cleaned product to the pneumatic transport installation.

The cell is a metallic construction, cylindrical, removable, with sheet metal walls that alternate with special walls that allow natural and artificial ventilation. Adequate aeration is important in the processes of grain storage systems and is essential to preserve the quality of the stored products.

Figure 2 – Central column ventilation



a. b.

Figure 3 – Pre–set cell location schemes: a, b – the variant with 7 cells with different location

The central ventilation column, fig. 2, is a cylindrical metal construction, made of perforated sheet metal. At its base is a connection that allows it to be connected to the mobile ventilation installation. On the side surface of the cell there are connections for collecting samples and for temperature control.

The mobile pneumatic transport installation includes a mono–suction radial fan whose functional parameters can be adjusted with the help of a mixer with flap mounted on its suction. The product receiver and the flexible tube that ensures the transport of the pre–cleaned product from the pre–cleaning group to the product distributor mounted on the cell are mounted on the fan outlet. The mobile pneumatic transport installation is a mobile installation.

The mobile aeration installation is similar to the pneumatic transport installation, but it is characterized by other constructive and functional parameters. This installation is provided on the discharge side with a pipe to connect to the cell's aeration column and can be used to aerate a group of cells if the cell layouts allow it fig. 3, a and b.

The SDC grain storage system – fig. 4, ensures optimal storage conditions for bulk seed stocks, with technical–functional performances competitive with those on a global level and is composed of: cell with control system, CSC–0; horizontal helical conveyor, TEO Ø 152–0. The cell with the CSC control system is a metallic construction, cylindrical in shape, removable, with corrugated galvanized sheet walls. The cylindrical body is made of quality FeE350G galvanized corrugated sheet with Z350NA and Z450NA coating (EU standard). The corrugated panels that form the walls are made of high strength steel and assembled together. The cell is equipped with a control system that ensures the control of the temperature and aeration of the seeds in the cell. The cell has a storage capacity of 400 m^3.

After the harvesting process, agricultural products (seeds, fruits, vegetables, etc.) cannot be used directly for various purposes such as: storage, consumption, industrialization, marketing, seeding material, etc., because they also contain impurities (vegetable residues, other bodies, etc.) and damaged products.

Before receiving a specific destination, it is necessary and mandatory for the harvested products to undergo cleaning and sorting operations. Through these operations, the aim is to increase the purity of the product, at the same time achieving better storage conditions, a reduction in the volume of transport and storage.

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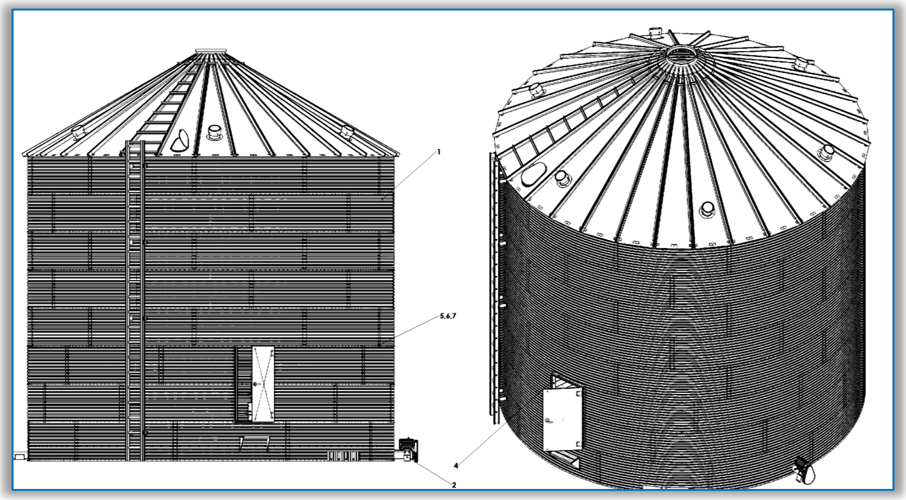

Figure 4 – The SDC grain storage system, [2]

3. DETERMINATION OF THE TECHNOLOGICAL EFFECT

The ISC 10 grain storage and preservation plant is provided as we previously presented with a pre–cleaning group. During the experiments, the technological effect of the pre–cleaning group of the ISC 10 grain storage and preservation facility was analyzed compared to the product standards and the results were evaluated according to the results obtained in a single pass through the machine of the product undergoing processing. To determine the technological effect, the following notations were made:

EcsM – % of large foreign bodies removed
Ecsm – % of small foreign bodies removed
Ecsu –% of light foreign bodies removed
Cps – % of good seeds of the processed product lost in by–products

The calculation relationships for determining the technological effect of the used pretreatment group were as follows:

$$E_{csM} = [(C_{sMi} - C_{sMe}) / C_{sMi}] \times 100, [\%] \quad (1)$$

in which: CsMi – the content of large foreign bodies at the entrance to the machine (%)
CsMe – the content of large foreign bodies at the exit from the machine (%)

$$E_{csm} = [(C_{smi} - C_{sme}) / C_{sMi}] \times 100, [\%] \quad (2)$$

in which: Csmi – the content of small foreign bodies at the entrance to the machine (%)
Csme – the content of small foreign bodies at the exit from the machine (%)

$$E_{csu} = [(C_{sui} - C_{sue}) / C_{sui}] \times 100, [\%] \quad (3)$$

in which: Csui – the content of light foreign bodies at the entrance to the machine (%)
Csue – the content of light foreign bodies at the exit from the machine (%)

The Cps coefficient is calculated with the formula:

$$C_{ps} = (\Sigma m_k / M) \times 100, [\%] \quad (4)$$

in which: Σm_k – the sum of the masses of good seeds, in the products collected at the exits of the machine, for the entire duration of the sample and determined by laboratory analysis, based on the samples collected separately from each by–product, expressed as a percentage of the total mass of the analyzed sample;

M – the mass of good seeds at the entrance to the machine, determined by laboratory analysis based on the samples collected at the entrance of the product to be processed into the machine and expressed in % of the total mass of the samples.

4. DETERMINING THE AMOUNT OF AIR REQUIRED FOR ACTIVE AERATION

The mobile aeration installation allows aeration of the seeds in the storage cell. Amount of air to be blown in (Q) is expressed in m^3air/hour/ton of seeds (sometimes in m^3air/hour/m^3 of seeds) and is calculated:

$$Q = \frac{D}{G} \quad (5)$$

in which: D – air flow rate provided by the fan, m^3/h; G – weight of the lot subjected to aeration, t.

When calculating the amount of air required for active aeration in the storage cells, the number of air exchanges was also taken into account. The required number of air exchanges per hour in the intergranular space varies depending on the humidity of the seeds and is calculated using the relationship:

$$N=\frac{D}{P} \quad (6)$$

in which: D – fan flow rate, m^3/h; P – the porosity of the seed mass.

For the seeds of the main species, the mass porosity is as follows: wheat 35...45%, barley 45...55%, oats 50...79%, corn 30...50%, sunflower 60...80%, oil flax 30...50%.

5. RESULTS

Following experiments under operating conditions with the ISC 10 grain storage and preservation facility, the qualitative and functional parameters were obtained, table 1.

Table 1. Qualitative and functional parameters in load

Crt. No.	Parameter determined	MU	Value of the measured parameter	
			Provided	Achieved
1	Cell capacity	t	10	10.5
2	The pre–cleaning capacity	t/h	2	2.2
3	Technological effect:	%	–	97.97
	– large foreign bodies removed *EcsM*	%		95.49
	– small foreign bodies removed *Exm*	%	–	94.88
	– light foreign bodies removed *Ecsu*	%	–	98.5
	– retention of ferromagnetic bodies	%	–	0.17
	– the degree of breakage of the installation	%	–	0.065
	– the loss coefficient of good seeds in by–products (Cps)	ºC	–	18.5
	– air temperature	ºC	–	12
	– the height of the wheat layer in the cell	m	–	2.6
	– temperature drop after one hour of aeration	ºC	–	0.28
4	The total power absorbed by the installation	kW	7.6	7.513
5	Power absorbed by the screw conveyor	kW	0.75	0.53
6	Fan of the pretreatment plant:	m^3/h	1800	1540
	– debit	mmCA	116	116
	– total pressure	kW	1.1	0.856
7	– absorbed power	kW	0.55	0.526
8	The fan of the mobile pneumatic transport installation:	m^3/h	710	699
	– debit	mmCA	290	290
	– total pressure	kW	2.2	2.73
9	– absorbed power	kWh/t	–	1.864
10	Specific electricity consumption for pre–cleaning and charging the cell	$m^3/h/t$	–	125
11	Specific air flow per t of seeds	$m^3/h/t$	–	450

It is recommended that active aeration should also be done in the cell loading flow, i.e. start as soon as the product layer has covered the distribution channels and continue throughout the filling period.

In this way, the seeds that fall have a fuller contact with the blown air, and for good ventilation it is necessary not to exceed a difference of 12°C, between the temperature of the air and that of the seeds. Above this threshold, there is the possibility of condensation along the cell wall, which causes wetting.

6. CONCLUSIONS

The facility for storing and preserving grains ISC 10, the Facility for storing and preserving grains IDC 5 and the System for storing grains SDC are facilities made within INMA Bucharest that compete to promote a sustainable agriculture with the aim of improving the entire food chain by providing storage spaces and storage for agricultural producers, in optimal storage conditions (temperature, humidity according to standards) of cereal seeds necessary for consumption, sowing and obtaining concentrated fodder for the livestock sector.

The provision of new, high–performance domestic technologies necessary for agriculture, in the field of seed preservation with the unaltered maintenance of their biological value properties, but with an appropriate technological effect of pre–cleaning and disinfestation possibilities. Ensuring storage spaces of up to 150 tons, by arranging the cells according to different schemes and environmental protection.

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