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ACHIEVING HIGH PRODUCTIVITY IN GRAIN DRYING AND STORAGE: NECESSITIES AND PROBLEMS

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Abstract. *Production based on the development of an automatic control system of the technological process, drying of grain with the help of computers in closed control cycles and creation of centralized control. Centralized control systems based on microprocessors providing high efficiency and reliability were analyzed. Grain drying and storage are crucial stages in the agricultural value chain, directly impacting food security and economic viability. High productivity in these processes is paramount, ensuring minimal losses, maintaining grain quality, and maximizing profitability for farmers and stakeholders. However, achieving optimal productivity faces significant challenges, ranging from technological limitations to logistical hurdles and unpredictable climatic conditions. This article explores the necessities for high productivity in grain drying and storage, analyzes the prevalent problems, and proposes potential solutions.*

Key words: *technological process, grain, processing, automation control, energy efficiency, quality maintenance, microbiological damage, environmental impact.*

Introduction. Grain drying regimes are set to achieve high performance of the dryer, ensure continuous operation, control and maintain the quality of grain crops. Adjustable grain dryer parameters: maximum heating temperature, heat carrier temperature, as well as grain cooling temperature. Air humidity, its movement speed is not regulated. Grain drying regimes are selected depending on the type of agricultural crops, the initial moisture content of grain, its physiological state, purpose, type of grain dryer

There are different methods of extracting moisture from grain. In particular, the free moisture on the grain surface can be removed mechanically, for example, by squeezing it in a separator or mixing the grain with another substance that quickly absorbs water. Grain drying can be conditionally divided into two groups:

The first group includes the method of mechanical dehydration and the method of sorption drying (the process is carried out almost without thermal drying, in which only a small amount of drying is used). In both cases, moisture is removed from the grain in liquid form. Let's talk about costs: the energy for such drying is relatively low, and grain moisture can be reduced only by a small amount (1-2%). In addition, sorption drying of grain takes a long time.

The second group includes the thermal method of grain drying. The main amount of moisture in the grain is compacted with dry substances and layers. It can be removed from the grain only by steaming.

This drying method requires more energy than mechanical dehydration or sorption drying. Heat drying is also known as the most common drying method nowadays. Only heat drying is used as the most effective way to store grain, which allows to quickly reduce grain moisture

I. Necessities for High Productivity:

High productivity in grain drying and storage hinges on several interconnected factors:

A. Efficient Drying Technologies:

1. **Appropriate Drying Method Selection:** The choice of drying method (e.g., natural air, solar, low-temperature, high-temperature) significantly impacts efficiency. Factors influencing selection include climate, available resources, grain type, and desired final moisture content. High-temperature drying, while faster, risks quality degradation if not carefully managed. Low-temperature methods are gentler but require longer drying times. [1]
2. **Technological Advancement:** Modern drying technologies, such as computer-controlled systems with automated sensors for monitoring temperature and moisture content, are crucial for optimizing the drying process. These systems allow for precise control, minimizing energy consumption and reducing the risk of over-drying or under-drying. [2]

3. **Energy Efficiency:** Energy costs are a major component of grain drying expenses. Improving energy efficiency through better insulation, optimized airflow patterns, and the use of renewable energy sources (e.g., solar, biomass) is vital for sustainable and cost-effective operation. [3]

4. **Capacity and Throughput:** Drying systems must have sufficient capacity to handle the expected volume of grain harvest within a reasonable timeframe. High throughput is essential to avoid delays and potential quality deterioration during periods of peak harvest.

B. Effective Storage Infrastructure:

1. **Proper Storage Facility Design:** Storage facilities must be designed to minimize grain losses due to insects, rodents, moisture, and spoilage. This includes features like adequate ventilation, rodent-proofing, and appropriate materials resistant to pests and moisture. [4]

2. **Storage Capacity:** Storage capacity should match or exceed expected harvest volumes, preventing overcrowding and ensuring safe and efficient storage. Adequate storage minimizes post-harvest losses and allows for strategic marketing and sales.

3. **Climate Control:** Maintaining optimal temperature and humidity levels within storage facilities is crucial for preventing spoilage and preserving grain quality. Controlled-atmosphere storage (CAS) and other advanced techniques can significantly extend storage life and maintain quality. [5]

4. **Cleanliness and Sanitation:** Maintaining cleanliness and sanitation within storage facilities is crucial to prevent pest infestations and microbial contamination. Regular cleaning, fumigation, and proper aeration help minimize losses and maintain grain quality.

C. Optimized Management Practices:

1. **Pre-harvest Management:** Proper field management practices, including timely harvesting and appropriate pre-drying techniques, can significantly reduce the workload on drying and storage facilities. Minimizing field losses and ensuring consistent grain quality at harvest is crucial. [6]

2. **Harvesting Techniques:** Efficient harvesting techniques that minimize grain damage and losses during harvest are essential. Properly calibrated combine harvesters and careful handling of grain minimize the need for extensive drying and reduce the risk of quality degradation.

3. **Grain Handling and Transportation:** Efficient grain handling and transportation systems minimize losses and delays during the transfer of grain from the field to the drying and storage facilities. Minimizing damage during transportation preserves grain quality.

4. **Monitoring and Quality Control:** Regular monitoring of grain moisture content, temperature, and quality parameters during both drying and storage is crucial for detecting potential problems early and taking corrective action. This proactive approach minimizes losses and maintains quality.

Problems Affecting Productivity:

Despite the necessities outlined above, numerous problems hinder high productivity in grain drying and storage:

A. Technological Constraints:

1. **Limited Access to Modern Technologies:** Many farmers, particularly in developing countries, lack access to modern drying and storage technologies. This limits their ability to optimize drying processes and minimize post-harvest losses.

2. **High Initial Investment Costs:** Modern drying and storage equipment can be expensive, making it unaffordable for smallholder farmers. This necessitates government support and financial incentives to encourage adoption.

3. **Lack of Maintenance and Repair Services:** The lack of skilled technicians and maintenance services can lead to equipment malfunction and downtime, reducing overall productivity.

4. **Inadequate Infrastructure:** Poor infrastructure, including inadequate roads and electricity supply, can hinder the efficient transportation and operation of drying and storage facilities.

B. Climatic Challenges:

1. **Unpredictable Weather Patterns:** Unpredictable rainfall and temperature fluctuations can delay harvesting and increase the risk of spoilage during drying and storage. This requires flexible drying strategies and robust storage facilities.

2. **Extreme Weather Events:** Extreme weather events, such as floods, droughts, and heatwaves, can cause significant damage to crops and storage facilities, leading to substantial losses.

3. **High Humidity:** High humidity levels can hinder effective drying and promote mold growth during storage. This requires appropriate ventilation and climate control measures.

C. Management and Logistical Issues:

1. **Lack of Technical Expertise:** Many farmers lack the necessary technical expertise to operate and maintain modern drying and storage equipment effectively. This necessitates training and capacity building programs.
2. **Poor Storage Management Practices:** Inefficient storage practices, such as inadequate ventilation and poor sanitation, contribute significantly to grain losses. This requires improved training and enforcement of best practices.
3. **Inadequate Market Access:** Lack of market access and price volatility can make it challenging for farmers to sell their grain at profitable prices, reducing the incentive for investment in improved drying and storage facilities.
4. **Post-Harvest Losses:** Post-harvest losses due to insects, rodents, and spoilage remain a significant problem, especially in developing countries. Improved storage practices and pest management are crucial to minimize losses.

Potential Solutions:

Addressing the problems outlined above requires a multi-pronged approach:

A. Technological Interventions:

1. **Promoting Affordable Technologies:** Developing and promoting affordable and appropriate drying and storage technologies suitable for smallholder farmers is crucial. This includes exploring low-cost, locally adapted solutions.
2. **Investing in Research and Development:** Continued investment in research and development of improved drying and storage technologies is necessary to enhance efficiency and sustainability.
3. **Improving Infrastructure:** Investing in better roads, electricity supply, and communication networks is essential to support the efficient operation of drying and storage facilities.

B. Strengthening Management Practices:

1. **Farmer Training and Capacity Building:** Providing farmers with the necessary training and technical expertise to operate and maintain drying and storage equipment effectively is crucial.
2. **Promoting Best Practices:** Disseminating information and promoting the adoption of best practices in grain drying and storage through extension services and farmer field schools.
3. **Improving Market Access:** Providing farmers with better market access and information on market prices to enhance their profitability and incentivize investment in improved technologies.

C. Policy and Institutional Support:

1. **Government Policies and Subsidies:** Government policies and subsidies can incentivize farmers to adopt modern drying and storage technologies and improve their management practices.
2. **Investment in Storage Infrastructure:** Government investment in public grain storage facilities can provide backup storage capacity during periods of peak harvest and help stabilize market prices.
3. **Strengthening Extension Services:** Strengthening agricultural extension services to provide farmers with timely information and technical support on grain drying and storage best practices.

Conclusion. Achieving high productivity in grain drying and storage is essential for ensuring food security and economic prosperity. This requires a holistic approach addressing technological constraints, climatic challenges, and management issues. By investing in modern technologies, strengthening management practices, and providing appropriate policy and institutional support, significant progress can be made towards reducing post-harvest losses, enhancing grain quality, and improving the livelihoods of farmers and stakeholders across the globe. Continued research and development, coupled with effective extension services and farmer empowerment, are critical for sustainable and productive grain management systems.