

Process Standardization for Improving the Operational System of an Animal Feed Plant: A Case Study of “El Aire”

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Abstract

The lack of process standardization and formal management tools in animal feed plants can lead to operational variability, negatively affecting production efficiency and final product quality. This study aims to optimize the performance of the operational system of an animal feed plant through the implementation of process standardization, quality assurance, and lean manufacturing tools. The study was conducted under an applied approach using a case study at the “El Aire” animal feed plant, located in the state of Jalisco, Mexico. The methodology was structured in three phases: process standardization through procedure manuals, flowcharts, and Standard Operating Sheets; strengthening of the quality system through technical specifications and a quality control plan; and implementation of the 5S methodology to improve operational environment conditions. The results show a significant improvement in the control of the production system, reflected in an increase in the level of process documentation, improvements in critical product quality parameters, and an increase in the level of order and cleanliness in operational areas, which rose from an average of 16% to 85%. These actions contributed to greater efficiency in operational execution and improved compliance with production schedules. It is concluded that the structured and progressive application of standardization and lean manufacturing tools strengthens operational management in animal feed plants, even in highly automated environments, providing a solid foundation for continuous improvement and the sustainability of the production system.

Keywords: Process standardization, Animal feed, Operational efficiency, Lean manufacturing, 5S.

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INTRODUCTION

Today, animal feed production is a key activity within the agricultural sector, as it directly influences animal productivity, the quality of livestock products, and the efficiency of supply chains. In this context, production plants face increasing pressure to ensure stable processes, consistent products, and timely adherence to production schedules, making well-structured and controlled operating systems essential.

However, even in plants with high levels of automation, problems persist related to a lack of process standardization, absence of formal operational documentation, and limited application of continuous improvement methodologies. These conditions generate variability in operating parameters, hinder quality

assurance, and reduce responsiveness to changes in demand, affecting the efficiency and reliability of the production system. A preliminary analysis of the operating system, based on the 6M approach (materials, machinery, manpower, measurement, method, and environment), identified the method as a critical factor for improvement due to the lack of formal control and standardization tools.

The "El Aire" animal feed plant, belonging to the El Gran Chaparral Agricultural Company located in the Los Altos region of Jalisco, represents a relevant case study due to its high production capacity and its strategic role as the main supplier of feed for the organization's livestock operations. Despite having a highly automated infrastructure and favorable performance in cost and productivity indicators, the growth in demand and the

variability of production requirements have highlighted areas for improvement in operational management, particularly in the control and standardization of work methods.

In this context, the present study aims to optimize the performance of the operating system of the "El Aire" animal feed plant by implementing process standardization tools, quality assurance and lean manufacturing, in order to strengthen operational consistency, improve compliance with production programs and raise the quality of the products manufactured.

BACKGROUND

The animal feed production process in agro-industrial plants is characterized by the integration of multiple interdependent stages, including the reception and storage of raw materials, milling, dosing, mixing, heat conditioning, and, depending on the species, pelleting or meal production. The proper coordination of these stages is fundamental to ensuring the quality of the final product, operational efficiency, and traceability of the production process (Sartori *et al.*, 2017). Furthermore, to survive, companies need to make the most of available resources. It is a continuous struggle to eliminate unnecessary production costs, improve manufacturing performance, processes, and the business, increase productivity, reduce cycle times, and maintain quality (Cottyn *et al.*, 2013).

At the "El Aire" animal feed plant, the production system is structured around two main process flows, corresponding to the production of feed for laying hens and pigs. The products are manufactured in different formats flour, crumbles, and pellets and are adapted to various phases of the animals' production cycle. The plant operates with a high level of automation, managed from a Machine Control Room (MCR) using a Material Requirements Planning (MRP) system, which allows for centralized control of equipment, conveyors, and operating parameters. It also has a quality control laboratory for the analysis of raw materials, in-process products, and finished products, ensuring compliance with established standards.

Despite the system's technological advancements and favorable performance in cost and productivity indicators, a limited application of formal continuous improvement and process standardization tools was identified. Several studies indicate that the absence of operational documentation and standardized methods increases process variability, hinders the detection of deviations, and limits the capacity for systematic improvement in animal feed plants (Harrington, 1991; Sánchez *et al.*, 2021). It is also necessary to consider exceptions, understood as differences between the actual and expected state of the production system. Machine breakdowns, changes in job priorities, the dynamic introduction of new jobs, order

cancellations, increased job arrival rates, changes in part combinations, and job rework due to quality problems are examples of exceptions (Brucoleri *et al.*, 2006). In this sense, standardization allows for the definition of critical parameters, ensures consistency in the execution of operations, and strengthens the traceability of production processes.

The foundations of lean manufacturing, practiced for many years in Japan, are cost reduction and employee empowerment. Lean manufacturing focuses on eliminating or reducing waste and maximizing or completely initiating activities that add value from the customer's perspective (Mehta & Dave, 2020). Some of the key production aspects that the company "El Aire" could modify through the implementation of this tool include: converting most raw materials into finished products, avoiding excess waste, preventing overproduction, using space efficiently, and reducing defective products. In particular, food manufacturing companies focus on product quality, lead time, and product cost to achieve a higher economic value compared to the competitive market (Soltanali *et al.*, 2020).

Technical data sheets or product specifications are a fundamental tool for quality assurance, as they clearly define the technical requirements and acceptance criteria for the finished product, facilitating conformity classification and decision-making in quality control (Juran & Godfrey, 1999). Additionally, flowcharts contribute to the comprehensive visualization of the production process, allowing for the identification of operations, critical points, and relationships between stages, thus promoting the analysis and improvement of complex systems (Harrington, 1991). The concept of lean manufacturing in production aims to increase profitability to expand markets and improve operational performance (Soltanali *et al.*, 2020).

The 5S methodology is recognized as one of the foundations of lean manufacturing, aimed at establishing order, cleanliness, and discipline in the workplace. Several authors agree that implementing this methodology facilitates the reduction of unproductive time, improves safety, and prepares the organizational environment for the adoption of more mature management system tools (Imai, 1997). In animal feed plants, the application of continuous improvement methodologies has demonstrated positive impacts on reducing waste, operational errors, and process variability (Gómez-Ramírez *et al.*, 2019). Since the introduction of 5S is linked to improved performance in terms of productivity and quality, it is recommended to make efforts from different angles to promote the adoption of these improvement methodologies, enabling companies to enhance their competitiveness (Bayo-Moriones *et al.*, 2009).

On the other hand, recommended approaches for evaluating supplier performance, developing, and managing internal quality within companies are available within the framework of various quality management systems (Csikai, 2011). Quality management encourages companies to generate knowledge and information about their own products and their links to the initial and final stages of the supply chain. Therefore, performance measurement methods and tools have been established to optimize internal product processes, achieve product quality and conformity, and thus improve efficiency (Csikai, 2010).

In this context, the selection of process standardization, quality assurance, and lean manufacturing tools responds to the need to strengthen the operating system of the "El Aire" plant, establishing methodological foundations that will improve the execution of operations, ensure compliance with product requirements, and facilitate the evolution of the system toward more robust management schemes focused on continuous improvement.

METHODOLOGY

The study was conducted using an applied and descriptive approach, with a case study methodology, focused on the analysis and improvement of the operating system of an animal feed plant. Qualitative and quantitative techniques were integrated to understand the current functioning of the production system, identify areas of opportunity, and evaluate the implementation of standardization, quality assurance, and lean manufacturing tools.

The unit of analysis corresponds to the operating system of the "El Aire" animal feed plant, considering its production processes, support areas, and control mechanisms associated with the manufacture of feed for laying hens and pigs. Data collection was carried out through plant tours, direct observation of operations, unstructured interviews with key personnel, and review of existing documentation.

The methodological strategy was structured in three main phases, defined based on the system's maturity level and the priority of intervention, as shown in Figure 1. These phases allowed for a progressive implementation of the selected tools, ensuring consistency between working methods, quality controls, and operating environment conditions.

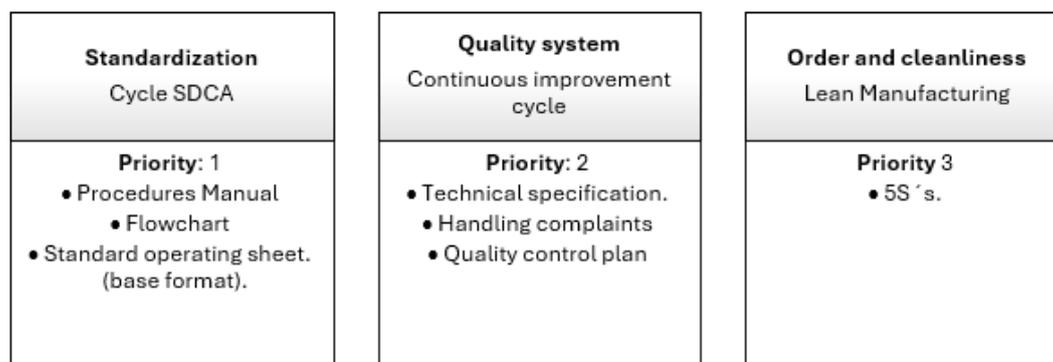


Figure 1: Scheme of methodologies and tools to be implemented based on priority

The project was developed in three main phases, which are described below.

1. Priority 1: Standardization of processes.

The first phase focused on standardizing production processes, with the goal of documenting and standardizing the execution of operations. To achieve this, a detailed analysis of the current process was conducted, breaking it down into stages and operations, and identifying critical parameters, responsible parties, and resources involved.

The main tools developed were the procedures manual, production process flowcharts, and Standard Operating Procedures (SOPs). The procedures manual allowed for the structured documentation of responsibilities, activities, and the overall sequence of processes. The flowcharts facilitated the graphical representation of the complete production system,

identifying inputs, outputs, decisions, and control points. The SOPs were used as detailed operating instructions, describing step-by-step the execution of activities, associated risks, required personal protective equipment, and quality control parameters.

2. Priority 2: Quality assurance.

Once the work methods were defined, the second phase focused on strengthening the quality assurance system. This stage involved developing technical data sheets or product specifications for both raw materials and animal feed, considering relevant nutritional, physicochemical, and process parameters for each species and production phase.

Additionally, a quality control plan was designed, establishing inspection points, measurement methods, analysis frequency, equipment used, and

actions to be taken in case of non-compliance with the established requirements. This phase allowed for the alignment of quality criteria with previously standardized operating methods, strengthening decision-making and process traceability.

3. Priority 3: Lean manufacturing tool – 5S's.

The third phase involved implementing the 5S methodology as a core tool for lean manufacturing, with the aim of improving order, cleanliness, and discipline in operational and service areas. An audit form was designed to evaluate the level of compliance with each of the five stages of the methodology (sorting, setting in order, shining, standardizing, and disciplining).

The audit results were recorded in a database for statistical analysis and monitoring over time, allowing for the identification of trends, critical areas, and opportunities for improvement. Periodic reports were also generated with the findings and proposed corrective actions, fostering employee participation and continuous improvement of the operational environment.

Overall, the applied methodology allowed for a structured intervention in the plant's operating system,

ensuring consistency between work methods, quality controls, and the conditions of the production environment, and laying the foundation for the evaluation of the results obtained.

RESULTS

The results obtained are presented according to the intervention phases established in the methodology, allowing for the evaluation of the impact of process standardization, quality assurance, and the implementation of the 5S methodology in the operating system of the "El Aire" animal feed plant.

Results of Process Standardization

As a first step, the plant's procedures manual was updated to improve its document structure, incorporate relevant operational information, and ensure compliance with basic document control criteria. Table 1 presents a comparison between the previous version (V1) and the updated version (V2), showing a significant increase in the number of documented items and in the formalization of control elements

Table 1: Comparison of version changes in the Procedures Manual of "El Aire" Feed Plant

Category of information	Versions			Modifications
	V1	V2	%	
Introduction	11	11	0%	
Content	14	17	21%	Content added for positions of plant manager, forklift operator and maintenance in chief. The information for the other job position was updated.
Final	3	5	67%	Added formats and approval signature sections were removed. The document control manager was incorporated
Structure	1	5	400%	Add a fixed border, header, main address and watermark.
Document control	2	4	100%	The document code and revision date were added to the document.
Total	31	42	118%	

The update made it possible to expand the coverage of documented job positions, improve the clarity of operational responsibilities, and strengthen the document structure through the inclusion of standardized

headers, version control, and review criteria. As a result, the level of documentation of production processes increased from 5% to 45%, facilitating the standardization and communication of work methods.

Table 2: Operations of the balanced feed production system

No.	Stage	Number of operations
1	Raw material reception	20
2	Storage and handling of raw materials	18
3	Primary production process	19
4	Secondary production process	9
5	Loading and dispatch of shipments	6
6	Boilers	5
7	Quality laboratory	12
	Total	89

Subsequently, the flow diagram of the complete production system was developed, which made it possible to identify and classify a total of 89 operations distributed across seven stages of the process (Table 2).

This classification facilitated a comprehensive visualization of the system, as well as the identification of inputs and outputs of materials, services, and documents associated with each operation (Table 3).

Table 3: Input and out concepts of materials and services in the production process

Code	Input concept	Code	Output concept
E-01	Supplier delivery note	S-01	Large plastic bag for reuse
E-02	Product intake control	S-02	Grain, meal, and flour sample
E-03	Large plastic bag for samples	S-03	Product intake control
E-04	Grain, meal, and flour sample	S-04	Supplier delivery note
E-05	Water	S-05	Sanitizing solution for sanitation arch
E-06	Disinfectant solution	S-06	Big bags
E-07	Truck entry control	S-07	Grain waste
X E-08	Ventilation	S-08	Stover
E-09	Big bags	S-09	Hot air
E-10	Grain waste	S-10	Weighbridge ticket
E-11	Caubiol	S-11	Balanced feed sample
E-12	Fungicide	S-12	Quality certificate
E-13	Production order	S-13	Stretch film
E-14	Stover	S-14	Cardboard
E-15	Steam	S-15	Pallets
E-16	Air	S-16	Empty sacks
E-17	Straps		
E-18	Weighbridge ticket		
E-19	Shipping station control sheet		
E-20	750 ml plastic container with lid		
E-21	Self-adhesive plastic label		
E-22	Sacks		
E-23	Thread		
E-24	Small bag for feed samples		
E-25	Quality certificate		
E-26	Crossbar for big bags		
E-27	Basket for pallets		

The structuring of the process into stages and operations laid the foundation for the development of Standard Operating Sheets (SOS), which enabled the

detailed documentation of critical activities, including estimated times, control parameters, risks, and required personal protective equipment (Table 4).

Table 4: Structure of a Standard Operation Sheet (SOS)

No.	Category
1	Operation name
2	Operation description
3	Estimated time
4	Steps to follow in order
5	Personal protective equipment and accident risks
6	Quality parameters
7	Critical control points
8	Document control information
9	Materials and tools

Quality assurance results

During the quality assurance phase, technical data sheets were developed for the entire catalog of products manufactured at the plant. For feed intended for laying hens, 14 technical data sheets were created corresponding to the different feeding phases, while for

swine production processes, 10 technical data sheets were developed aligned with their production cycle. These specifications made it possible to formally define nutritional, physicochemical, and process requirements, as well as the acceptance criteria for product release.

Product: Formula Booster 1			
Species: Poultry			
Description: Balanced feed for laying hens of any strain.			
Ingredients: Corn (yellow and white), sorghum, soybean meal, wheat bran, aciduulated fat, granulated calcium, canola, distilled grain, molasses, meat and bone meal, salt, sodium bicarbonate, pigments, amino acids, vitamins, minerals, and enzymes. <i>(Ingredients and quantities may vary according to the version of the formula.)</i>			
Form: Meals			
Presentation: Bulk		SAP Code: 170000021	Unit of Measure: kgs
Parameters	STD	Min–Max	Control Frequency
Particle size (µm)	1,150	1,100 – 1,250	Once per week
Mixing efficiency (%)	95	90 – 100	Once every 2 months (global)
Whole grain - Sorghum (%)	1	0 – 6.5	Once per week
Whole grain - Corn (%)	0	0 – 2	Once per week
Moisture (%)	10.82	9.32 – 12.32	Once per week
Protein (%)	18	17 – 19	Once per week
Energy (Mcal/kg)	2,908	2,708 – 3.108	Once per week
Calcium (%)	4.10–4.31	3.90 – 4.30	Once per week
Fat (%)	3.24	3.31 – 5.31	Once per week
Fiber (%)	10.58	2.24 – 4.24	Once per week
Ash (%)	—	10.45 – 16.45	Once per week
Phosphorus (%)	—	0.48 – 0.68	Once per week

Figure 1: Technical data sheet format for balanced feed specification.

The implementation of these tools strengthened quality control and operational decision-making, resulting in improvements in critical product parameters. One of the most relevant indicators was the Pellet Durability Index (PDI) in swine feed, which showed a sustained improvement trend throughout the analyzed period (Table 6). The increase in PDI contributed to a reduction in complaints related to excessive fines in feeding, improving product consistency during storage, transportation, and on-farm consumption.

Table 6: Annual Average of PDI

Year	Average PDI
2018	72.0
2019	73.5
2020	74.7
2021	75.3
2022	76.7
2023	73.5
2024	77.5

Results of the Implementation of the 5S Methodology

The application of the 5S methodology significantly improved housekeeping and organization conditions in the plant’s operational and service areas. Starting from the first audit conducted in March 2023, a sustained increase in the scores obtained across all evaluated areas was recorded, reaching an overall

improvement from 16% to 85% during the study period (Table 7).

As a complement to the quantitative results obtained in the 5S audits, relevant qualitative improvements were identified across the plant’s operational areas. These improvements were mainly associated with the assignment of designated spaces for tools, materials, and equipment, as well as the removal of unused items and the implementation of visual organization in work areas.

Primary and secondary processing areas showed significant progress in the organization of critical equipment such as mills, mixers, bagging machines, and pelleting systems. Similarly, in warehouses and service areas, the arrangement of packaging materials, waste, and maintenance tools was improved. Additionally, in support areas such as the quality laboratory and the Machine Control Room, specific spaces were defined for equipment and materials, facilitating daily operations and reducing interference in activities.

Overall, these actions strengthened visual standardization, reduced search times, and improved personnel mobility, creating a more suitable environment for the efficient execution of operations and contributing to a reduction in delays in meeting production schedules.

Table 7: Historical 5S Audit scores in the areas of the El Aire feed plant

Year	2023	2023	2023	2023	2023	2024	2024
Month	March	May	July	September	November	January	March
Unloading	16%	38%	39%	67%	56%	60%	71%
Dry warehouse	18%	43%	84%	90%	92%	86%	79%
Primary process	16%	43%	34%	79%	73%	83%	81%
Automated premix intake	14%	41%	29%	75%	82%	85%	92%
Manual premix intake	12%	45%	49%	86%	88%	89%	94%
Secondary process	9%	41%	36%	75%	82%	88%	91%
Services	16%	36%	84%	87%	89%	92%	90%
Shipping	12%	32%	64%	86%	75%	73%	77%
Quality laboratory	25%	47%	94%	90%	92%	84%	90%
CCM	18%	38%	32%	74%	74%	87%	87%
Total	16%	40%	55%	81%	80%	83%	85%

Overall, the implementation of standardization, quality assurance, and lean manufacturing tools strengthened control over the plant's operating system, improved the consistency of production processes, and established more favorable conditions for meeting production and quality objectives. The results demonstrate that the structured application of these methodologies generates tangible benefits in feed mills, even in highly automated environments.

CONCLUSIONS

The implementation of process standardization tools, quality assurance, and lean manufacturing made it possible to optimize the performance of the operating system at the "El Aire" feed mill, achieving the objective set out in the study. Prior to the intervention, high variability in the execution of operations and limited formalization of work methods were identified, which affected process consistency and compliance with production schedules.

Process standardization through the procedure manual, flow diagrams, and Standard Operating Sheets strengthened operational control and internal communication, clearly defining responsibilities, critical parameters, and the sequence of activities. As a result, the level of documentation of the production system increased significantly, establishing a solid foundation for personnel training and the replicability of operations.

In terms of quality assurance, the development of technical data sheets and the definition of a control plan made it possible to formalize product requirements and align acceptance criteria with operating methods. This was reflected in observable improvements in critical product parameters, such as the Pellet Durability Index, as well as in a reduction of complaints associated with inconsistencies in feed quality.

Meanwhile, the implementation of the 5S methodology generated substantial improvements in housekeeping and organization within operational areas, contributing to reduced non-productive time, improved safety, and greater efficiency in task execution. The

positive trend in audit scores demonstrates that this tool served as a key enabler for adopting continuous improvement practices within the plant.

Overall, the results demonstrate that the structured and progressive application of management and standardization tools can generate tangible benefits in feed mills, even in highly automated environments. This study provides practical evidence of how method standardization and strengthening the quality system contribute to improving operational efficiency, process reliability, and final product quality.

Finally, although the results correspond to a specific case study, the methodology applied can be adapted to other feed mills with similar characteristics. As a future line of work, it is recommended to further assess the impact of these tools through additional performance indicators, as well as to integrate process engineering techniques to continue optimizing productivity and the sustainability of the operating system.

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