

Ecole des Hautes Etudes Commerciales

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Final dissertation for the completion of a Master's degree

in Commercial Sciences

Option: Distribution and Supply Chain Management

THEME:

**The contribution of demand forecast by
the Box-Jenkins method
on making the production plan process
Study case: High plateaus Grains Branch / SPA**

Developed by:

AKNOUCHE Sami

Supervised by:

GHIDOUCHE Faouzi

Professor at EHEC

10th Promotion

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Abstract

The production planning process is the Brain and the central of orders in the Supply Chain Management with an objective of meeting the predicted market demand with the production and logistic disponible resources. And that can be applicable only by using an accurate sales forecast with a minimum percentage error.

The objective of this thesis is to find out what are the potential benefices of implementing the Box-Jenkins forecasting method on making the production planning process.

In order to do that, an experience has been made within the Upper Plateaus Cereals Branch located in Setif city belongs to the Agro-div Group. Which consist on making the sales forecast based on this time series method, showing the percentage of accuracy and using the results to establish a Production plan. This last one will be subject of comparison between two different scenarios possible representing by The Sales and Operation plan. The first one with constant production and hiring option, and the second one with constant production and extra hours option.

The results shows that the Box-Jenkins forecasting method shows a high level of accuracy and it can be used to elaborate the two production plans, these last ones had been compared and we have concluded that the Sales and operation planning with a constant production and hiring option is the best scenario that the company can apply. It can be justified by its low cost.

Key terms: Production plan process, Sales forecast, Box-Jenkins method, Accuracy of predictions, Sales and operation plan.

Dedication

I dedicate this modest work to my dear parents
who supported and encouraged me throughout my studies. I will be forever grateful to you.

To my brothers, and all my family
to my friends who made these 5 years an enjoyable experience.

With-out forgetting all the teachers in the School of Ecole des Hautes Etudes Commerciales -Alger-

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Abbreviations List

Abbreviation List

Abbreviation	Expansion
AC	Auto correlation
ADF	Augmented Dickey Fuller
ARIMA	Auto-Regressive Integrated Moving Average
FCA	Forecast Accuracy
HPGB	High Plateaus Grains Branch
ICC	Industrial and Commercial Complex
MO	Manufacturing Order
MRP	Manufacturing Resources Planning
PA	Partial Auto correlation
PO	Purchasing Order
PPP	Production Plan Process
S&OP	Sales and Operation Plan
Salessa	Sales with seasonal adjustment
Salesf	Sales forecasts
SCM	Supply Chain Management

Summary

Summary

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General Introduction

General Introduction

Supply chain resilience is more important than ever in the globalized, highly linked world of today. Businesses must be ready to respond to disruptions, especially as they grow in a volatile environment that is susceptible to a number of causes such as natural catastrophes, political unrest, and other unanticipated occurrences that might have a big influence on the supply chain. one among the worst

The supply chain, which includes all the processes involved in making and delivering a product, from acquiring raw materials to delivering completed items, is an essential part of every corporate operation. Considering that it entails the transfer of products and services from the provider to the final client.

Several aspects must be taken into account in order to manage a supply chain properly, hence it's crucial to have a comprehensive understanding of the different aspects of the supply chain and how these functions impact the overall business operation.

One good method is to estimate demand accurately and schedule production appropriately. These activities can have an effect on how well a business operation performs overall and aid in enhancing customer happiness, increasing operational effectiveness, and eventually boosting profitability. These functions can impact the overall performance of a business operation and help it to achieve, improve not only operation efficiency but also better customer satisfaction which automatically lead to profitability.

Forecasting future demand and then creating a plan to create items in the necessary amount and quality to satisfy that need are both essential components of effective production planning. By using reliable data and analysis tools, supply chain experts can develop accurate production plans that enable them to optimize inventory levels, reduce production costs, and minimize waste. However, establishing accurate forecasting can be a challenging task for businesses due to various factors that impact demand including industry trends, consumer behavior, and outside events. We can add to these variables the challenges and complexity of today's worldwide economy's supply networks, which can be affected by things like lead times, transportation delays, and supply chain interruptions.

Regardless of these difficulties, forecasting is still a vital component of supply chain management as it enables businesses to anticipate future demand, make and optimize the production planning as the initial step for applying it, leading ultimately business success.

There are two main types of forecasting methods: qualitative methods and quantitative methods. Qualitative techniques use a non-mathematical methodology (although they may involve numerical values). In contrast, quantitative techniques are based on mathematical models. However, the last method perceived as more effective than those based on judgment and generate more accurate forecasts.

Based on these statements, we have decided to concentrate our study on the production's planification process within The High Plateaus Grains Branch / SPA, branch of AGRODIV group and more specifically the demand's predicting part.

The choice of The High Plateaus Grains Branch for our study is not random. Indeed, this selection can be justified by the place of this enterprise as not only the official representative of the Algerian government but also as the leader of the Agri-food industry field in the national territory, specially when it comes to strategical products such as Semolina and Floor because of the strict regulations concerning the supply of raw materials. In addition of the importance of how production and demand are planned within this later.

The goal of our research is to investigate how the use of quantitative forecasting methods, specifically the Box-Jenkins method, can benefit The High Plateaus Grains Branch in terms of forecasting accuracy and in the production planning decisions. This Branch currently uses its own method of forecasting with a specific process of production planning, and we aim to explore whether this approach could possibly be used for predicting future sales and planning production.

In this order of ideas, the main question that arises is:

What are the potential benefits of implementing the Box and Jenkins method on the accuracy of forecasts and the production planning process?

To address this issue more comprehensively, the following questions were established:

- ❖ Can the High Plateaus Cereals Branch satisfy the market needs?
- ❖ Does the Box-Jenkins method provide performant results in term of forecast precision?
- ❖ Which of the different production planning scenarios provides better outcomes for the company?

In this regard, we aim to address these questions based on the following assumptions:

- ❖ The Box-Jenkins method generates accurate forecasts and can be used for planning production.
- ❖ The S&OP constant production scenario with Hiring option generates better results than the S&OP synchronise production scenario with Hiring option.

We have adapted an epistemology posture resumed on a descriptive methodology that involve conducting bibliographical and documentary research to clarify the fundamental concepts pertinent to our research topic, as well as internal reports and documents from the company with a SWOT analysis and an Interview Guide in order to assess the veracity of these assumptions. We have also conducted an analytical methodology research resumed on a demand forecasting test on historical data from the company in question, comparing them with the real sales made by the company during the same period and elaborating from these results a production plan in order to asses our issue.

Our work is divided into 03 chapters:

- ❖ The first chapter will present the theoretical aspects of the demand forecasting as well as the production plan process and concluding it with the relation between the two variables.
- ❖ The second chapter aims to present the High Plateaux Grains Branch and its production planning process, which will be the subject of a diagnosis by a SWOT analyse and an Interview Guide.
- ❖ The third and final chapter is dedicated to conducting a demand forecasting test on historical data from the company in question using the method mentioned above, using the software E-views 13, and then comparing the results with the real sales made by The High Plateaux Grains Branch during the same period before ending it with elaborating a production plan in order to draw conclusions about our problem.

**Chapter 01: The sales forecasting and the
production planning**

Chapter introduction

Before we start into our case study, it is essential to perform in-depth research on the many theoretical components of our topic. The role of sales forecasting has been considerably influenced by the present competitive environment and economic climate, making it an essential component of the company's strategic planning. Every commercial and industrial planning process begins here.

Indeed, it is considered as an introduction of a key idea in supply chain management which is production planning, this last one tries to guarantee that business decisions about operations and sales are coordinated. Because of this, it is an important component of planning and performance in big businesses.

In this chapter, we will first explain the concept of sales forecasting, including its ideas, methods, and performance metrics. Then, we will focus on production planning, discussing its principles and the stages involved in its process. Before ending it with showing the relation between these two variables.

Section 01: The sales forecasting

In this section we will present the theoretical side of the sales forecasting.

1 Key ideas

It is important to know the basics of sales forecasting before getting into details, for that, the following titles were established.

1.1 Role of forecasting

The demand prediction is the cornerstone of every supply chain planning. A pull-type supply chain bases its operations on explicit client demand as opposed to a push-type supply chain, all activities are executed based on the customer demand forecast. In both situations, forecasting the amount of consumer demand is the first thing a manager must do. The forecasting process is essential for supply chain management. For mature items with steady demand, like milk or paper towels, demand forecasting is simpler. However, it becomes difficult and much tougher when the demand is for a completed goods and the supply of raw resources are erratic like for example: Fashion items and high-tech products. This is what explain how important demand forecasting are in some points that companies have expressed their need for demand planning managers and forecasting engineers confirming that there technical and analytical abilities in the process should receive special attention.¹

1.2 Objectives of demand forecasting

Forecasts are essential to a company's strategic planning since they offer insightful information about the company's future direction. Long-term, medium-term, and short-term are the three different time periods into which these predictions are categorised.

Long-term predictions, which generally cover a period of three years or longer, are used to guide strategic choices including diversification, investment, and the creation of new products. For medium-term forecasts, ranging from six months to two years, are focused on defining and managing production and supply capabilities, including the acquisition of equipment, hiring personnel, and procurement of items with long lead times. In the other hand, operational planning and production operations use short-term projections, which generally cover a period

¹ CHOPRA, (S) et MEINDL, (P): *Supply Chain Management Strategy, Planning and Operation*, edition Pearson, 5th edition, 2013, p.178

of up to six months. This covers scheduling and workload management, as well as inventory and procurement management.

Short-term forecasts are generally more reliable because they are closer to the present. In contrary long-term forecasts are less definite because they depend on several variables that are subject to change.²

1.3 Typology of demand

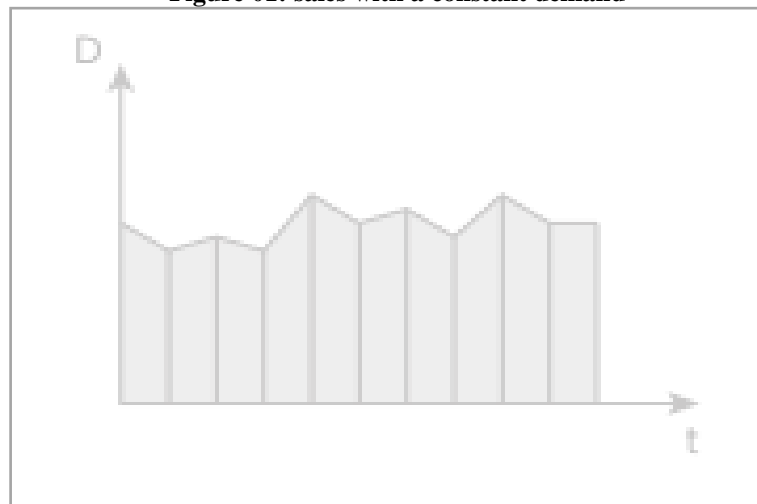
There are several typologies of demand that are commonly used in supply chain management, and it is possible to notice that the clients demand follows different laws depending on the product.³

Based on that we can mention these types:

- **Constant demand**

The set of values of the study variable varies around a roughly constant average level.

Figure 01: sales with a constant demand



Source : COURTOIS, (A), MARTIN-BONNEFOUS, (C) et PILLET (M) : *Gestion de production*, Editions d'Organisation, 4^{ème} édition

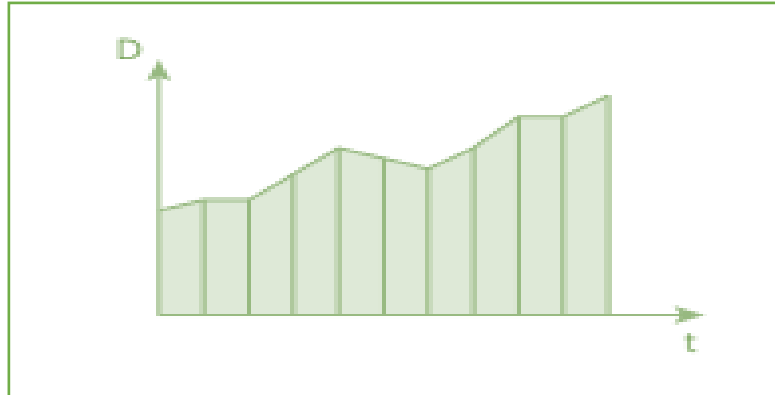
² COURTOIS, (A), MARTIN-BONNEFOUS, (C) et PILLET (M) : *Gestion de production*, Editions d'Organisation, 4^{ème} édition, 2003, p.66

³ JAVEL, (G) : *Organisation et Gestion de la Production*, édition Dunod, 4^{ème} édition, 2004, p.74-75

- **Trend demand without seasonality**

The set of values of the study variable varies around a mean level that increases (or decreases, in the case of a decreasing trend) by a roughly constant amount, thus determining a trend line.

Figure 02: sales on trend demand without seasonality

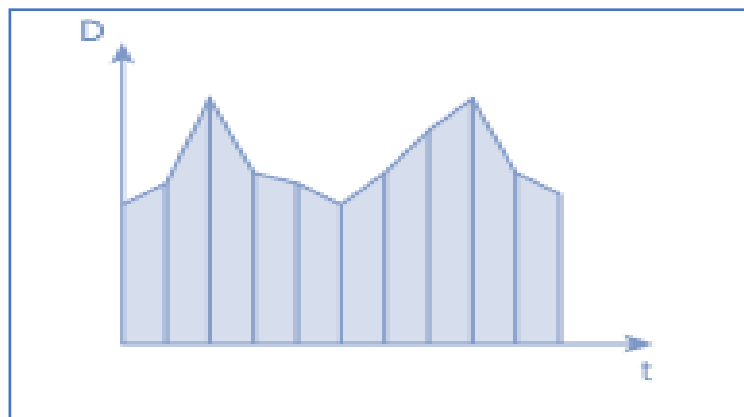


Source : COURTOIS, (A), MARTIN-BONNEFOUS, (C) et PILLET (M) : Gestion de production, Editions d'Organisation, 4^{ème} édition

- **Seasonal demand without trend**

Seasonality refers to fluctuations in demand that repeat at regular intervals. These fluctuations are generally related to one or more environmental factors (such as weather factors, calendar effects, vacations, etc.). Therefore, customer demand undergoes significant positive or negative variations at the same times each year. Seasonal variations constitute increases and decreases in the values of the data, occurring according to a periodicity called a seasonal cycle.

Figure 03: sales on seasonal demand without trend

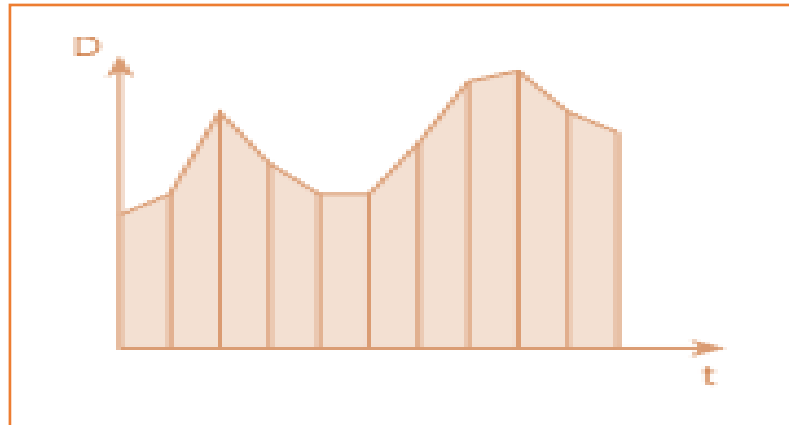


Source : COURTOIS, (A), MARTIN-BONNEFOUS, (C) et PILLET (M) : Gestion de production, Editions d'Organisation, 4^{ème} édition

- **Seasonal trend demand**

This law, a combination of the two previous ones, shows that seasonal variations (positive or negative) tend to increase or decrease regularly.

Figure 04: sales on seasonal trend with trend demand



Source : COURTOIS, (A), MARTIN-BONNEFOUS, (C) et PILLET (M) : *Gestion de production*, Editions d'Organisation, 4^{ème} édition

- **Erratic demand**

The set of values of the study variable is completely random over time.

2 Forecasting data

Some elements must be taken in consideration to make a sales forecast, we can see the most important ones above.

2.1 Identification of the choosing elements

In order to select the best forecasting strategy for a certain circumstance, there are several elements to take into account. One of the most fundamental questions to ask is what the objective of the forecast is. This is because the answer to this question can impact the choice of method in a significant way because it has a big influence on the choosing technique (whether it is aimed for strategic needs, operational...). The accessibility and quality of historical data are two other significant factors. The desired level of accuracy must be taken into consideration when selecting a forecasting method. Depending on the situation and the intended application of the forecast, some may demand a higher level of accuracy than others (forecasts used for inventory hasn't the same level of accuracy as the forecasts used for general planning). Another factor to take into account is the expense of creating and implementing a forecast, some

forecasting methods may be more expensive than others, and it is important to determine what resources are available and how much the organization is willing to invest in forecasting. Finally, the time horizon of the forecast. Indeed, Forecasts made for longer periods of time may be subject to more uncertainty than forecasts made for shorter periods of time.⁴

2.2 Unit of consumption for these elements

One of the first challenges encountered in developing a sales forecast is to clearly distinguish between sales budget/plan (the first one is used for formalizing business objectives and the second one is used for sales volumes of products). The second challenge often involves translating commercial and financial estimates that use monetary currencies as a unit of account. This requires a significant amount of conversion work to make different perspectives compatible, each with their own interests.

It is also important to understand the unit in which the forecast is made, which is generally the management unit used to track inventory. However, in a stock management system, there may be many different units for the same item: units of purchase, units of delivery by the supplier, units of warehousing, management units, accounting units, distribution units, etc. The fewer units used, the better, as this helps to avoid many errors. Stock managers often have stories of incidents, sometimes comical but always costly, resulting from a unit error that leads to unlikely deliveries.⁵

2.3 Unit of time for the forecast period

In any forecasting technique, selecting the proper unit of time for a forecast period is an important choice. In order to make this decision, one needs to consider various factors, such as the nature of the business, the market trends, and the availability of historical data. Whether the prediction is being used for short-term or long-term planning, the specific objectives should be considered while choosing the unit of time.

The prediction should use a larger unit of time, such as years or even decades, if it is intended to guide long-term strategic planning. As a result, the company will be able to manage resources more effectively, plan better, and decide on prospects for development and investment more intelligently. On the other hand, if the forecast is for short-term operational

⁴ PIMOR, (Y) et FENDER (M) : *Logistique*, édition Dunod, 5ème édition, p151.

⁵ FENDER, (M) et PIMOR, (Y) : *Logistique & Supply Chain*, édition Dunod, 7ème édition, 2016, p.270.

planning, the unit of time should be shorter, such as weeks or months. By doing that, the company will be able to promptly evaluate and modify its operations in response to the most recent market trends and client needs.⁶

2.4 Forecasts horizon

Forecasts horizon can be defined as the period of time for which a forecast is made it is an essential consideration in forecasting as it affects the accuracy of the prediction and the decision-making process. The forecast's goal and the data at hand are the main factors that determine the forecast horizon to be used (Strategic, operational...). It also affects the level of aggregation used in the forecast due to the rule of big numbers, a forecast that is made using data that has been collected over a longer time period is usually more accurate. Additionally, it is really necessary to keep in mind that forecasts are inherently uncertain, and that as the forecast horizon lengthens, so does the accuracy of the prediction.

It is not always easy to choose the best forecast horizon, and it depends on many different things such as the quality of available data, the forecast method used, and the type of decision problem. Most of the time, shorter time horizons are typically simpler to anticipate with higher accuracy than longer time horizons. However, in some circumstances, it could be required to take into account longer time horizons to spot patterns and trends that aren't apparent in⁷

3 Forecasting methods

To put it differently, there are two major categories of forecasting methods: qualitative and quantitative. Qualitative methods involve a non-mathematical approach (although they may involve numerical data), whereas quantitative methods are based on mathematical models.

Additionally, these methods are classified as intrinsic when they use data directly related to the product being forecasted. On the other hand, they are considered extrinsic when the data used is related to events that are associated with the item but not directly relevant to it.⁸

⁶ PIMOR, (Y) et FENDER, (M) : *Logistique*, Op.cit, p.153.

⁷ PIMOR, (Y) et FENDER, (M) : *Logistique*, Op,cit, p.154.

⁸ FENDER, (M) et BARON, (F) : *Le Supply Chain Management*, édition Dunod, 2ème édition, 2019, p.69.

3.1 Qualitative methods

A group of approaches known as qualitative forecasting methods are used to create forecasts about upcoming trends or occurrences based on personal judgments. These methods are often used when there is limited or no historical data available, or when the future is uncertain and hard to predict. In other words, these estimates based on non mathematical equations, common sense and experience have value when the activity is simple and demand is relatively stable over time. However, they become challenging to employ when there is a substantial amount of product variation and fluctuation.

There are numerous qualitative methods, the common ones are⁹:

3.1.1 Executive opinion

A qualitative forecasting technique that relies on the judgments and insights of key decision-makers within an organization to make prediction about future trends and events. With this approach, top executives or other educated and knowledgeable people are often surveyed or interviewed to gain their ideas and insights on variables that can affect future demand for a specific good or service.

3.1.2 Market survey

It entails gathering data from a representative group of people or organizations to learn more about their attitudes, views, and preferences on a specific good, service, or market trend. The purpose of a market survey is to provide qualitative data that can be used to inform marketing strategies, product development, and business expansion. It is carried out using a variety of techniques, including focus groups, phone interviews, in-person interviews, and internet surveys. In order to find trends and patterns in the target market by evaluating and analyzing it.

3.1.3 Sales force composite

This technique entails obtaining forecasts of future sales from a company's sales team. It is frequently utilized by businesses when the sales force has close contact with consumers and a thorough awareness of their requirements and purchasing habits.

⁹ MATOQ, (Eman): Eman ali, <<Arma model using Eviews>>, 05/01/2022.

3.1.4 Delphi method

This method involves obtaining opinions and estimates from a panel of experts through a series of iterative rounds. The estimations are offered by the panelists separately, without consideration of one another's thoughts. After each round, the results are summarized and provided to the panel members, who are then asked to revise their estimates based on the new information. This procedure is repeated until a decision is made or until there are no more modifications.

3.2 Quantitative methods

In the field of demand forecasting, there are two primary types of quantitative methods: time series methods and causal methods.

To find patterns and trends in historical data, time series approaches analyze a set of observations made throughout time at regular intervals. Businesses may forecast future demand by knowing these trends.

Causal methods, on the other hand, involve establishing cause-and-effect relationships between different variables that may impact demand.¹⁰

3.2.1 Time series methods

In order to assess historical demand trends, seasonality and estimate future demand, sales forecasting uses time series, which are a collection of observations made over a period of time. This technique involves analyzing historical sales data, identifying trends and patterns, and projecting those trends into the future in order to estimate future demand¹¹.

We can mention some common time series techniques that are used to calculate future demand:

3.2.1.1 Naive method

This strategy makes forecasts about future demand based on recent historical data, especially the demand seen in the most recent period. By analyzing the demand from the

¹⁰ CHOPRA, (S) et MEINDL, (P): *Supply Chain Management Strategy, Planning and Operation*, Op.cit, p.183.

¹¹ Hyndman (RJ), and ATHANASOPOULOS (G): *Forecasting: Principles and Practice*, 2018, OTexts, Chapter 1

immediate past, businesses can gain insight into current trends and make more accurate forecasts about future demand.

$$\hat{Y}_{t+1} = Y_t$$

where:

\hat{Y}_{t+1} is the forecast for the next period

Y_t is the actual value for the current period

3.2.1.2 Moving Average:

This technique calculates the average demand for a specific time period (such as a month or quarter) by taking the average of the demand values over a rolling window of that period. Moving averages are helpful for spotting patterns and minimizing demand swings.

$$\hat{Y}_{t+1} = (Y_t + Y_{t-1} + Y_{t-2} + \dots + Y_{t-n+1}) / n$$

where:

\hat{Y}_{t+1} is the forecast for the next period

Y_t is the actual value for the current period

n is the number of periods used in the moving average calculation

3.2.1.3 Exponential Smoothing:

This technique is similar to moving averages but gives more weight to recent demand values. In order to predict future demand, exponential smoothing models take a weighted average of prior demand values. For predicting demand over the short term, this strategy is especially helpful.

$$\hat{Y}_{t+1} = \alpha Y_t + (1-\alpha) \hat{Y}_t$$

where:

\hat{Y}_{t+1} is the forecast for the next period

Y_t is the actual value for the current period

\hat{Y}_t is the forecast for the current period

α is the smoothing parameter ($0 \leq \alpha \leq 1$)

There are different exponential smoothing in which we can make the difference between them by showing their dependence on trend, seasonality, or both at the same time. they can be representing in this table.¹²

Table 01: The types of exponential smoothing:

Seasonality Trend	DEPEND	DON'T DEPEND
DEPEND	Winter's smoothing method	Holt's smoothing
DON'T DEPEND	Winter's smoothing method	Simple exponential smoothing

Source : BENMAKHLOF (Adam) : Les prévisions de ventes comme outil de planification

De la production, Mémoire de Master, p 52.

3.2.2 Casual method

Causal forecasts help managers measure the relationship between dependent and independent variables. It enables managers to measure the possible impact to their business from the changes.¹³

4 Measuring Forecasting Performance

When we measure forecasts performance, we mean by that the accuracy of this one.

To determine how accurate a forecast is, the simplest method is to plot the forecast against the actual values as a direct comparison

There are a number of methods to determine accuracy of the forecast, often more than one is included in a set of series.

4.1 Mean absolute error (MAE)

The Mean Absolute Error (MAE) is a common method to measure the accuracy of a forecast. It represents the average absolute difference between the predicted values and the actual values.

The equation for MAE is:

¹³ <https://onlinelibrary.wiley.com/doi/10.1002/9781119199205.ch16> (publish on 02/01/2012, has been consulted on 15/03/2023).

$$\text{MAE} = (1/n) * \sum_{i=1 \text{ to } n} |Y_i - \hat{Y}_i|$$

Where:

n is the number of observations

Y_i is the actual value of the i-th observation

\hat{Y}_i is the predicted value of the i-th observation

4.2 Mean Absolute Percentage Error (MAPE)

The Mean Absolute Percentage Error (MAPE) is the percentage difference between actual and predicted values. It is a percentage and indicates the size of the forecasting mistake in relation to the actual data. The MAPE is calculated as follows:

$$\text{MAPE} = (1/n) * \sum (|(A-F)/A|) * 100\%$$

Where:

A = Actual value

F = Forecast value

n = number of observations

4.3 Root Mean Square Error (RMSE)

Another metric used to assess a forecasting technique's accuracy is the Root Mean Square Error (RMSE). It measures the average magnitude of the forecasting error. We calculated it as follow:

$$\text{RMSE} = \text{sqrt}[(1/n) * \sum (A-F)^2] \quad \text{Where:}$$

A = Actual value

F = Forecast value

n = number of observations

Another aspect of these forecast quality measures is to raise awareness among forecasters about the quality of their forecasts, in the hope of gradual improvement.¹⁴

¹⁴ CHOPRA, (S) et MEINDL, (P): *Supply Chain Management Strategy, Planning and Operation*, Op.cit, p.193.

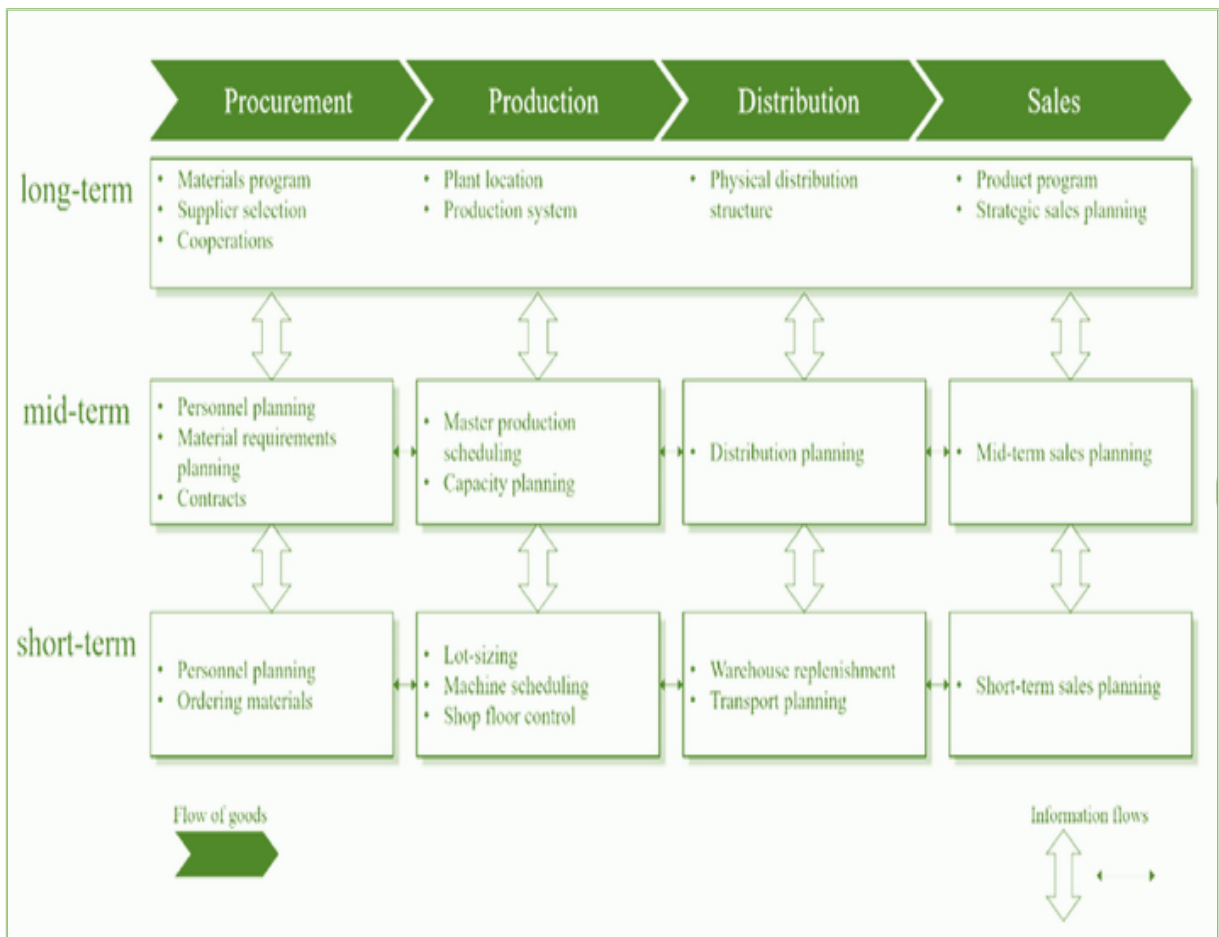
Section 02: the planification of production

Planning production is one of the most important processes in an industrial company, above we will see the theoretical side of it

1 Supply chain planning process

An operational process (or Business Process) is a set of activities that defines roles and relationships, and systematizes the organization and policies of a company in order to achieve certain objectives. The four primary business operations of a corporation are distribution, sales, production, and procurement. Stadtler and Kilger (2005) provide a process/decision-making level matrix to categorize these jobs.¹⁵

Figure 05: The supply chain planning process



Source: ReasearchGate.com / SCP-Matrix based shipyard APS design

¹⁵ MARIEM (T) : *Planification d'une chaine logistique : approche par satisfaction de contraintes dynamiques. Automatic Control Engineering*. Thèse de doctorat de l'INSA de Toulouse, 2014. France, p32.

- **Procurement process**

The supply process refers to the multiple steps taken in order to obtain the raw materials, components, and other resources required for the production of goods and services. To ensure that the inputs are provided on time and at a reasonable cost, this requires finding suppliers, negotiating contracts, and monitoring supplier relationships.¹⁶

- **Production process**

The production process covered the necessary actions to convert raw materials and components into finished goods. This includes planning, scheduling, and executing manufacturing processes, as well as monitoring and ensuring the quality of the finished products.¹⁷

- **Sales process**

The sales process is the series of steps taken to find, assess, and close deals with new clients. This includes generating leads, prospecting, customer needs analysis, proposal creation, and contract negotiations¹⁸

- **Distribution process**

The distribution process the steps taken to deliver finished items to consumers or retailers. To make sure that products reach customers in a timely and effective manner, the distribution process uses transportation, warehousing, managing inventory, and fulfilling orders.¹⁹

¹⁶ DOUGLAS (M), *Supply Chain Management: Processes, Partnerships, Performance, Supply Chain Management Review*, Vol. 1, No. 1, 1997.

¹⁷ KRAJESWKI Lee (J), *Operations Management: Processes and Supply Chains*, Pearson, 2018.

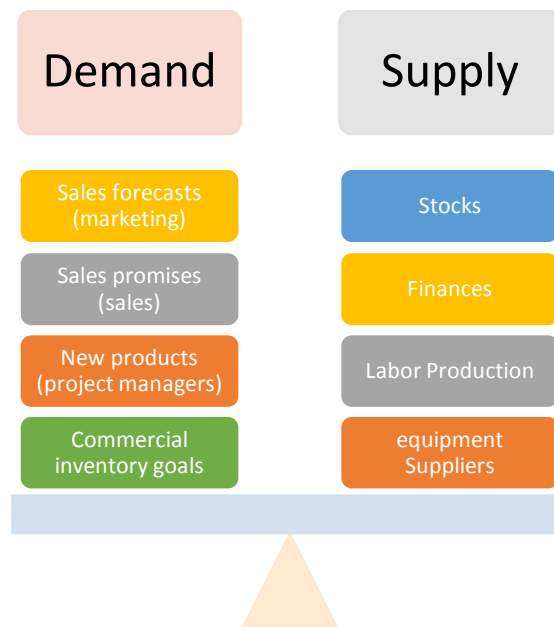
¹⁸ SOBCZAK (A): *The Art of Sales: The Top 10 Sales Processes for Closing Complex Deals, Sales & Marketing Management*, July-August 2019

¹⁹ RAFAIL (D), *Distribution Channels and Logistics Management*, Journal of Business Research, Vol. 69, No. 11, 2016.

2 Industrial Planning in the supply chain

Current economic laws require every business leader to anticipate their activities in order to optimize their investment, manufacturing, sales policies, etc. Thus, in every company, there is at least one planning process that materializes these predictions. Industrial planning is a process that involves developing and revising an interdependent set of plans (sales, production, procurement, cash flow, etc.) that must ensure the best possible balance between supply and demand at every point in the logistics chain at any given time.²⁰

Table 02: Production planning Balance between supply and demand



Source : Organisation et gestion de la production, By GEORGES (J)

2.1 levels of the production planning

The production planning knows 03 main level that are presented as following

2.1.1 Long-term Production Planning (Strategic plan)

Long-term production planning known as the greatest degree of production planning is the process of creating a detailed plan for the production of goods and services based on long-term demand estimates and company objectives. It often spans one to five years. The primary objective of long-term production planning is to establish a framework for production capacity

²⁰ GEORGES (J), *organisation et gestion de la production*, 4eme édition, Dunod-Paris, 2010, p 153.

that can support the company's long-term growth goals (Investment, capital equipment, production facilities, supplier relationship, market trends...).

In order to make sure that the company's production capabilities are in line with the overall business plan, it is imperative to reach this level. It allows businesses to forecast production volumes and capacity requirements, determine investment needs and opportunities, and identify potential constraints or bottlenecks that could impact production efficiency and profitability.

2.1.2 Medium-term production planning (Tactical plan)

The intermediate stage of production planning, known as medium-term production planning, often spans a period of three to eighteen months. Businesses transform the long-term production strategy into detailed manufacturing schedules, resource needs, and inventory levels at this stage. Medium-term production planning also involves identifying and managing risks, such as production delays, supply chain disruptions, or changes in customer demand.

This level is critical for ensuring that businesses can respond to changing market conditions and customer demands while maintaining production efficiency and profitability.

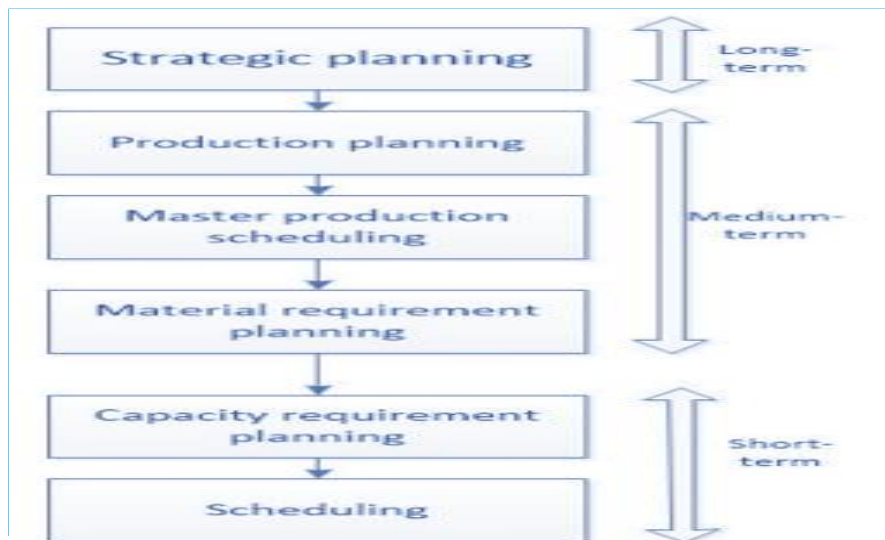
2.1.3 Short term production planning (Operational plan)

The lowest level of production planning, known as short-term production planning, often spans one day to one week. At this level, businesses schedule daily production activities, manage inventory levels, and respond to changes in demand or supply. This level of production planning's main purpose is to guarantee that daily production targets are reached while minimizing production downtime and maximizing resource use. This includes decisions about production scheduling, material handling, and quality control.

In order for firms to fulfill client orders and keep up high levels of customer satisfaction, effective short-term production planning is essential.²¹

²¹ ROBERT JACOBS (F), CHASE (R), *Manufacturing Planning and Control for Supply Chain Management*, 6th edition, p.377

Figure 06: levels of production planning



Source: Analysis and improvement of production planning production - Scientific Figure on ResearchGate.com

3 The organisation of the production plan

The organisation of production refers to the way in which companies' structure and manage its production, there are mainly 03 different approaches to organizing production

3.1 Push production

The traditional organization of production is based on forecasts of final demand. It is from the bill of materials and typical manufacturing lead times; one may calculate what needs to be put into production for each period and each component utilized by using these forecasts of the availability of completed goods²².

In this production approach, The MRP method holds a prominent place. It is implemented, in fact, in the vast majority of industrial companies.

3.1.1 Manufacturing resources planning (MRP)

The MRP (Material Requirement Planning) method was developed in the 1960s, and the original version (also known as MRP I) focused on planning the requirements for components.

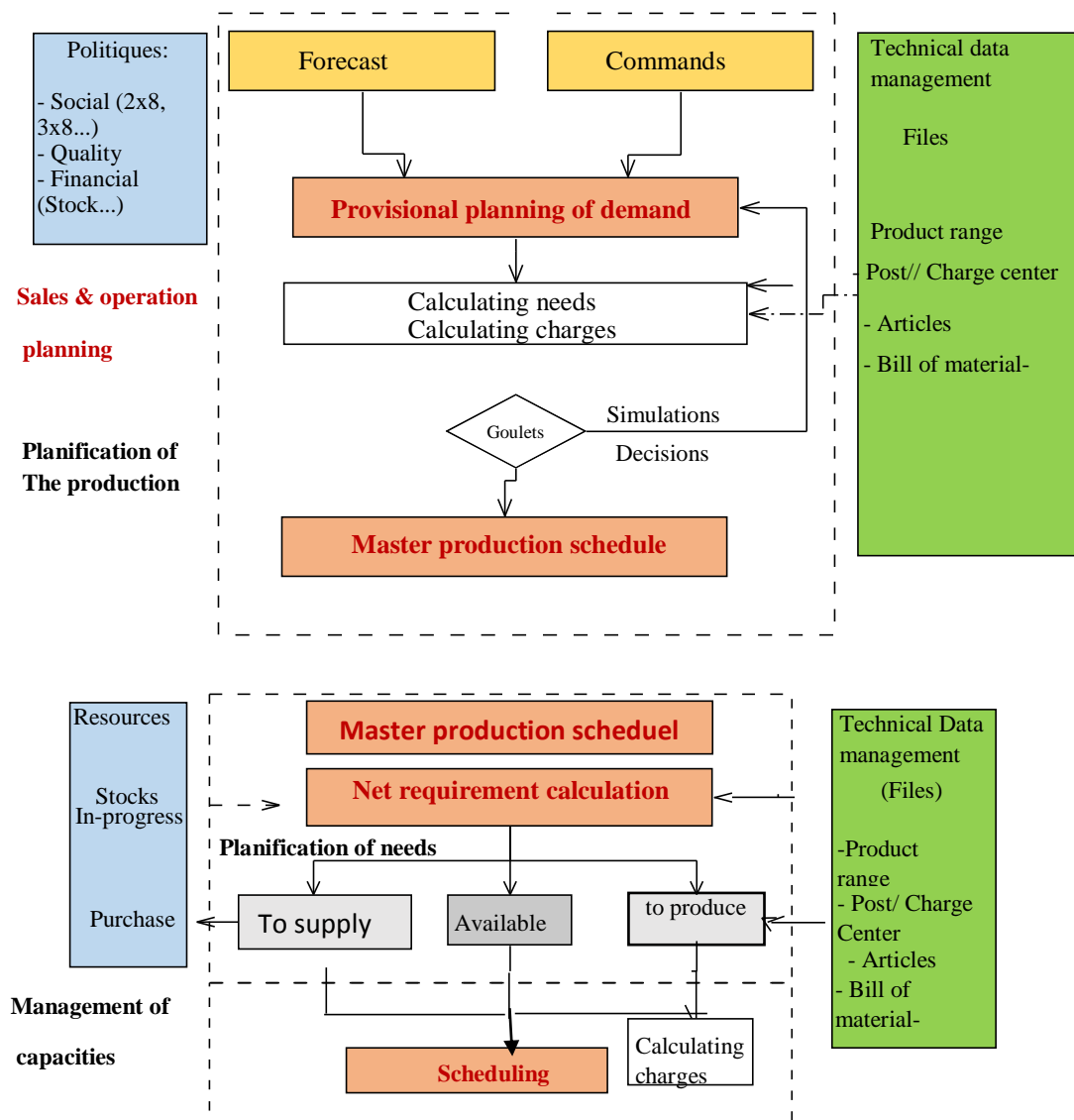
²² Mahadevan (B), *Operation Management: Theory and Practice*, 2009, Pearson Education India.

It distinguishes between independent needs (those that depend on external demand, typically finished products) and dependent needs (those that depend on internal demand, ex: component).

In the 1970s, the Manufacturing Resources Planning (MRP II) was introduced, which added capacity planning to material requirement planning. The objective was:

- to manufacture what was planned, within the specified timeframe (Forecasts)
- meeting delivery deadlines / reducing production costs.²³

Figure 07: MRP02 with the 04 level of planning



Source: Grenoble, school of management / Management of operations course

²³ GEORGES (J), *organisation et gestion de la production*, Op.cit, p.164.

3.1.1.1 Sales and operation planning (S&OP)

The Sales and operation planning (S&OP) is a key element in the management of production resources, located just below the company's strategic plan. It is created by frank discussion between the executive team of the firm and the commercial, production, and purchasing managers.

The S&OP seeks to offer a broad framework for business operations based on product families. This framework facilitates the distribution of important resources, including personnel, machine capacity, long-term supplies, and engineering office hours. The Sales and operation planning anticipates potential problems, such as an inadequate capacity to meet commercial demand. Early decision-making ensures the desired level of customer service at a global level.

At monthly meetings between senior management and operational directors, including commercial, industrial, and logistics managers, the S&OP is frequently evaluated. All parties involved must attend this meeting in order to evaluate how the business is doing.²⁴

The S&OP is a comprehensive agreement between the Production department and the Sales department. Its approach is based on the establishment of sales and production forecasts. The responsibility for sales forecasts lies with the Sales department, while the responsibility for production forecasts lies with the Production department. The reasoning results in defining the stock that is accessible at the conclusion of each period.

The stock objective is a compromise between a number of competing interests, including the Sales department's desire to maintain an adequate stock to ensure good customer service, the company's economic goal of minimizing financial immobilization, and finally, the production capabilities' requirement that it has to be done in order to smooth out workload.²⁵

3.1.1.2 Master production schedule (MPS)

The Master production schedule (MPS) is a crucial element in production resource management. It acts as a link between the sales and operation plan and the Material Requirement Planning (MRP). The MPS specifies the precise production schedules and numbers for each final good. It is crucial for both the commercial and production functions

²⁴ GEORGES (J), *organisation et gestion de la production*, Op.cit, p.153.

²⁵COURTOIS, (A), MARTIN-BONNEFOUS, (C) et PILLET (M) : *Gestion de production*, Op.cit, p.224.

since it acts as the production's reference program, assuring consumer pleasure while taking industrial limitations into account. In addition, the MPS is crucial in predicting commercial variances and assisting the management in preparing for them.

While the industrial and commercial plan is based on monthly periods, the MPS uses a schedule whose period is generally weekly (or even daily), this allows it to be in adequation with sales²⁶.

The schedule of each item managed by the MPS is represented as following:

Table 03: Master production schedule

Product: Table				Order policy (units)					
				Lead time (week(s))					
Quantity on Hand		1	2	3	4	5	6	7	8
Forecast									
Customer orders									
Projected on-hand inventory									
MPS quantity									
MPS order									

Source: Operation management Master production schedule, By SOLVER (H)

At the top of the table are values similar to those used in the calculation of requirements:

- Quantity on hand (IS)
- Order policy: lot size
- and lead time.

Two additional values complete this header.

First, safety stock (SS), which is intended to ensure good customer service despite the inaccuracy of commercial forecasts.

In second, the close zone which is naturally used to stabilize the MPS and avoid it from becoming too volatile.

²⁶ COURTOIS, (A), MARTIN-BONNEFOUS, (C) et PILLET (M) : *Gestion de production*, Op.cit, p.232.

In the other hand, the table lines refer to:

- Forecast orders are orders based on weekly sales forecasts minus firm orders.
- customer orders are irrevocable orders placed by customers (orders to be delivered in the indicated week).
- Project on-hand inventory: represents the state of the stock at a given week.
- MPS (Order): Number of lots to be launched at a given date.
- Available to sell reflects the company's ability to fulfill an order. A value is to be given in the first period (it has to be mentioned that all the inventory can be sold in the first period even the security stock), and then each time there is a new resource (an order in MPS quantity).

In order to implement the MPS, some conditions must be available

- The MPS must be realistic and achievable (production capacity, delivery times).
- The MPS requires near-perfect control of information (sales, stocks, etc.).
- The sum of the quantities of the different MPSs must correspond to the quantity to be produced at the level of the S&OP with a tolerance to be set in advance.
- The action zones (closed zone, flexible zone) are designed to provide a minimum of stability for managers.²⁷

3.1.1.3 Net requirement calculation

The MPS is considered as the starting point for the Net requirement calculation, it provides the supplies and manufacturing launches for all articles other than finished products, in the coming periods. It also verifies the coherence of delivery dates and need dates, especially if the needs change or are shifted over time²⁸.

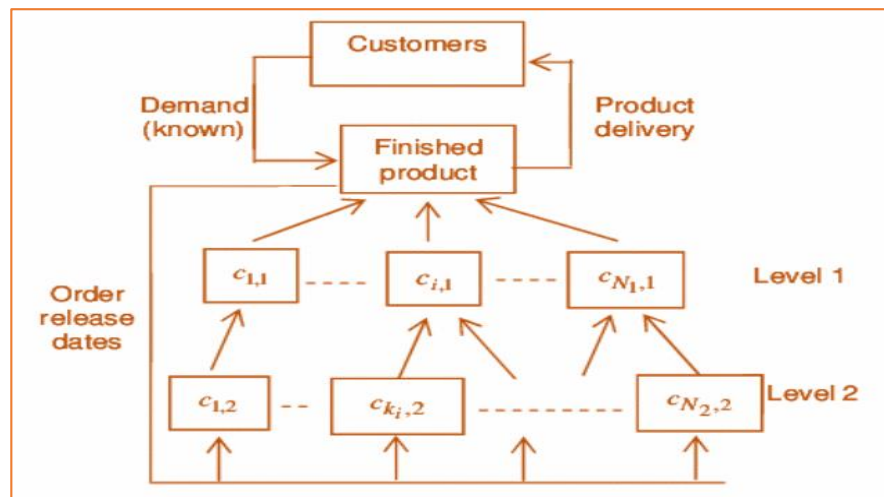
Some information must be present to calculate it:

- **The bill of materials:** is a hierarchical representation of the requirements for components and sub-components necessary for the manufacturing of a product. The specifications are also connected to the lead times for acquiring the various components.

²⁷ RENARD (JP), *Grenoble école de management*, Cours MRP, management des opérations, p.7.

²⁸ Ibid, p.9.

Figure 08: Bill of material of two-level assembly system



Source: Planned lead time optimization in material requirement planning environment for multilevel production systems – Scientific figure on Researchgate.com

- **The manufacturing process sheet:** (or the process plan) describes all the operations required to manufacture a product or component. It includes information on the equipment used and the duration of each operation.
- **All other information available in the MPS:** With these Data we can generate the needs for purchased components (PO), and manufactured components (MO). We schedule in time according to the lead time.

3.1.1.4 Scheduling

we precisely position the SOs and the MOs over time and make the necessary adjustments. Scheduling uses stock data and technical data (process plans, routings, etc.) to develop a detailed schedule. We can define 03 types out of these orders: Proposed order, launched order, Firm order.

The goal is to define the most beneficial scheduling in term of time.²⁹

3.2 Pull production

Pull production is a manufacturing approach that relies on customer demand to trigger the production of goods. Production stage is starting only when preceding steps are completed, and

²⁹ ACOBS (F.R) et alii: *Manufacturing Planning and Control for Supply Chain Management*, APICS/CPIM Certification Edition, McGraw-Hill, 2011, P.223.

materials are pulled through the production process as they are needed. This approach reduces waste and excess inventory.

3.3 Just in time production

A manufacturing concept known as just-in-time (JIT) production seeks to manufacture the appropriate number of goods at the appropriate moment with the least amount of waste. Because JIT production concentrates on creating only what is required, when it is required, and in the appropriate amount, it is closely connected to pull production. The goal is to cut waste, increase manufacturing efficiency, and keep inventory levels to a minimum.³⁰

4 Production typology

Every enterprise is unique with its propre organisation and its product specificity. However, there are several typologies of production that are commonly used in manufacturing and operations management that we can classify in the 03 following titles:

4.1 Classification based on series importance and repetitiveness

This classification is based on the importance and quantity of production, and the way the enterprise launches this product (weather with repetitiveness launches or with non repetitiveness launches). Theses launched quantities can be:

- Custom production
- Production in small batches
- Production in medium batches
- Mass production

³⁰ <https://www.manufacturing.net>. (Published on le 23/05/2019, has been consulted on 25/03/2023).

Table 04: classification based on quantities and repetitiveness

	Repetitiveness launches	Non repetitiveness launches
Custom production	Rocket engine Pumps for nuclear applications	Public works Molds for presses
Production in small and medium batches	Tools or Equipment Machine Tools	Subcontracting (mechanical, electronic)
Mass production	Household Appliances Automobiles	Newspapers Fashion items

Source : Gestion de la production, By Courtois (A) and MOURICE (P)

Each of these types of production requires a particular type of management, as well as an appropriate implementation of production resources³¹.

4.2 Classification based on production flow organization

The simplest classification of the methods of production can be:

- Continuous production
- Discontinuous production
- Project-based production

We have to mention that the mains methods of production are the continuous and discontinuous production, any other method is considered as an intermediate method³². Such as:

- Mass production
- Batch production
- Small batch production

³¹ COURTOIS, (A), MARTIN-BONNEFOUS, (C) et PILLET (M) : *Gestion de production*, Op.cit, p.18.

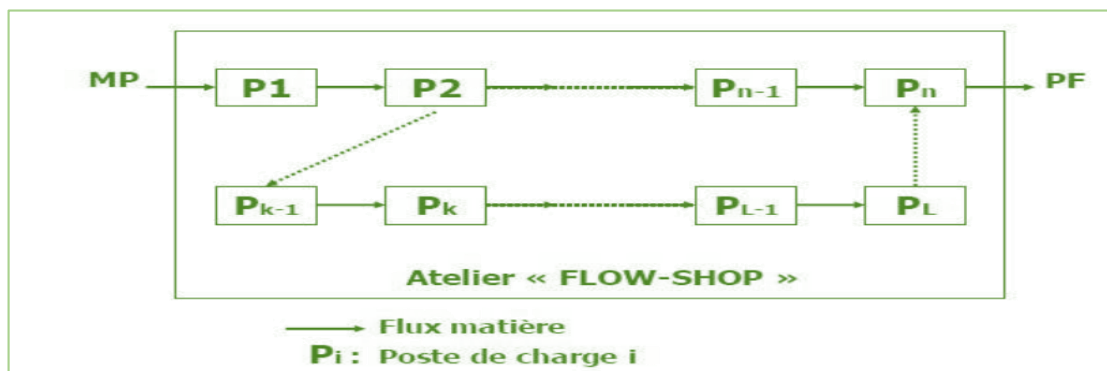
³² LAJMI (F) : *cours gestion de la production*, Institut des hautes études commerciales Carthage, p.53.

4.2.1 Continuous production (Flow-Shop)

Continuous production, also known as continuous process production or continuous flow production, is a type of manufacturing process that involves the continuous, uninterrupted production of a product. In this type of production, the production process is highly automated, and products are produced in large quantities with minimal interruptions or downtime.

This type of industry's manufacturing process is highly automated, minimizing the need for human interaction, lowering the chance of mistakes, and accelerating output. Additionally, continuous production allows for a high degree of control over the production process, ensuring that products are produced to high quality standards.³³

Figure 09: Flow shop method



Source : Institut des hautes études commerciales Carthage, Cours de gestion de la production

We can find this type of production where large quantities of products are produced on a continuous basis such as chemical, petrochemical and food industry.

4.2.2 Discontinuous production (Job-Shop)

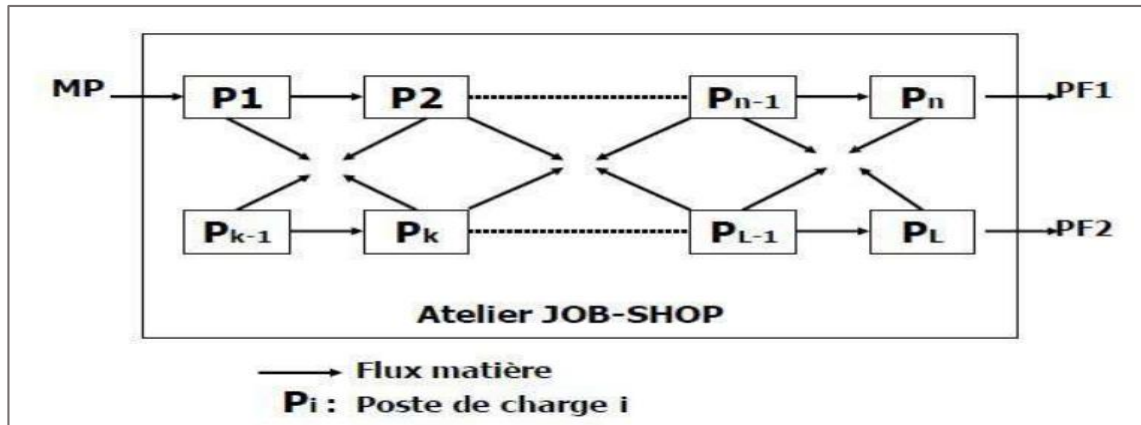
Discontinuous production, also known as batch production, is a manufacturing process where products are made in small quantities or batches. For each production run, a fresh batch is generated since the production process is not continuous.

The capacity to create a broad variety of product variants is one of batch production's key advantages. Manufacturers may readily alter the manufacturing process to make different

³³ HAZER (J), RENDER (B), *Operation management*, 11th edition, Person, 2013, p.259.

goods with varied specifications since the production process is not continuous. This enables them to react rapidly to changes in demand or client requirements.³⁴

Figure 10 : Job-Shop method



Source : Institut des hautes études commerciales Carthage, Cours de la gestion de la production

We can find this type of production where products require a high degree of customization or specialization, such as pharmaceuticals, biotechnology, and aerospace.

4.2.3 Project-based production

We can say about a process of production that is following a project-based production in the case when a project is being produced, or singular product is created, and the manufacturing process is not replicated. The objective of project production is to complete all essential procedures with the least amount of downtime in order to deliver the product on schedule or by the deadline. This type of production cannot be formally stabilized, so the organization must be able to handle significant external disruptions and allow for modifications. Some businesses make identical goods that are modified and made specifically for each order, such rockets or specialized pumps. These businesses frequently employ project production.³⁵

4.3 Classification based on customer relationship

In the classification of production based on the relation between companies and their clients, we can distinguish between 04 principal types:

³⁴ HAZER (J), RENDER (B), *Operation management*, tenth edition, Person, 2011, p.263.

³⁵ COURTOIS, (A), MARTIN-BONNEFOUS, (C) et PILLET (M) : *Gestion de production*, Op.cit, p.21.

4.3.1 Make-to-stock production (MTS)

Make-to-stock is a type of production where involves producing goods in big numbers and keeping them on hand until orders from customers come in. The manufacturing process is incredibly repetitious, and mass production of standardized goods is used. Make-to-stock manufacturing is frequently employed for low-value or commodity goods with steady and predictable demand.

4.3.2 Make-to-order production (MTO)

Make-to-order production is a type of production where products are manufactured based on specific customer orders. The goods are customized to each customer's specific requirements, and the production process is extremely flexible and adaptive. Personalization is a key component in make-to-order production, which is typically utilized for high-value or important items.³⁶

4.3.3 Assemble-to-order production (ATO)

Assemble-to-order production is a type of production where products are manufactured from pre-existing components or modules based on specific customer orders. Pre-existing modules or components are joined in a variety of ways to generate customized goods in a production process that is both flexible and repetitive. Typically, somewhat complicated products with considerable customization needs are produced using assemble-to-order methods.

4.3.4 Engineer-to-order production (ETO)

A sort of production known as "engineer-to-order" involves creating items that are specifically engineered to meet the needs of the customer. Customized products are designed and made from scratch in a highly sophisticated, non-repetitive manufacturing process. Typically, high-value, one-of-a-kind goods with distinctive customer needs are produced using the engineer-to-order method.³⁷

³⁶ <https://www.investopedia.com>. (Published on 08/11/2020, has been consulted on 28/03/2023).

³⁷ <https://www.erp-information.com>. (Last updated on 31/03/2023, has been consulted on 02/04/2023).

Section 03: The relation between sales forecast and the production planning

This section will discuss in one hand, the importance of sales forecast on the performance of the production planning. On the other hand, the presentation of the box-Jenkins forecasting technique and its different steps.

1 Importance of sales forecasts on the performance of the production plan

Considered as the initial step for establishing the production planning process, sales forecasts are crucially important not only for the good industrial planification but also by assuring the continuity of the enterprise activity. Indeed, it is based on the previsions of the expected demand over a specific period that the production plan can determine the optimal quantity of products to produce, the production schedule, and the resources required to meet customer demand.

With this, it is clearly obvious that an accurate forecast is a synonym of an accurate production plan. The more our previsions are precise the more our production plan is performant³⁸.

From this prospective, we can present the impact that sales forecast can have on the production plan and its consequences on the company itself.

Table 05: sales forecasting impact on the production plan and the company

Sales forecasts	Production plan	Consequences
<p>The previsions are significantly below the real demand</p>	<ul style="list-style-type: none"> - Low quantity of product despite the demand - High-cost investment with an Inactivity in the production process (labors, manufactories...) - inventory problem and production in global (out of stock, lost of control in the raw material, finished product....) 	<ul style="list-style-type: none"> - Sales lost - Negative impact of the brand image - Lost of a part of the market

³⁸ STEVENSON (W), *Operation management*, 13th edition, 2019, McGraw-Hill Education, p.559.

<p>The previsions are accurate (near the real demand)</p>	<ul style="list-style-type: none"> - An optimise production plan - Minimise cost (inventory, lead time....) - Maximise the performance (production, benefits, delivery....) 	<ul style="list-style-type: none"> - Meeting the demand market - Client satisfaction - Realisation of benefits
<p>The previsions are significantly above the real demand</p>	<ul style="list-style-type: none"> - Overproduction - High cost of over-stock (electricity, place....) - High expenses 	<ul style="list-style-type: none"> - High expenses - Can create problems both inside and outside the company -

Source: Established by us

From this table, we can tell that:

- there is an important relation relating these two variables.
- The sales forecasts are the starting point for planning production.
- They play a major role in the enterprise's performance.
- We can't have a 100% accuracy when predicting future, however it is possible to estimate with the appropriate methods the quantity that will be sold in a defined time.

2 Sales forecasts by the Box-Jenkins method

As we have seen before, we can't predict the exact quantity that we are going to sold in the market. However, there are some techniques which can be use to estimate with accuracy those amount of production. One of these methods is the Box and Jenkins method.

The Box-Jenkins method, developed in 1976, is a scientific approach to modeling time series data. It involves using a law of reproduction to extrapolate future trends based on information contained within the time series itself, without relying on external factors. This technique is

called endogenous forecasting. To use the Box-Jenkins method, there are several steps that must be followed, including:

- identifying the appropriate model.
- estimating it (usually OLS).
- diagnosing any issues.
- using the model to make predictions about future trends.
- Identification:

This process involves identifying a rough idea of the model structure, specifically the order of the model (q, d, p) for ARIMA. In this step, a graphical representation is used to assess the original time series' stability. If the series is not stationary, the general trend is either increasing or decreasing, and the first difference, or first and second differences, are taken to stabilize the series, represented by the symbol d., The autocorrelation function (ACF) and partial autocorrelation function (PACF) can be used to determine if the time series is stationary or non-stationary, its value does not approach zero after the second or third lag, and this is referred to as simple correlation between adjacent dependent variables in the previous lags, replacing the ACF. The PACF, on the other hand, assumes the stability of the other lags and depicts the relationship between successive values of a stationary time series over several lags.. The series is considered stable when the PACF values decrease continuously with increasing lag. After ensuring that the series is stationary and determining the value of d, the order of the autoregressive component, p, is determined such that the estimated model residuals are free of autoregression and moving average components. The order of the ARIMA model is often determined using a combination of ACF and PACF, with a different combination being used for each ARIMA model.

- **Estimation**

In order to estimate the model, the estimation technique must first be used to determine the starting values for q, d, and p. Because the error limit in moving averages is inconsistent, the maximum likelihood technique is typically employed to estimate the function coefficients. However, if $q=0$, the ordinary least squares method (OLS) can be used to estimate the (p, d, q) model coefficients.

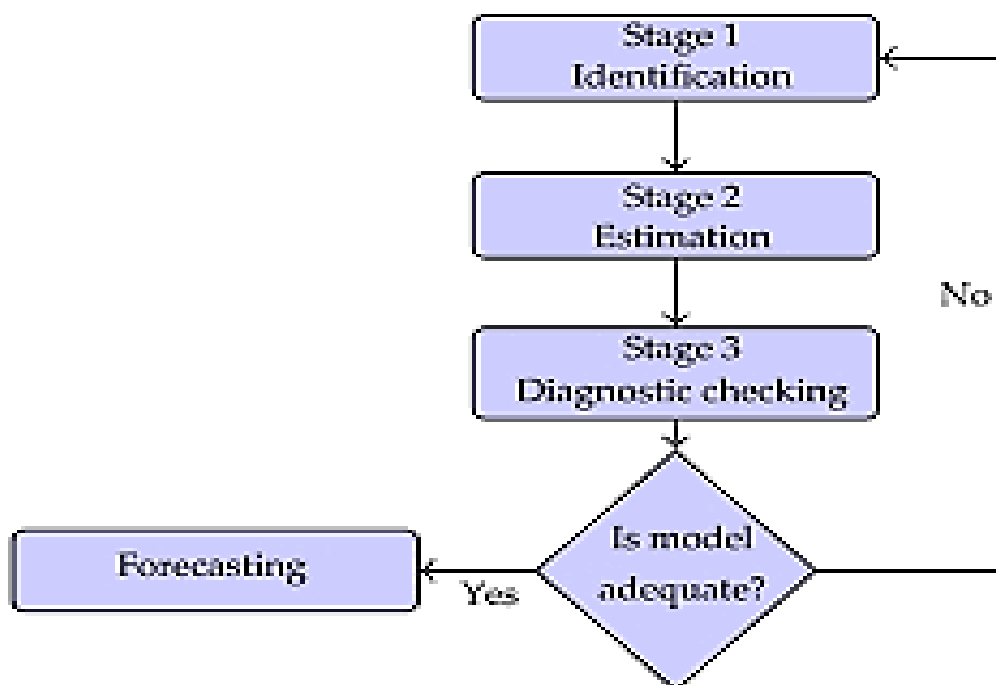
- **Diagnostic**

This phase involves looking at the model to make sure that it can fit the autocorrelation and moving average composition. Instead of using the original series, it is accomplished by looking at the partial autocorrelation and partial moving average composition of the model's residuals. If all of the autocorrelation measures for a number of lag gaps are within the 79% confidence interval, then the autocorrelation between the residuals is not statistically significant. The model can be considered suitable for estimate and prediction in this situation. If not, an alternative model has to be looked for and estimated.

- **Forecasting**

After determining the appropriate order of the model, q , d , p , based on previous tests, the model is then used for prediction by inputting positive and negative values for the dependent variable and the residuals, as estimated values. The minimum function error is then calculated to obtain the predicted future value, y_{t+1} , which is known as forecasting for one future period.³⁹

Figure 11: Flowchart-of-determining-ARIMA-model-parameters



Source: HASSEB (K.M), and Nadia (M): Time Series Analysis of KSE-100 Using Box- Jenkin's Methodology

³⁹ KHANCHOUHE, (Sabrina) : شهادة : حالة مؤسسة توزيع مواد البناء، شهادة :
 ماجستير، جامعة أم البواقي، 2015، ص 26

Chapter conclusion

To summarize the chapter, we believe that production planning involves aligning an activity's demand and resources to maximize operational profitability and minimize risk. Critical resources, which are the most expensive and have lengthy adaptation periods, are the main emphasis. The time horizon for this planning process varies, depending on the need to anticipate decisions regarding critical resource capacities.

Demand forecasting is estimating how industrial and logistical activities, such as production, procurement, transit, or storage, will be able to meet future demand. To begin this forecasting activity, several data must be identified, including the article or article family, consumption unit, time unit, and forecasting horizon. These projections may be made using a variety of techniques, including quantitative methods based on mathematical models and qualitative techniques based on judgment.

We strongly proved that there is a relation between the sales forecasts and the production plan in a complementary way, both must be executed in a precise path in order to achieve the companies' goals and objectives.

**Chapter 02: The production planning process at The
High Plateaux Grains Branch**

Chapter introduction

Previously, we discussed the theoretical aspects of both Production Plan, and Sales Forecast including their objectives, principles, and stages. In this chapter, we will discuss how those variables are applied and analyze what is actually done within the company.

During our internship, we worked at The High Plateau Grains Branch, which is one of the subsidiaries of AGRODIV group and a leader in the Agri-food industry. We specifically worked in the Operations Department, which houses the production process planning service, allowing us to conduct our study on the process.

This chapter focuses on the production planning process at The High Plateau Grains Branch and it is divided into two sections. The first section presents the host organization, its activities, industrial and commercial complexes, and how it is organized. The second section discusses the various activities carried out as part of the production planning process following a model used by one of the company's complexes.

Section 01: Presentation of the host organisation

In this section, the main objective is to present the High Plateaus Grains Branch and it can be done as followed.

1 AGRO-DIV group

The AGRO-INDUSTRIE group, abbreviated as AGRODIV, is a public shareholding company that was created through the restructuring of the public commercial sector in February 2015. It was formed through the merger and absorption of three state-owned companies: CEGRO, COJUB, and TRAGRAL. The AGRODIV group has over 60 years of experience, having inherited the structure of SN SEMPAC created in 1965. It has a share capital of 10,260 MDA.

AGRODIV's main objective is evolving in the Agri-food industry sector, including the production, design, marketing, import, and export of products resulting from the transformation of raw materials from agriculture, livestock, or fishing.

The group's objectives are:

- to strengthen its position as a leader in the first and second transformation of cereals.
- to position itself as a quality leader in the domestic market.
- to achieve 35% market share in this sector by 2023.
- to differentiate itself in other sectors such as the transformation of fruits and vegetables.
- to establish connectivity with the agricultural upstream sector.

The group also aims to create regional transformation hubs by targeting high-value markets, to improve the Agro-logistics segment, to promote import substitution, to carry out research and development (R&D) activities for continuous improvement, and to ensure food security and financial stability for the Algerian Agri-food industry sector⁴⁰.

The group's activities include:

- the first and second transformation of cereals and derivatives
- the production of juices, beverages, and preserves from the transformation and packaging of fruits and vegetables.

⁴⁰ Document of the company : Fiche technique d'identification de l'entreprise.

- date cultivation and processing, packaging of coffee, sugar, pulses, and rice, as well as the storage, packaging, and marketing of various food products.

2 The High Plateaus Grains Branch

2.1 Presentation

The High Plateaus Grains Branch is one of the branches of the AGRIDEV Group, an extension of the former Riyad Sétif and Sampack Company. As part of the restructuring of the public sector and in implementation of State Shareholding Council⁴¹, the Upper Plateau Grains Branch was founded by the AGRIDEV Group during the extraordinary general assembly⁴². The operation entered into force on January 1, 2016, by including five (05) industrial and commercial vehicles, namely:

- The Upper Plateau Grains Mills industrial and commercial complex - Setif (including the Oubeid Ali unit).
- The Biban Grains Mills industrial and commercial complex - Bordj Bou Arreridj.
- The Sidi Aïch Soummam Grains Mills industrial and commercial complex (including the lathe unit).
- The Sidi Issa Grains Mills industrial and commercial complex.
- The Ain Bsas Grains Mills industrial and commercial complex⁴³.

2.2 History of The Upper Plateaus Grains Branch

The branch has Known multiple events that can be resumed in the text below:

1962: To continue and maintain the units that were under the direction of the French government after Algeria regained its independence, the Algerian government was forced to create a management body known as the Management Committees.

1964: the state established the National Semolina Company, known as “**Sempac**”, which was responsible for managing everything related to grain processing and development of the units.

⁴¹ Regulation No. 04/146 dated November 5, 2015

⁴² Extra-ordinary assembly held on June 7, 2016

⁴³ Document of the company : *Fiche technique d'identification de la filiale Céréales des hauts plateaux / Spa*, p.1.

1982: following the restructuring of “**Sempac**”, the National Institution for Food Industries from Grains and its Derivatives (**RIAD**) was created. There were five regional institutions within it, namely: (RIAD - Setif, has headquarters in the Bizar district, RIAD – Algiers, RIAD - Sidi Bel Abbes, Constantine RIAD, Tiaret RIAD).

02/04/1990: after entering the stage of independence, the institution transformed into an independent entity and began handling its financial affairs and supervising its branches in numerous provinces.

07/10/1997: It was created as an entity with a 265,000,000.00 DZA capital by a notarial deed.

February, 2015: “**AGRO-DIV**” group was created through the restructuring of the public commercial sector.

June 7, 2016: during the extraordinary general assembly, the Upper Plateaus Grains Branch was founded by the AGRIDEV Group⁴⁴.

2.3 Workforce

As for the workforce, the branch employs 1,122 workers, including 540 permanent positions and 582 temporary positions, divided according to the following professional and social categories:

- Executives: 234 executives
- Control staff: 353 workers
- Execution staff: 535 workers

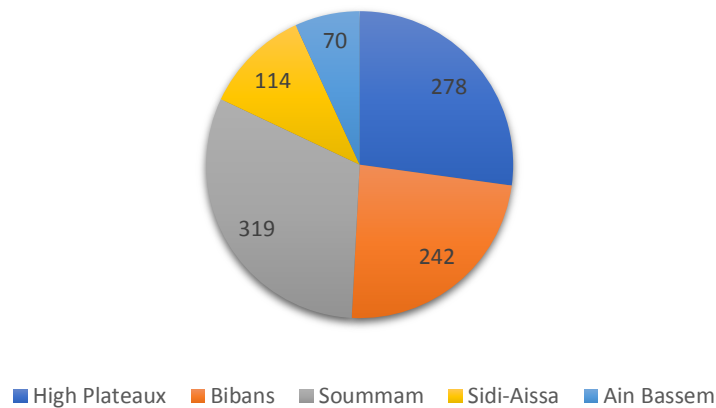
On 31/12/2021, the workforce of the subsidiary is distributed as follows:

- ICC des Hauts-Plateaux-Setif : 278 employees
- ICC of Bibans: 242 employees
- ICC of Soummam: 319 employees
- ICC of Sidi-Aissa: 114 employees
- ICC of Ain Bessem: 70 employees⁴⁵

⁴⁴ Document of the company: تعريف فرع حبوب الهضاب العليا

⁴⁵ بطاقة فنية عن فرع حبوب الهضاب العليا :

Figure 12: The distribution of the workforce



Source: established based on the company information

In line with developments in the food industries, all workers have benefited from long and short-term training courses in various specialties, including management, accounting, finance, exploitation, milling, marketing, trade, maintenance, and IT, among others, which aim to improve worker performance and thus enhance product performance.

2.4 Activities

The High Plateau Grains Branch specializes in the transformation of grains of both types (hard wheat and soft wheat), and the production and marketing of semolina, flour, pasta, and milling by-products. Has two main activities, which are: Production and commercialisation.

2.4.1 Production

This branch has made the production of a large range of agro-industrial product its main activity. Based on a precise planification and some specific criteria we can define those products as following:

Figure 13: Type of products in the branch



Source: Elaborated based on the company information

In terms of production, the company experienced an upward trend in 2022.

The company has registered a total of 2,150,177 quintals of semolina, a total of 1,970,253 quintals of flour and 6,412 quintals of food pasta, in addition of 4,250,144 quintals of milling waste.

2.4.2 Commercialisation

The High Plateaus Grains Branch commercialises its products to a variety of costumers. whether B to B (Bakery, Pastry shops, Farmers) directly from their ICC, or B to C (the consumers) in their own sales points reaching a total of 73 points located in 05 different cities in order to meet the market demand and satisfy the costumers needs.

In order to enhance its reputation and broaden its distribution network, the company created new designs and opened new sales points throughout its activity areas in the states of Setif, Bejaia, Bouira, Msila, and Boumerdes, as well as other neighboring states, reaching a total of 73 sales points by the end of 2022, an increase of 11 points compared to 2021, and expected to reach 80 sales points by the end of 2023. The firm placed a high value on this element by ensuring that vendors performance was improved and by offering high-quality items and reasonable rates. The Upper Plateau Cereal Branch also placed a high priority on constructing fresh, contemporary "super-market" outlets, broadening its range of endeavors to include more food items including oil, beans, dairy goods, and others. To increase the production rate of its affiliated vehicles and increase its market share, which is estimated at 30% and expected to reach 35%, the Upper Plateau Cereal Branch adopted an operational policy that included the modernization and renovation of its mills and the training of its staff, among other things⁴⁶.

2.5 Sales statistics

Despite competition in the marketing of these products, the Upper Plateaus Cereal Branch was able to increase sales to bakers, wholesalers, cooperatives, livestock breeders, feed units, and its affiliated sales points through its industrial and commercial vehicles. As a result, the business figure for 2022 was estimated at 3,746,098 Algerian dinars, an increase compared to 2021, distributed as follows:

- Semolina: 1,271,288 Algerian dinars
- Flour: 1,302,531 Algerian dinars
- Milling waste: 1,212,357 Algerian dinars

In numbers, the company was able to achieve a total evolution of 4% in their sales activity in 2022, an increase comparing at 2021, reflecting the strategic orientations of the AGRO-DIV Group and meeting the needs of the targeted consumers and audience, estimated at 5 million people.

⁴⁶ Document of the company : تعريف فرع حبوب الهضاب العليا

Table 06 : 2021-2022 sales

Designation	Reminder for Fiscal Year 2021	Previsions	Realisations	TRO	Evol.
		Exercise 2022			
Total Semolina	1,227,134	1,170,944	1,271,288	109%	4%
Total Flour	1,245,065	1,275,327	1,302,531	102%	5%
From milling	1,081,688	1,058,904	1,121,357	106%	4%
Pasta	29,302	37,585	40,889	109%	40%
Couscous	5,198	2,628	6,637	253%	28%
Dry vegetables	2,223	1080	2,126	197%	-4%
Others	1,523	1,200	1,270	106%	-17%
	3,592,132	3,547,668	3,746,098	106%	4%

Source : Document of the enterprise : Ventes et Révision 2021-2022

As we can see throughout this table, the Upper Plateaus Grains Branch has made a slight progress in the majority of their products. Indeed, the most evolutionist articles are both Pasta and couscous with 40% and 20% more than the 2021 sales. In the other hand, Both Dry vegetables and the rest of articles presented a slight decrease on their sales with 4% to 17% less than the 2021 serie.

However, the 03 main articles of this enterprise are obviously Semolina, Flour and from milling because of their high sales quantities and their high demand in the market by all type of Algerian consumers. It is completely logical that the high plateau company focuses mostly in these kind of products despite the other ones, which can explain the variety and the investment destined for them.

That also can be explain by the government low⁴⁷ in which its precises that the Algerian market is saturated in term of number of Privat Semolina mill and Privat flour mill with defining the Max quantity of production no authorised to cross and fixing the price of semolina and flour.

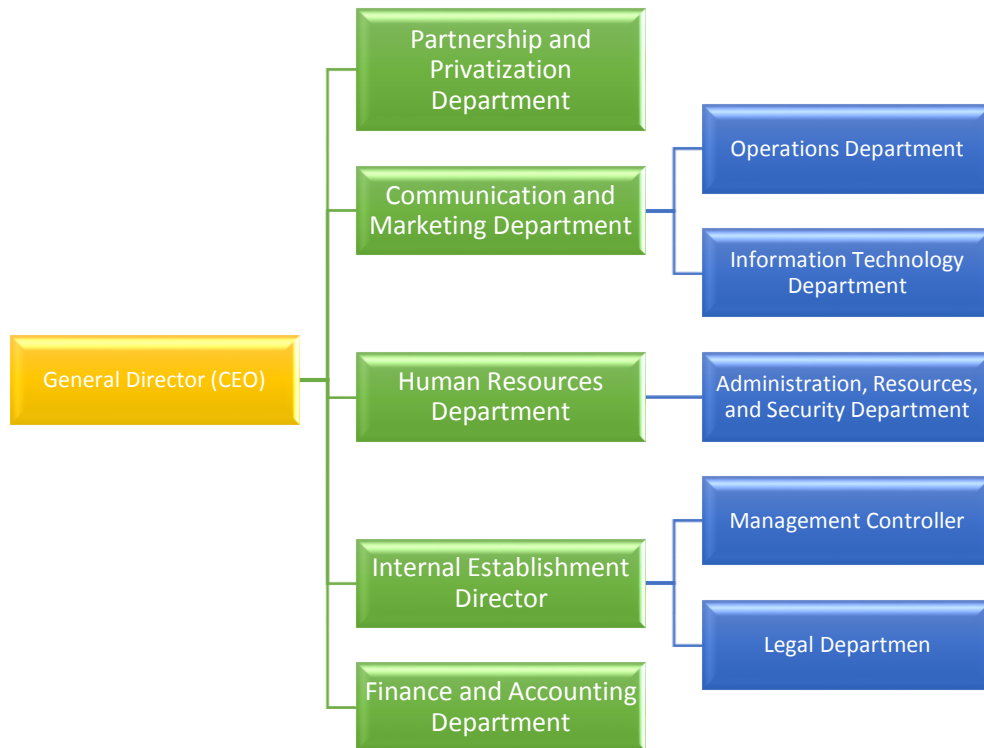
⁴⁷ Executive Decree No. 20-241 dated August 31, 2020

3 Organization of the branch

Here we will present both the branch organization and their Industrial and commercial complexes

3.1 Organizational chart

Figure 14: High Plateaux Grains Branch organization



Source : Established based on document of the entreprise : Organigramme Filiale

- **General Director or Chief Executive Officer (CEO)**

He is the General Supervisor for all business operations and the representative of the Foundation at all conferences and meetings. His job is to Ensure the implementation of the regulations of public associations and the Board of Directors, Presentation of action plans to official bodies and to Follow-up activity and functioning at the unit level.

- **Partnership and Privatization Department**

This department is responsible for managing partnerships with other companies and government entities, as well as overseeing privatization initiatives.

- **Communication and Marketing Department**

This department is responsible of Displaying a communication and marketing plan, Implementing the annual internal and external communication scheme approved by the General Directorate and Makes suggestions in all matters related to marketing and communication.

- **Information Technology Department**

The responsibility of this department is focused on Implementing the Foundation's annual programme in the field of automated media, submits proposals in its area of competence and monitors automated information procurement.

- **Administration, Resources, and Security Department**

This department is responsible for managing the company's administrative functions, such as finance, human resources, and facilities management, as well as ensuring the safety and security of the company's assets.

- **Internal Establishment Director**

This person is responsible for managing the day-to-day operations of a specific establishment or branch of the company.

- **Management Controller**

It is the responsible direction of managing the organisation by monitoring the conformity of operations with applicable laws, preparing quarterly reports on operations and periodically monitors transactions and financial transactions.

- **Legal Department**

This department is responsible for ensuring the implementation of decisions issued in favour and/or against the institution, following up on legal provisions relating to the institution and Provides advice and solutions in legal cases.

- **Human Resources Department**

This department is responsible for managing the company's workforce, including recruitment, training, compensation, and employee relations.

- **Operations Department**

It works to ensure the financing of mills with wheat, Supervises the supply of primary materials to mills, follows up on agreements concluded with customers in the field of supply (OAIC) and finally it creates the annual catering and selling programs.

- **Finance and Accounting Department**

The main objective for this one is to monitor the financial operations of the foundation, adjusts the financial budget of the complex and mills and concluding it with the preparation of annual financial report.⁴⁸

3.2 Industrial and commercial complex of the branch

The high Plateau Cereals Branch has a total of 05 operational Industrial and commercial complex⁴⁹.

Tables 07: Characteristics of the ICC of the Branch

ICC	Unit of Production	Area	Capacity pf Production	Inventory Cpacity
ICC The Mills of High Plateau “Setif”	- Semolina mill of Lahmar Chérif	26 079 m2.	4000	Drum wheat 39000
	- Flour mill of Zaim Cherif	3 443 m2	2000	
	- Minoterie Abid Ali	8 513 m2	800	
	- Pasta factory	XX	240	

⁴⁸ Document of the company: البطاقة + شرح الهيكل التنظيمي للمؤسسة

⁴⁹ Document of the company: Fiche technique d'identification de la filiale Céréales des Hauts Plateaux

ICC The Mills of Bibans "Bourdj Bou Arrerige"	- Semolina mill of Bibans	120 000 m2	4000	-Durum wheat : 625.000
	- Flour mill of Bibans		2000	-Soft wheat : 625.000 à louée à l'OAIC
ICC The Mills of Soummam "Sidi-Aich"	- Semolina mill of Sidi Aich	120 000 m2	4400	-Durum wheat: 70 500
	- Semolina mill of Kherrata		1000	-Soft wheat: 62 500
	- Flour mill of Sidi Aich			
	-Flour mill of Sidi Aich			partly rented to OAIC
ICC The mills of Sidi Aissa "Msilla"	- Semolina mill of SIDI AISSA	52 702 m2	1000	Wheat: 500.000 partly rented to OAIC
	- Flour mill of SIDI AISSA		1000	
ICC The Mills of Ain Bassem "Bouira"	- Flour mill of Ain Bessem	43 872 m2	3000	Wheat: 500.000 partly rented to OAIC
ICC The Mills of Bouira	- Flour mill of Bouira	27 050 m2	2000	Soft wheat: 90.000 partly rented to OAIC

Source : Documents of the Enterprise : Fiche technique d'identification de l'entreprise

The High Plateau Grains Branch has a significant production and milling capacities with a total of:

- 14,400 tons per day of hard wheat
- 9,800 tons per day of soft wheat
- 200 tons per day of food pastes

This Branch also has a huge storage capacity up to 2,174,000 quintals of wheat of both types.

4 SWOT Analyse

4.1 Definition of the diagnostic tool

A SWOT matrix is a framework for analyzing the company strengths and weaknesses as well as the opportunities and threats that can face it. This helps on focusing on the strength's points, minimizing the weaknesses, and take the greatest possible advantage of opportunities available by comparing between both Opportunities and Threats.

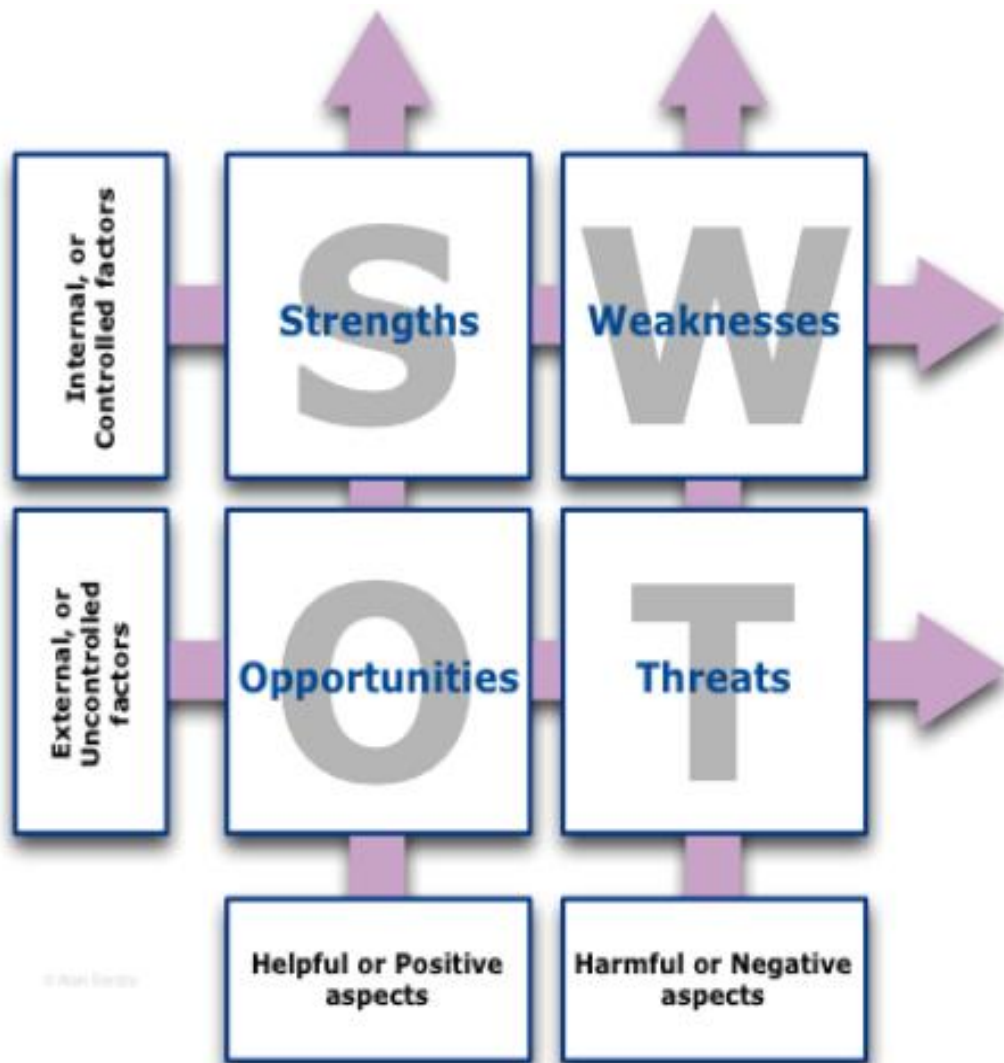
It can be used to devise a successful strategy for the future, working and uncover area of business that hold back the company and underlining what we do well and how we can improve those points⁵⁰.

SWOT analyze both internal and external environment of the company

- Internal environment: representing by the strength points and weaknesses, they can be control by the company in order to develop the Business.
- External environment: representing by both opportunities and threats, they cannot be controlled by the company because this environment is in a constant change.

⁵⁰ SARSBY, (A): *A Useful Guide to SWOT Analysis*, Sterling house, Nottingham, November 2012, p.10.

Figure 15: theoretical SWOT Analysis

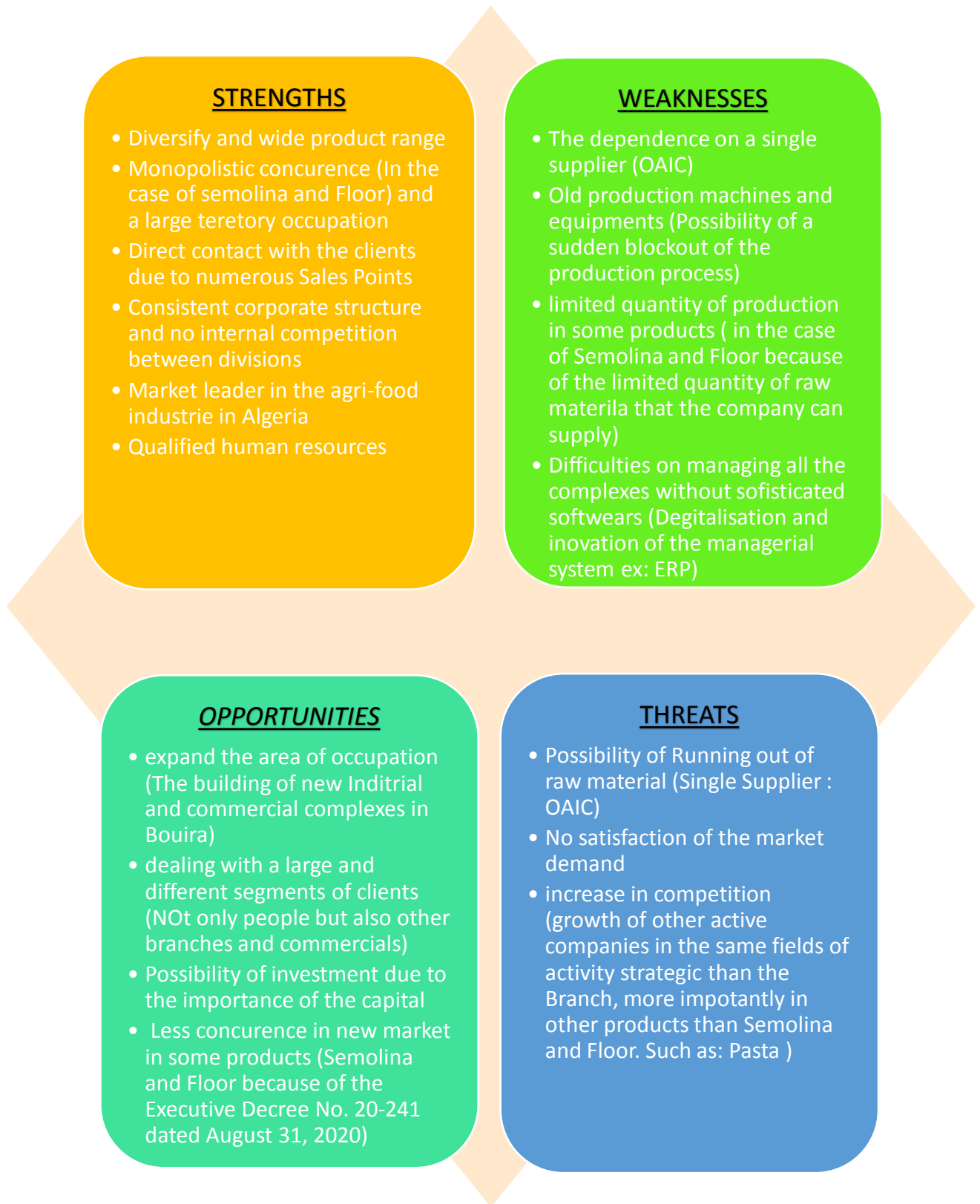


Source: A Useful Guide to SWOT Analyses by SARSBY, (A), p9

4.2 SWOT analyses of the branch

From the previous presentation of the Upper Plateaux Cereals Branch, in addition of our internship within this company. We have established a SWOT analyse which will help us to define the Strengths, weaknesses points, Opportunities and threats facing this enterprise in both internal and external environment. This approach will facilize and clarify the objective of this section.

Figure 16: SWOT Analyse of the Branch



Section 02: Analysis of the Production Planning Process at AGRO-DIV of the High Plateaus

We conducted a qualitative survey using the appropriate tool that we will present in this section. It will allow us to clarify how the production planning process works inside the High Plateaus Grains Branch, the technique used for making forecasts and the different steps for realizing the overall.

1 Presentation of the Research tool

Qualitative survey is an interview which allowed a conversation that permits information exchange; it is a one-way game of questions and answers involving a pair of individuals that enables you to get private and sensitive information about a certain subject.⁵¹

2 Types of Interviews

There 03 main types of interviews:

2.1 Non-directive interview

A qualitative research technique centered on conducting one-on-one or group interviews with the respondents while maintaining the least amount of active participation on behalf of the instructor.

2.2 Semi-directive interview

It is comparable to the non-directive interview but offers less freedom. In this style, the interviewer asks fewer questions and provides the person being interviewed more freedom, but they still want justifications, arguments to support, and examples.

2.3 Directive interview

It is a data gathering technique that straddles the qualitative and quantitative research range. During the interview, the person conducting the study leads the subjects and offers questions

⁵¹ OUACHRINE, (Hassane) et CHABANI (Smain) : *Guide de Méthodologie de la Recherche en Sciences Sociales*, 1ère édition, 2013, Alger, p.72.

that have brief or closed-ended answers. A questionnaire is a common format for these inquiries.⁵²

3 The research objective

This research has been established within the Branch Direction in Setif more precisely in the commercial department, and inside one of the Industrial and commercial complexes which is The Mills of High plateau -Setif- in the operation department. Our Interview was with the directors of both the two departments in order to have a brief descriptive about the forecast method employed and the planification of production process.

3.1 The structure of the interview

We have made an interview with the two directors of the mention departments above in order to clarify the objective of this section. For this specific reason, we have chosen the semi-directive interview as we believe it is the most suitable technique for our research.

This interview was divided into 4 Steps, every single one of them contains a number of questions that have been resumed in an Interview Guide. (Annexe 1)

- The 1st step: will be about a brief presentation of the two directors (Interviewers) and their hierarchical status inside the branch and their functions.
- The 2nd step: will treat the forecast part, the method used by the Upper Plateaus Cereals Branch and its process.
- The 3rd step: will discuss the Production planning process, the strategical planning and the tactical and operational planning.
- The 4th step: concerned the relation between the two variables, and all other processes that can have an impact or a relation with the production process of the complex: Commercial, Inventory and distribution process.

⁵² ACHOURI, (Zakaria) et DAOUD (Sameh) : *L'impact de la digitalisation sur la performance de la logistique de distribution* : Henkel Algérie, Mémoire de master en Distribution et Supply Chain, Ecole des Hautes Etudes Commerciales, Alger, 2020, p.121.

3.2 The significant sample

In the context of our interview, we had as interviewers the commercial director of the Upper Plateaus Cereals Branch, and the operational director of the industrial and commercial complex of the Mills High Plateaus -Setif-. Both has a significant experience in the agri-food field within this company. We have chosen these two interviewers based on their hierarchical status and experience to collect the precise data possible for our study.

3.3 Date, Place and Hour of the interview

Our interview was made inside the direction of the branch located in Setif, and the ICC installed in the same city. On 04/25/2023 and it took 45 minutes each.

4 Interview results

In this part we will present the questions that have been asked for the two interviewers to respond at, and their reactions to them.

4.1 Presentation of the two Interviewers

Question 1: Can you present yourself?

- Commercial and Marketing Director at the High Plateaus Grains Branch / SPA Academic, 25 years of experience.

- Production Manager at ICC HPS, Engineer in the agri-food industry, 20 years of experience (10 years at the management level).

Question 2: what is your statue in this company, what are your functions?

- Commercial and Marketing Director, His functions:
 - Monitoring the marketing and commercial process within the subsidiary.
- Production Manager, His function:
 - Daily monitoring of the production process at the HPS complex.

4.2 The forecast technique used by the enterprise's experts

Question 3: what is the method of prevision that your company use?

In the case of the High Plateaus Grains Branch the prevision technique used is not the Sales one based on the quantity of the product they should provide to the market but it is a Budget prevision approach which take on consideration the recent activity's results.

Question 4: How do you realise that kind of forecast technique?

We can realise The Budget prevision approach by fixing a specific turnover as an objective for the current year. It can be realised by taking on consideration the recent activity's results, also known inside the enterprise by the name of (the Cloture Previsions), it is established in the last 02 or 03 months, and by taking in account:

- The goals aimed and communicated by the AGRO-DIV General Direction installed in Algiers.
- The turnovers realised throughout the previous activity years.
- The Industrial and Commercial Complex capacities related to the branch and the raw materials allowed to supply.

We have to mention that the General Direction located in the capital is the one whom has the authority to put the global objectives that every single branch in the Algerian territory need to fulfill, including our Branch.

Question 5: can you describe the process for establishing the Budget prevision?

An order letter will be communicated to the general director of the branch containing the Sales rates and other tasks. Based on this one, a reunion will be organized with the presence of all the operational directors inside the branch in order to see whether the continent of the order letter is achievable or not. (Annexe 2)

After that, a second meeting with the AGRO-DIV general direction should take place following a certain schedule fixed by this last one (every ½ day with the director of a specific branch) before transferring a rapport to the administrative council and having the agreement.

4.3 The different level of the production Planning process

Question 6: how do you put in place a Strategic plan?

This phase is the next step after confirming the Business objectives of the year with AGRO-DIV General direction. It consists on making an annual budget of all the charges and needs of the company for the current activity year based on: the closure Budget of the previous year as a support and the actual + future recourses needed. It has as name The Plan and Budget. (Annex 3)

Question 7: what are the competent of this Plan and Budget?

It contains 08 components:

- Preamble
- Correspondence from AGRO-DIV holding company
- Closure forecast
- Financial Connection
- Major event of the previous financial year
- Data synthesis Current year's budget
- Financial Connection
- Management ratios
- Human Resources
- Jobs and recruitment
- Wages
- Training
- Physics
- Procurement
- Crushing
- Production

-Physical Sales and Turnover

- Performance (TCR)

-Management aggregate

- Financing plan

-Investment subsidies

- Outlook for the current year

It is important to note that Both the Cloture Prevision and The Plan and Budget have to take in consideration the public holidays and a full month for the technical stop in all complexes related to the Branch.

The strategic plan is elaborated inside the branch direction located in Setif, it can be subject of changeset and modification for strategic purposes (Generally to deal with the external changes of the branch environment which can impact the previsions and the activity). In that case, another reunion must take place and a report must be transferred to AGRO-DIV general direction.

Question 8: what about the Tactical and operational planning?

This step is the gate through the operational part of the planification of production in this company. After defining the Plan and Budget by the Direction of the High Plateaus Grains Branch, this last one will be divided into specific quotum for each Industrial and commercial complex depending on their Production Capacity and the Type of products manufactured inside theme.

After that, every ICC Director will organize a monthly reunion with the operational and commercial department to discuss how to achieve the objectives put by the branch direction, and devise those objectives into a weekly one in order to handle in the best way possible the expected demand.

Question 9: What type of production do your complex use?

Generally, the type of production employed is a Push production with a Make to Stock approach. It is a continuous production of the articles needed in the market with an objective to be placed in the inventory, so the commercial department can confirm the availability of the

merchandise to the different operators dealing with theme. But in some cases, the complex can change its policy and adapt the Make to Order approach.

Question 10: when do you use the first approach, and the second one?

These two approaches depend on the balance between the offer and the demand, from that we can distinguish two situations of production.

- If the Offer > Demand:

In this kind of situation, the complex will use the Make to Order approach with taking on consideration the inventory availability. The production department will launch at some point the alert to anticipate an overstock case with the collaboration of the commercial department in order to find an appropriate solution:

- How to sell a maximum quantity of product (Batch selling, special offers....).
- Mill stops.
- Suturing
- Dismissal

This operation can't be applicable without the agreement of the branch directors.

- If the Offer < Demand

We can face this kind of situation in crises and deficits, the production department will receive the demand of the market from the commercial department. It has to anticipate this command by verifying the inventory availability of both raw materials and finish products, in addition of the production capacity and the necessary resources to satisfy this demand.

An important note that should be clarify is that every Branch can not supply the raw materials by their own. It is a law established by the government which indicates that only one provider is allow to import the wheat. Which is the public company OAIC, this last one can provide every branch with 50% of their global complex capacity of production amount in normal cases. However, when it comes for this situation. The Branch can make an unusual demand for buying 100% of the qoutum allowed with explaining the reason and a supply routine based on the agreement (7/7, 24/24).

In addition, the complex production department with the collaboration of the commercial department can make some other decisions in order to solve this problem:

- Sell the available products and applicate the Make to Stock approach.
- try to meet the customer's request by offering quotas for each class for a certain period of time and this is by taking into account other customers.
- Hiring more employees.
- Additional hours.

This operation can't be applicable without the agreement of the branch directors.

4.4 The contribution of forecast and other functions in the production planning process?

Question 11: in your opinion, how can forecasts contribute on the performance of the production planning inside your company?

In our case, and probably in the case of the most companies. Forecast whether the method that can be used are essential for the good performance of the whole company and more importantly for the planification of production, we can't launch our industrial process without a backup to land up with. It is also crucial to have an idea for deciding when we start our process or when we stop it, when to decide for employing a certain method behalf the other one.

In conclusion, forecast allows us to make the right decision depending on the circumstances that can face us in the future, and avoiding any possible problem that can affect the performance of our production planning.

Question 12: is there any other functions that can have an impact on the performance of the planification of production?

Yes, In the Supply Chain everything is related with each other. So, it is obvious that there are some functions which have a significant impact on the planification of production and its organization inside the High Plateaus Grains Branch

- **The commercial process**

Any demand from any outsider operator will be treated by this department. Based on the availability of the products in the stock, the complex can satisfy the demand or make different other options (making a deal to provide the client with the necessary quantity per range). The process of commercialisation changes from the type of client the complex is dealing with, from that we can distinguish 03 different clients:

- Sales points

The 73-sales point related to the Upper Plateaux Cereals Branch are considered as the link between the company and the consumers. Every end of the week, these sales points communicate the situation of their stock and the quantity of product needed to be delivered and sold. It is the duty of the commercial department of every complex to treat these commands and give the production department the weekly report.

- Commercial

If any commercial wants to Buy from the complex its product, he has to:

- Present some documents to the commercial department inside the complex which he wants to work with (commercial register.....).
- The enterprise confirms the originality of his documents.
- The directorate of commerce in the complex city confirms if this Personne is paying his financial dues with the Trade Directorate of Setif Province

After that, the commercial can present a purchase order whenever he wants to buy the complex's products.

- Between the complexes or Branches

This kind of commercialisation is possible under the AGRO-DIV general direction supervision. Indeed, this process need a specific demand that only the commercial director of the branch can make it in order to bring some unavailable type of product in the market (in case of its demand) or to help the production and operation department to satisfy the demand in the market.

- **The inventory**

Our Complex uses a really simple method of stockage based mostly on FIFO method in case of the raw material, and LIFO method in case of final products with presenting both Entry and Exit order.

- **The distribution processes**

When it comes for the distribution process, every complex has its own fleet and distribution network with presenting a delivery order.

Chapter conclusion

In a short way, The High Plateaus Grains Branch is considered as one of the most important branches of the AGRO-DIV group. With its 05 Industrial and commercial complexes divided in 05 different cities, this last one can occupy a large territory and can reach and provide the market with various products depending on their specific needs.

This branch uses a budget prevision as the initial step of their production planification, a delicate approach that need to be studied by the different operational directors of the branch and be confirmed by the AGRO-DIV general directions in Algiers.

The operational step will be accomplished by the Industrial and commercial complexes, it consists of realising the branch objectives communicated through the Plan and Budget document, and satisfy the market needs. Different scenarios can face the complexes, and it is their responsibility to make the production plan the most flexible possible in order to fulfill their tasks that have been assigned to them.

The commercial process, and the inventory and distribution process have also a major important not only for the production part but also for the performance of the company activity.

**Chapter 03: Case study: Forecast experiments
following the Box-Jenkins method and development
of S&OP**

Chapter introduction

Following our diagnosis of the planification of production inside the High Plateaus Grains Branch. We will discuss in this chapter about another method of planification which consist on making forecasts from the quantity of products sold in the market using the quantitatively method named, Box-Jenkins, with a S&OP trail establishment based on the results of these predictions.

It is essential before starting any study or research to fix an objective we want to achieve. This objective must be SMART, meaning specific, measurable, achievable, realistic and Time-bound. Indeed. this approach will allow us to have a clear vision of our work and avoid any deviation in the realisation of the study.

In our case, the main objective is to show the results of establishing a sales forecast using the Box-Jenkins method on a specific product of the Upper Plateaux Cereals Branch and its contribution on making the production plan representing by the S&OP.

It is important to specify that we want to remain neutral in the realisation of this study by avoiding Cherry picking which can completely affect the reliability of our research. In order to do that we decided to devise our study plan in two sections. The first one will be about the sales forecast by Box-Jenkins, the data selections and its application. Well, the second one will discuss the S&OP Choice of scenario, data selection and its establishment.

Section 01: Sales forecast Application

In this section, we will present our experimental study concerning sales forecast using the box-Jenkins method

1 The forecast technique choice

For our study, we decided to privilege the time series method of forecasting among all the other forecast families. Based on analysing the historical data, these types of techniques are the most fashionable and attractive to companies because of their cost, Their performance and availability.

Several time series methods can be proposed for forecasting future demand. Some are very simple like the naïve method; other techniques are more complicated to make such as the exponential smoothing methods. As part of our research, we decided to work using the Box-Jenkins method from ARIMA models (Auto Regressive Integrated Moving average) one of the most popular and widely used techniques for univariate time series forecasting.

We have chosen this method for the simple reason that the company does not use that kind of forecast. Indeed, sales budget is the one applicable inside the High Plateaus Grains Branch, it is used for formalizing business objectives, while our technique will be used for sales volumes of products.

To support our forecast method, we will add a performance measuring technique named MAPE (Mean Absolute Percentage Error) that we had already given its definition and how it will be calculated in the first chapter. The reason of this choice is for the simplicity and efficiency that this technique can provide.

2 Data selection

2.1 Article choice

The High Plateaus Grains Branch is specialized on making different Agro-industrial food, they can be produced in 05 Industrial and commercial complexes as it is shown in the chapter two.

As a result, it is impossible for us to make our study research on every single item of this enterprise. Which had led us to choose one specific product that can help us to clarify our work and make it realisable. For that, we have chosen as an article the semolina family of product

representing one of the highest sold products of this company, the product with the most available data on both the complex and branch, without forgetting that a Sales and Operation Planning requires a family of product in order to be established.

2.2 Unit time choice

Defining the unit time is a crucial step in defining results in line with the objectives sought. For this study we will establish a Sales and Operation Plan which demand a monthly prediction in order to be done. So based on that, the time unit must be months.

2.3 Forecast horizon

In order to make the sales forecast, we have decided to realise our study based on the real quantities of semolina sold by the branch in the last 04 years. In other word, from 2019 to 2022.

This horizon will allow us to see the different variables that can affect the forecast (seasonality, trend....) and make a judgement about the performance of our forecast method by comparing the predicts quantities by Box-Jenkins method in 2022 with the real ones in the same year.

3 Application

As we mention in the previous chapters, the sales forecast is mainly used based on historical quantities sales to predict the future. Which will lead us to procure the necessary data for our application.

At this step, we have created an Excel data-base including on it the amount of sold product all along the horizon of forecast in a specific industrial and commercial complex related to this branch (The Mills of High Plateaux – Setif).

The application of the Box-Jenkins method will be on E-views. Through an innovative, simple to use object-oriented interface, this software program gives financial institutions, businesses, governments, and academic organizations access to strong statistical, time series, forecasting, and modeling tools. For our case, an easy utilisation and an accurate forecast for our study.

3.1 Data presentation

The Table above represents the monthly evolution of the Semolina sales in quintal in the Industrial and commercial complex of the mills of high plateau -Setif- in the last 4 years (from 2019 to 2022).

Table 08: Evolution of Semolina sales (in quintal)

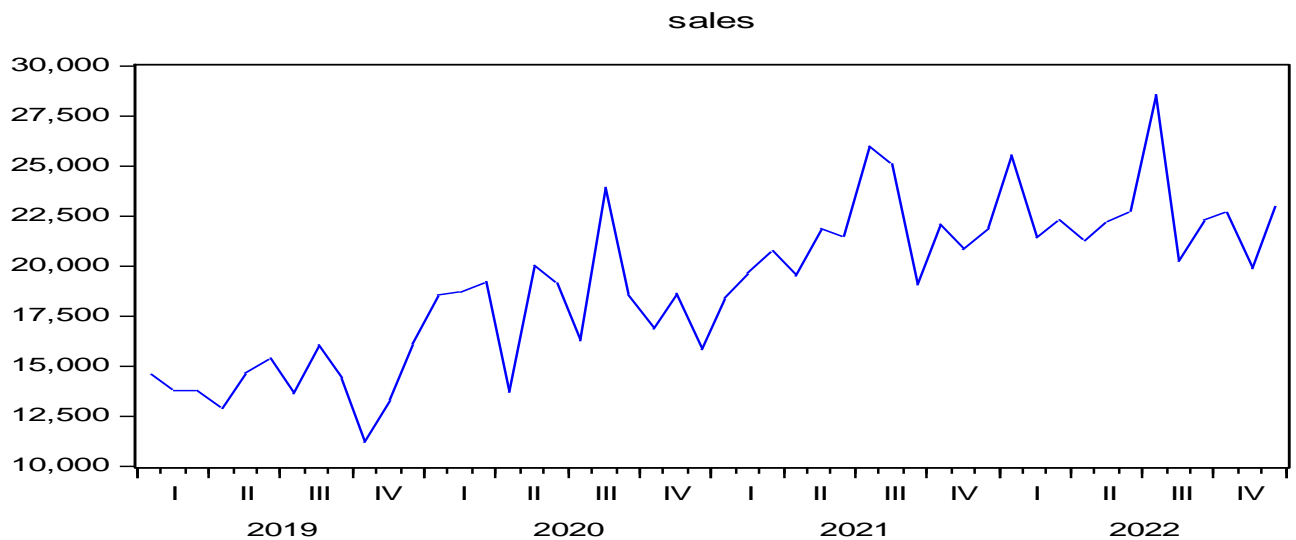
	2019	2020	2021	2022
January	14 600	18 586	18 410	25 586
February	13 762	18 702	19 644	21 402
March	13 780	19 250	20 800	22 344
April	12 868	13 730	19 508	21 260
May	14 676	20 004	21 882	22 238
Jun	15 368	19 188	21 518	22 774
July	13 604	16 254	26 008	28 592
August	16 066	23 914	25 102	20 268
September	14 390	18 572	19 110	22 338
Octeber	11 242	16 900	22 076	22 666
November	13 334	18 654	20 818	19 926
December	16 142	15 882	21 984	23 062

Source: Documents of the enterprise

To study Our Serie named (Sales)we firstly need to make the graph and the correlogram related to this last one in order to check if there are a seasonality and / or trend in it.

- **The Serie graph:**

Figure 17: The sales series graph

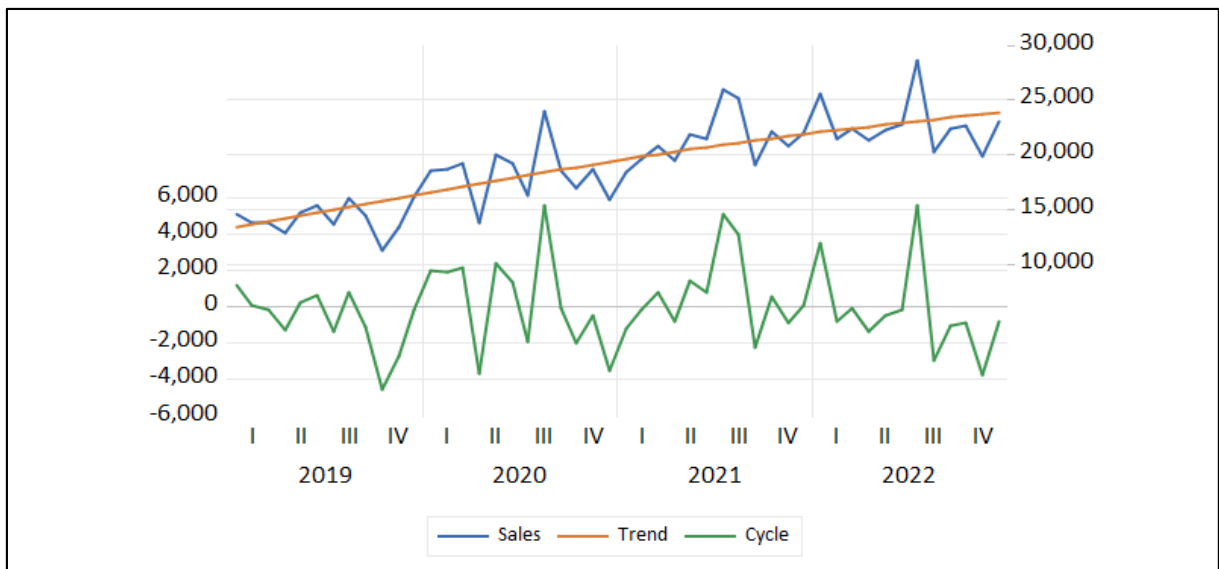


Source: Establish by us from E-views

This graph describes the evolution of the quantities sold of Semolina from 2019 to 2022. This graph probably shows that our Serie contains positive trend, which can lead us to conclude that our Serie is non stationary, and it can have a seasonal coefficient on it to. However, we can't build our research only on this graph. In other word, we have to make other test to evaluate if the previous variables excite or not.

- **Trend and seasonality**

Figure 18: seasonal and trend graph of the Serie



Source: Elaborated by us from E-views

This Figure is the results of the Hodrick-Prescott Filter, it allows us to see graphically the existence of both trend and seasonality.

We can obviously remarque the Serie contain a positive trend throughout these past 4 years.

And we can also remarque the cycle (seasonality) has the same perturbation during the same months in all the years consisting this Serie. So, an existence of a seasonality.

- **Correlogram**

What we can see in the table of the correlogram bellow is that all the autocorrelations' functions are mostly different from 0 and get smaller slowly. And the first one is significantly different from 0 which refers to a non stationary Serie.

Table 09: correlogram of the sales Serie

Date: 05/19/23 Time: 18:11							
Sample: 2019M01 2022M12							
Included observations: 48							
Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob		
		1	0.654	0.654	21.820	0.000	
		2	0.620	0.337	41.888	0.000	
		3	0.611	0.240	61.779	0.000	
		4	0.440	-0.161	72.319	0.000	
		5	0.553	0.294	89.391	0.000	
		6	0.531	0.128	105.51	0.000	
		7	0.380	-0.204	113.96	0.000	
		8	0.342	-0.218	120.98	0.000	
		9	0.327	0.165	127.55	0.000	
		10	0.174	-0.200	129.46	0.000	
		11	0.270	0.083	134.17	0.000	
		12	0.240	0.052	138.02	0.000	
		13	0.083	-0.128	138.49	0.000	
		14	0.187	0.073	140.96	0.000	
		15	0.046	-0.076	141.11	0.000	
		16	0.018	0.003	141.14	0.000	
		17	0.062	-0.096	141.43	0.000	
		18	-0.067	-0.097	141.79	0.000	
		19	-0.103	-0.090	142.68	0.000	
		20	-0.119	-0.080	143.89	0.000	

Source: Elaborated by us from E-views

3.2 Stationarity check

Before using the Augmented Dickey Fuller Test which is used for checking about the stationarity of our Serie, we should firstly check the existence of seasonality by applying the Fisher test.

3.2.1 Fisher test

This is a calculated test used by Data analysts when we can't relate only on the graphical tests. This last one can verify both trend and seasonality existence from the column and lines of our Serie table.

- **Lines:** To detect the presence of seasonality, we use Fisher's test which is based on the following assumptions:

H0: Absence of seasonality.

H1: Presence of seasonality.

- **Column:** To detect the presence of a general trend, we use Fisher's test which is based on the following assumptions.

H0: Absence of trend

H1: Presence of trend

Table 10: Fisher Test

Variance analyses

Variation source	sum of squares	Liberty degree	Squares average	F CALCULATED	Probability	F tabulated
Lines	69327970,67	11	6302542,788	2,489165597	0,18244498	2,093254411
Columns	520933549,3	3	173644516,4	41,02874803	3,0729E-11	2,891563517
Error	139664730,7	33	4232264,566			
Total	729926250,7	47				

Source: Establish by us From Excel

From the table, we can note that:

$F_{tab} = 2.093254411 < F_{cal} = 2.489165597$, This means that the calculated Fisher statistic is greater than the tabulated Fisher statistic. Therefore, we reject the H_0 hypothesis and accept the H_1 hypothesis, which allows us to conclude that the series is affected by seasonality.

$F_{tab} = 2,891563517 < F_{cal} = 41,02874803$, This means that the calculated Fisher statistic is greater than the tabulated Fisher statistic. Therefore, we reject the H_0 hypothesis and accept the H_1 hypothesis, which allows us to conclude that the series has a general trend.

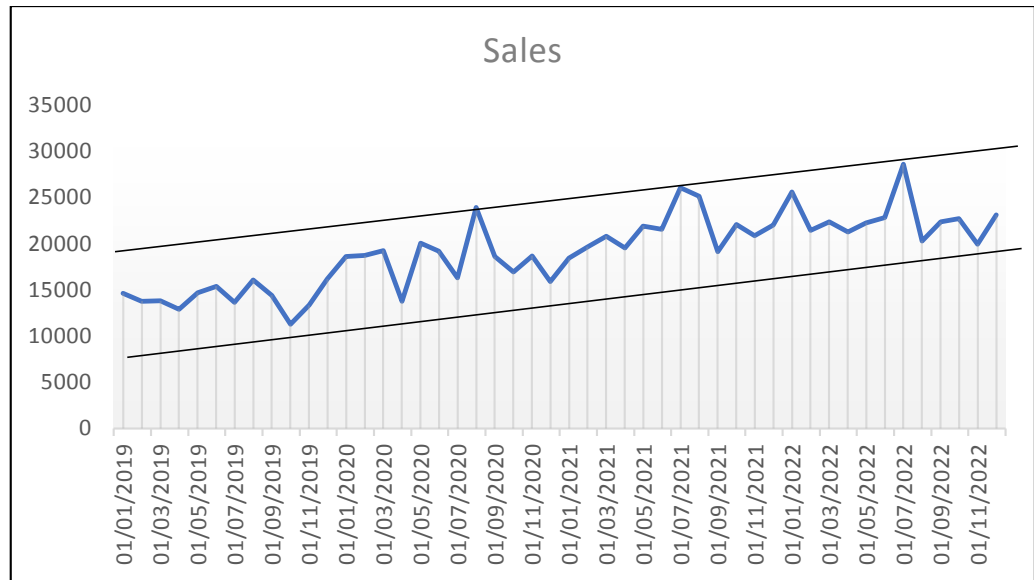
After making this test and confirming the existence of seasonality. In other words, we have to remove the seasonal coefficients from the original Serie (Sales).

3.2.2 Seasonal Coefficient

For this specific Point, we have to remove the seasonality from our Serie. To do that we must make a seasonal adjustment based on the moving average method and selecting one of the two applications: Multiplicative or additive.

We can make this decision by analysing the sales Serie graph.

Figure 19: Adjustment by the additive method



Source: Establish by us from Excel

we can notice through this graph that the two lines connecting the peaks of the curve are parallel. which means that we will apply the additive method.

- **Seasonal coefficients**

Now we can make the seasonal coefficients table

Table 11: seasonal coefficients of the semolina Serie

Date: 05/19/23 Time: 00:08	
Sample: 2019M01 2022M12	
Included observations: 48	
Difference from Moving Average	
Original Series: SALES	
Adjusted Series: SALESSA	
<hr/>	
Scaling Factors:	
<hr/>	<hr/>
1	1360.917
2	149.7222
3	862.9722
4	-2038.083
5	920.3611
6	518.0278
7	582.0000
8	3395.306
9	-1166.417
10	-2019.917
11	-1378.833
12	-1186.056
<hr/>	<hr/>

Source: Established by us from E-views

- **The new Serie without seasonality**

By removing these coefficients, a new Serie will appear under the name of Sales_sa which refers to Sales_ Seasonal Adjustment. This Serie shows the reality of the semolina sales without this variable.

The table and the graph bellow are our new Serie that we will be working on.

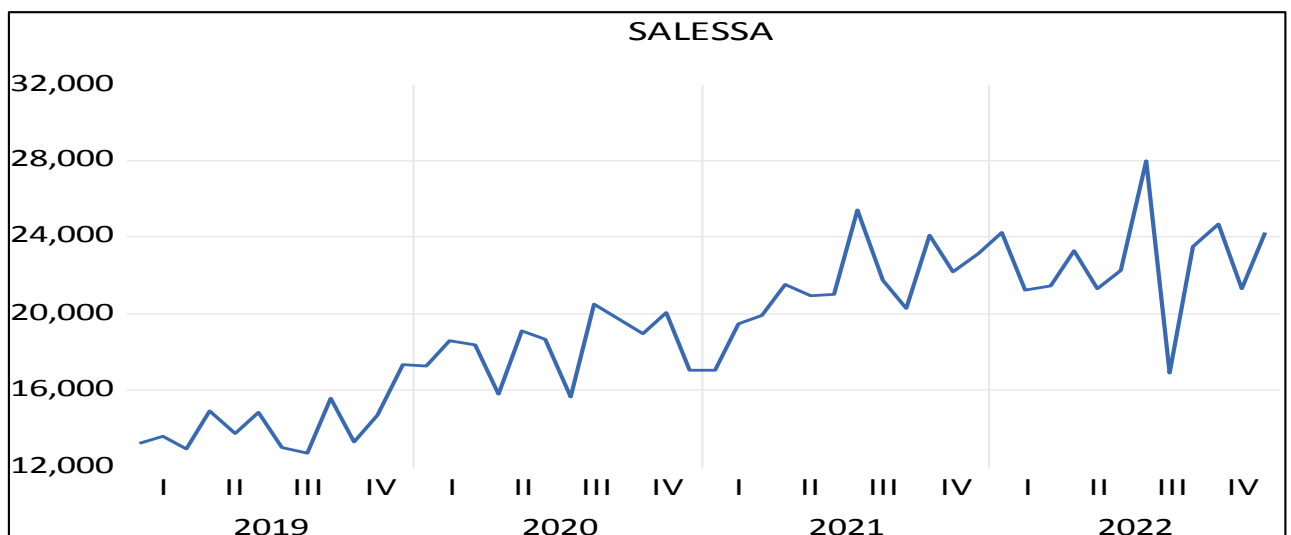
We can see that the quantity of Semolina Sales has changed comparing to the previous one and the graph clearly shows that the seasonality effect has disappear.

Table 12: The new Serie Salessa

	U=Q			
	2019	2020	2021	2022
January	13239.08	17225.08	17049.08	24225.08
February	13612.28	18552.28	19494.28	21252.28
March	12917.03	18387.03	19937.03	21481.03
April	14906.08	15768.08	21546.08	23298.08
May	13755.64	19083.64	20961.64	21317.64
Jun	14849.97	18669.97	20999.97	22255.97
Jully	13022.00	15672.00	25426.00	28010.00
August	12670.69	20518.69	21706.69	16872.69
September	15556.42	19738.42	20276.42	23504.42
October	13261.92	18919.92	24095.92	24685.92
November	14712.83	20032.83	22196.83	21304.83
December	17328.06	17068.06	23170.06	24248.06

Source: Establish by us from Excel

Figure 20: The Salessa graph



Source: Established from us from E-views

3.2.3 Augmented Dickey Fuller Test

After removing the seasonality from our Serie, we can proceed with the verification of the stationarity by using the Augmented dickey fuller test. But before that, we should firstly define the optimal P value of our new Serie which refers to the number of lags.

- **Choice of lags number**

The table bellow resumes our work

Table 13: The lags analyse

	Model 3		Model 2		Model 1	
	Akaike	Schwarz	Akaike	Schwarz	Akaike	Schwarz
P=0	18.13	18.35	18.70	18.78	18.84	18.87
P=1	18.20	18.36	18.51	18.63	18.54	18.62
P=2	18.03	18.23	18.06	18.22	18.08	18.20
P=3	18.55	18.79	18.74	18.94	18.79	18.95
P=4	18.13	18.41	18.16	18.41	18.18	18.38

Source: Elaborated by us from E-views

The optimal number of lags is the one who minimize both the Akaike and Schwarz criteria for the 03 following models

- Model 03: With trend and intercept
- Model 02: With intercept
- Model 01: Without trend, without intercept.

From this table we can easily choose P=2 because it's the number of lags who minimise both Akaike and schwarz criteria.

- **Estimation of the Models**

After defining the optimal number of lags, we can now use the Augmented dickey Fuller to verify the stationarity of the Salessa Serie (Annex 4).

The Augmented Dickey Fuller Schema Will Help us to estimate the right series.

○ **Model 03 estimation**

In this model the we will test the 02 hypothesis

- H0: trend absence
- H1: trend presence

Table 14: Model 03 estimation (Salessa)

Null Hypothesis: SALESSA has a unit root Exogenous: Constant, Linear Trend Lag Length: 2 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic				
Test critical values:				
	1% level		-4.175640	
	5% level		-3.513075	
	10% level		-3.186854	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(SALESSA) Method: Least Squares Date: 05/20/23 Time: 17:00 Sample (adjusted): 2019M04 2022M12 Included observations: 45 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SALESSA(-1)	-0.577246	0.265366	-2.175287	0.0356
D(SALESSA(-1))	-0.511150	0.215475	-2.372201	0.0226
D(SALESSA(-2))	-0.469009	0.144868	-3.237487	0.0024
C	8423.600	3497.713	2.408317	0.0207
@TREND("2019M01")	126.6111	68.34084	1.852641	0.0713
R-squared	0.641024	Mean dependent var		251.8006
Adjusted R-squared	0.605127	S.D. dependent var		3006.348
S.E. of regression	1889.158	Akaike info criterion		18.03009
Sum squared resid	1.43E+08	Schwarz criterion		18.23083
Log likelihood	-400.6770	Hannan-Quinn criter.		18.10492
F-statistic	17.85703	Durbin-Watson stat		1.809355
Prob(F-statistic)	0.000000			

Source: Establish by us from E-views

We compare the probability related to the trend with 5%

$P = 0.0713 > 0.05$ we can not reject the H0 and we estimate the Model 02 (with Intercept)

○ **Model 02 Estimation**

In this model we will test the 02 hypothesis

- H0: Constant absence
- H1: Constant Presence

Table 15: Model 02 estimation (Salessa)

Null Hypothesis: SALESSA has a unit root				
Exogenous: Constant				
Lag Length: 2 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-1.280117	0.6307
Test critical values:	1% level		-3.584743	
	5% level		-2.928142	
	10% level		-2.602225	
*Mackinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(SALESSA)				
Method: Least Squares				
Date: 05/20/23 Time: 17:03				
Sample (adjusted): 2019M04 2022M12				
Included observations: 45 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SALESSA(-1)	-0.111101	0.086790	-1.280117	0.2077
D(SALESSA(-1))	-0.836301	0.128662	-6.499961	0.0000
D(SALESSA(-2))	-0.624624	0.121482	-5.141702	0.0000
C	2695.882	1683.576	1.601283	0.1170
R-squared	0.610222	Mean dependent var		251.8006
Adjusted R-squared	0.581701	S.D. dependent var		3006.348
S.E. of regression	1944.387	Akaike info criterion		18.06797
Sum squared resid	1.55E+08	Schwarz criterion		18.22856
Log likelihood	-402.5293	Hannan-Quinn criter.		18.12784
F-statistic	21.39599	Durbin-Watson stat		1.897518
Prob(F-statistic)	0.000000			

Source: Establish by us from E-views

We compare the probability related to the Intercept (c) with 5%

$P = 0.1170 > 0.05$ we can not reject the H_0 and we estimate the Model 01.

○ **Model 01 estimation**

In this model we will test the 02 hypothesis

- H_0 : Our process is not stationary
- H_1 : Our process is stationar

Table 16: Model 01 estimation (Salessa)

Null Hypothesis: SALESSA has a unit root					
Exogenous: None					
Lag Length: 2 (Automatic - based on SIC, maxlag=9)					
			t-Statistic	Prob.*	
Augmented Dickey-Fuller test statistic			1.672638	0.9754	
Test critical values:	1% level		-2.617364		
	5% level		-1.948313		
	10% level		-1.612229		
*MacKinnon (1996) one-sided p-values.					
Augmented Dickey-Fuller Test Equation					
Dependent Variable: D(SALESSA)					
Method: Least Squares					
Date: 05/20/23 Time: 17:11					
Sample (adjusted): 2019M04 2022M12					
Included observations: 45 after adjustments					
	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	SALESSA(-1)	0.025750	0.015395	1.672638	0.1018
	D(SALESSA(-1))	-0.917153	0.120525	-7.609673	0.0000
	D(SALESSA(-2))	-0.659770	0.121687	-5.421857	0.0000
	R-squared	0.585845	Mean dependent var		251.8006
	Adjusted R-squared	0.566123	S.D. dependent var		3006.348
	S.E. of regression	1980.261	Akaike info criterion		18.08419
	Sum squared resid	1.65E+08	Schwarz criterion		18.20463
	Log likelihood	-403.8942	Hannan-Quinn criter.		18.12909
	Durbin-Watson stat	1.889290			

Source: Establish by us from E-views

We have $1.67 > -1.94$ for a risk of 5%

As conclusion we can not reject H_0 , our Salessa Serie is non-stationary and it is spawned by a DS process. therefore, it has a unit root. To determine the order of integration of the series, we are going to apply the ADF test to the series in first differentiation.

- **ADF in first differentiation**

We will use The ADF only for Model 01 because we have already specified that the trend and intercept are absent.

Table 17: ADF in First differentiation for the SALESSA series

Null Hypothesis: D(SALESSA) has a unit root				
Exogenous: None				
Lag Length: 2 (Fixed)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-4.894698	0.0000
Test critical values:	1% level		-2.618579	
	5% level		-1.948495	
	10% level		-1.612135	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(SALESSA,2)				
Method: Least Squares				
Date: 05/20/23 Time: 22:30				
Sample (adjusted): 2019M05 2022M12				
Included observations: 44 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SALESSA(-1))	-2.151377	0.439532	-4.894698	0.0000
D(SALESSA(-1),2)	0.362596	0.314678	1.152275	0.2559
D(SALESSA(-2),2)	-0.141070	0.156018	-0.904190	0.3712
R-squared	0.860539	Mean dependent var		21.68561
Adjusted R-squared	0.853736	S.D. dependent var		5319.375
S.E. of regression	2034.367	Akaike info criterion		18.13950
Sum squared resid	1.70E+08	Schwarz criterion		18.26115
Log likelihood	-396.0691	Hannan-Quinn criter.		18.18462
Durbin-Watson stat	1.971043			

Source: Establish by us from E-views

For This one we can see that $-4.89 > -1.94$, we accept the H1.

The Serie is stationary in the first differentiation. Now we can apply the Box-Jenkins Method.

3.3 Application of the Box-jenkins method

After making our Serie stationary, the box-Jenkins method can be applied.

3.3.1 Identification of the models

Our series is stationary, and we will search for an ARMA (p, q) model for it. To determine the orders of the ARMA (p,q) model, we examine the correlogram of the stationary series

SALESSA. The simple correlogram helps identify an MA(q) model, while the partial correlogram helps identify an AR(p) model.

Table 18: Correlogram of SALESSA series in first differentiation

Date: 05/20/23 Time: 23:49						
Sample (adjusted): 2019M02 2022M12						
Included observations: 47 after adjustments						
Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob	
		1	-0.546	-0.546	14.929	0.000
		2	-0.151	-0.640	16.100	0.000
		3	0.505	0.047	29.422	0.000
		4	-0.436	-0.155	39.590	0.000
		5	0.061	-0.155	39.792	0.000
		6	0.254	-0.075	43.412	0.000
		7	-0.321	-0.111	49.347	0.000
		8	0.119	-0.152	50.182	0.000
		9	0.206	0.114	52.765	0.000
		10	-0.351	-0.054	60.424	0.000
		11	0.211	0.003	63.271	0.000
		12	0.033	-0.097	63.343	0.000
		13	-0.275	-0.213	68.453	0.000
		14	0.288	-0.143	74.235	0.000
		15	-0.102	-0.176	74.991	0.000
		16	-0.062	0.011	75.279	0.000
		17	0.185	0.049	77.909	0.000
		18	-0.192	-0.095	80.836	0.000
		19	0.069	-0.034	81.223	0.000
		20	0.125	0.090	82.554	0.000

Source: Elaborated by us from E-views

Based on this correlogram we can define the possible models for our series forecast. We only have to choose the models which their bars cross the confidence or the error interval.

In the autocorrelation function, we have MA (1) is significantly different from 0. So, we take $p=1$.

In the correlation function, we have AR (1) and AR (2) are significantly different from 0. So, we take $q=1$ and $q=2$.

We can propose from them the following models:

- AR (1)
- AR (2)
- MA (1)
- ARMA (1,1)
- ARMA (2,1)

The choice of these models can be confirmed on E-views by choosing the automatic ARIMA forecast function

Table 19: The potential Models

Automatic ARIMA Forecasting Selected dependent variable: DLOG(SALESSA) Date: 05/20/23 Time: 18:27 Sample: 2019M01 2022M12 Included observations: 47 Forecast length: 0 Model maximums: (2,1)1(0,0) Regressors:
Number of estimated ARMA models: 6 Number of non-converged estimations: 0 Selected ARMA model: (2,0)(0,0) AIC value: -1.57884026331

Source: Elaborated by us from E-views

3.3.2 Estimations of the models

For this step we can use as before, the automatic ARIMA forecast function to select the best model among all the identified ones.

Table 20: Equation Output

Dependent Variable: DLOG(SALESSA) Method: ARMA Maximum Likelihood (BFGS) Date: 05/20/23 Time: 18:27 Sample: 2019M02 2022M12 Included observations: 47 Convergence achieved after 4 iterations Coefficient covariance computed using outer product of gradients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.805234	0.118828	-6.776490	0.0000
AR(2)	-0.546661	0.132364	-4.129972	0.0002
SIGMASQ	0.010397	0.002247	4.626369	0.0000
R-squared	0.500960	Mean dependent var		0.012876
Adjusted R-squared	0.478276	S.D. dependent var		0.145902
S.E. of regression	0.105386	Akaike info criterion		-1.578840
Sum squared resid	0.488672	Schwarz criterion		-1.460746
Log likelihood	40.10275	Hannan-Quinn criter.		-1.534400
Durbin-Watson stat	1.834642			
Inverted AR Roots	-.40-.62i	-.40+.62i		

Source: Elaborated by us from E-views

From the table above we can clearly see that E-views have selected the AR (2) model as the optimal model to use for our forecast. This selection has been made by comparing the Akaike and schwarz criteria.

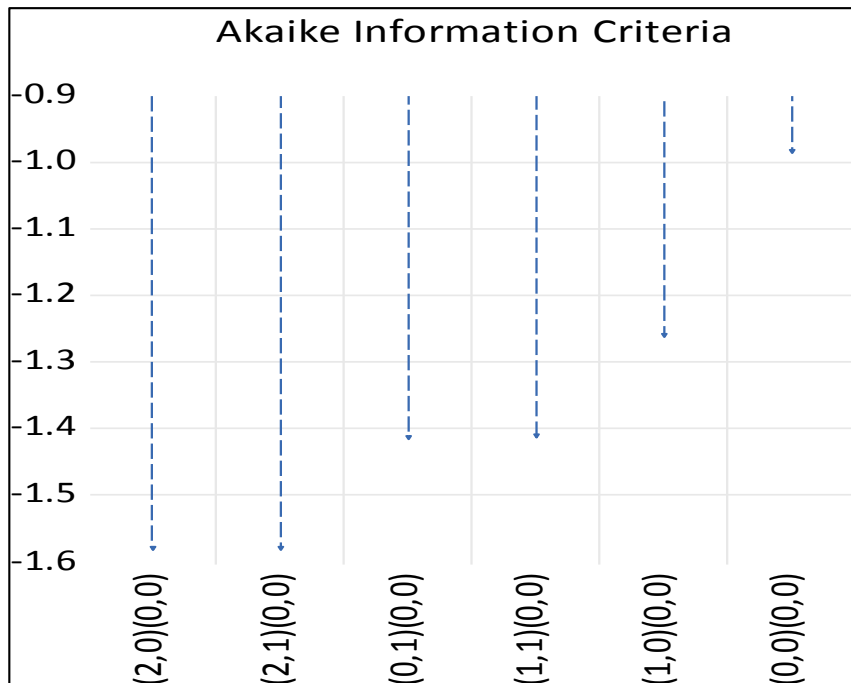
Table 21: ARIMA criteria table

Model Selection Criteria Table				
Dependent Variable: DLOG(SALESSA)				
Date: 05/20/23 Time: 18:27				
Sample: 2019M01 2022M12				
Included observations: 47				
Model	LogL	AIC*	BIC	HQ
(2,0)(0,0)	40.102746	-1.578840	-1.460746	-1.534400
(2,1)(0,0)	41.075751	-1.577692	-1.420232	-1.518439
(0,1)(0,0)	35.201450	-1.412828	-1.334098	-1.383201
(1,1)(0,0)	36.153950	-1.410806	-1.292712	-1.366367
(1,0)(0,0)	31.564992	-1.258085	-1.179355	-1.228458
(0,0)(0,0)	24.095468	-0.982786	-0.943421	-0.967973

Source: Established by us from E-views

The ARIMA criteria table shows that AR (2) Model is the one with least Akaike and schwarz value comparing with the other models. Which makes him the best model to use.

Figure 21: AKAIKE information criteria



Source: Established by us from E-views

This graph also can be used to confirm our model's selection.

3.3.3 Diagnostic of our estimated model

Before moving to the last step of the Box-Jenkins method a diagnostic of the chosen and estimated model must be done. If our model is good, we will be allowed to use it for our forecast, if not, we will be forced to do all over again the previous steps and choose another model which can pass the diagnostic.

- **Residuals Test**

Here we are going to test the autocorrelation for that we have two hypotheses to check using the Ljung-Box

H0: The residuals are white noise

H1: The residuals are not white noise

Table 22: Ljung-Box test

Date: 05/21/23 Time: 01:16						
Sample (adjusted): 2019M02 2022M12						
Q-statistic probabilities adjusted for 2 ARMA terms						
Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob	
		1	-0.010	-0.010	0.0051	
		2	-0.095	-0.095	0.4631	
		3	-0.107	-0.110	1.0595	0.303
		4	-0.182	-0.198	2.8271	0.243
		5	-0.015	-0.051	2.8398	0.417
		6	0.024	-0.033	2.8731	0.579
		7	-0.051	-0.108	3.0237	0.696
		8	0.088	0.037	3.4780	0.747
		9	0.124	0.106	4.4142	0.731
		10	-0.174	-0.183	6.3056	0.613
		11	-0.069	-0.079	6.6080	0.678
		12	-0.122	-0.133	7.5937	0.668
		13	-0.173	-0.233	9.6166	0.565
		14	0.162	0.023	11.445	0.491
		15	0.101	0.004	12.178	0.513
		16	0.105	0.047	13.004	0.526
		17	0.076	0.013	13.449	0.568
		18	-0.044	0.013	13.601	0.628
		19	-0.003	0.081	13.602	0.695
		20	0.013	0.029	13.616	0.754

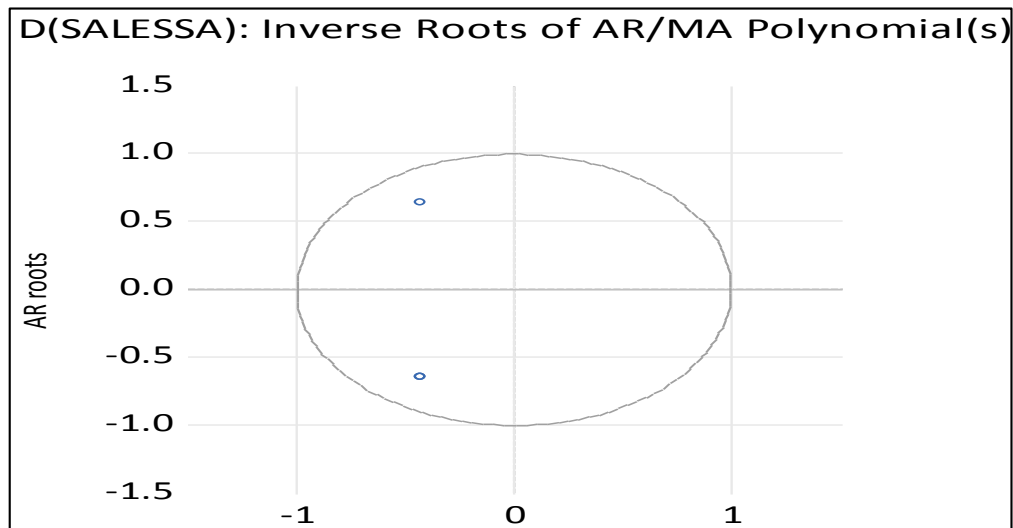
Source: Elaborated by us from E-views

In the autocorrelation function and the partial correlation, there are no values crossing the confident interval. Also, the P values are bigger than 0.05 and the Ljung Box statistics (Q=13.616) is lower than the value of Khi-deux tabulated (31.41) in 5% threshold (Annexe 05)

Based on that, we cannot reject our null-hypothesis. Which means that the residuals are White noise.

We can check the stationarity of our ARMA process is covariance (stationary) by using the graph bellow (If the AR roots are inside the cercle that means our ARIMA processes is stationary).

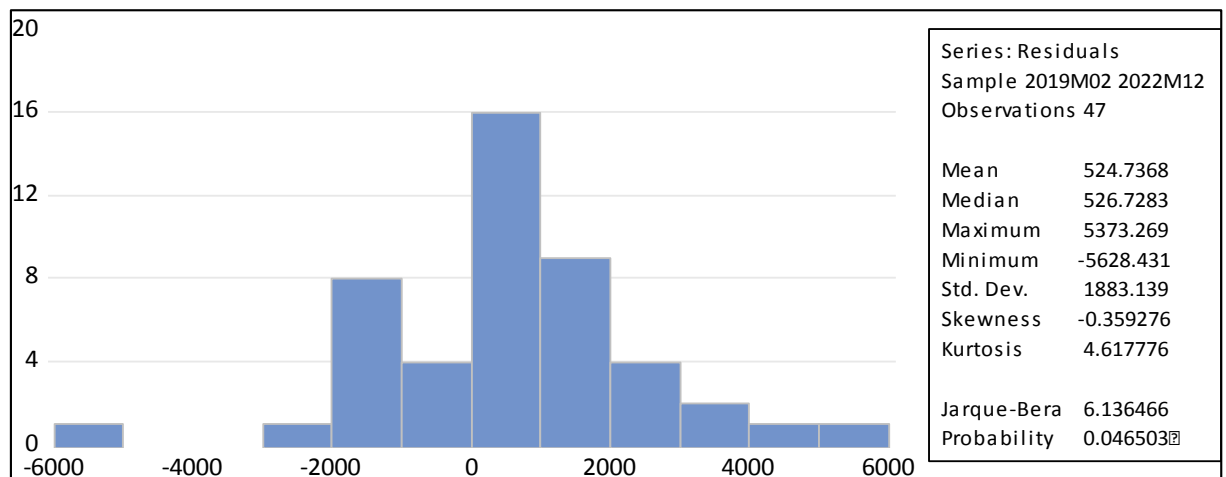
Figure 22:



Source: Elaborated by us using E-views

- Normality Test for the residuals (Test of Jarque-Bera)

Figure 23: Jarque-Bera Test



Source: Elaborated by us using E-views

Here we have The Jarque-Bera statistic of 6.136466 is less than the tabulated value of the khi-deux distribution with 2 degrees of freedom, which is equal to 5.991 at a significance level of 5%. Therefore, the residuals form a normal white noise.

We can conclude that the AR (2) model is valid, and we can proceed with forecasting the SALESSA series based on this model.

3.3.4 Forecasting

- **Calculation approach**

The application of the Box-Jenkins method to the observed data at ICC The Mills of High Plateaux / Setif for the years 2019, 2020, 2021, and 2022 allows us to obtain sales forecasts for the 2023 Semolina sales, as follows:

We have : **$DSalessa_t = -0.85Salessa_{t-1} - 0.59Salessa_{t-2}$**

From this equation, we will calculate the forecasts as follows:

In our case, we are using an additive model, and we have a deseasonalized series.

$DSalessa_t = -0.85DSalessa_{t-1} - 0.59DSalessa_{t-2}$

To return to the original series Sales, we will follow the above steps:

$$DSalessa_{49} = -0.85(2943.23) - 0.59(-3381.09)$$

$$DSalessa_{49} = -506.9$$

Now, we add the seasonal coefficient.

$$DSales_{49} = -506.9 + 1360.917$$

$$Sales_{49} - Sales_{48} = 854.01$$

$$Sales_{49} = 854.01 + Sales_{48}$$



$$Sales_{49} = 23916$$

- Graphical presentation

Table 23: Semolina Sales Forecast

date	Sales_f
2023-01-01	23916
2023-02-01	23768
2023-03-01	24726
2023-04-01	23107
2023-05-01	22793
2023-06-01	25336
2023-07-01	25640
2023-08-01	24093
2023-09-01	26491
2023-10-01	21128
2023-11-01	19476
2023-12-01	22901

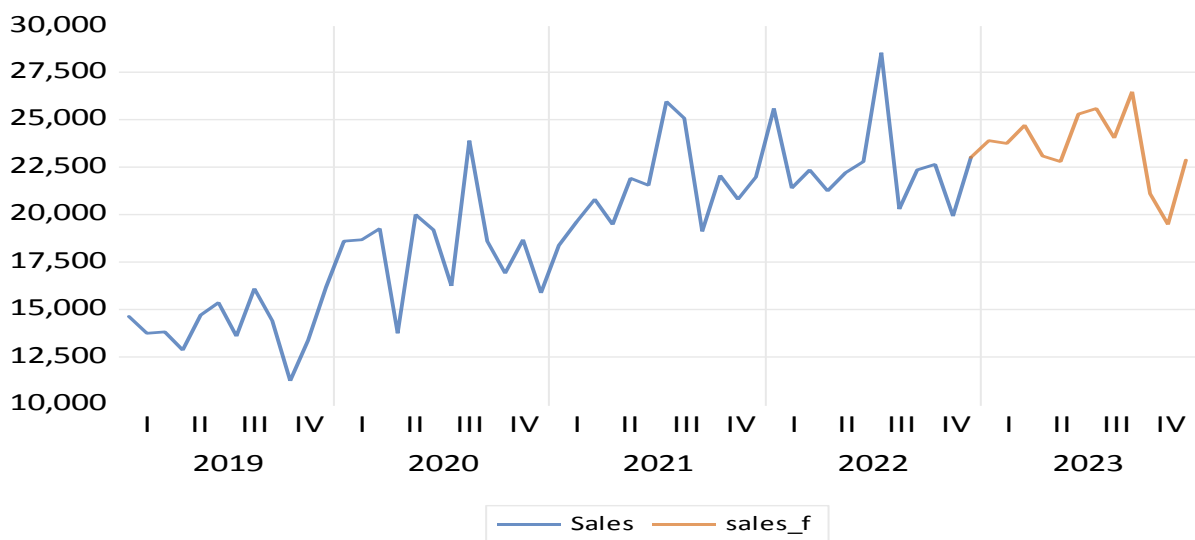
(U= Q)

Source: Established by us using E-views

This table represents the Semolina Sales Forecast for the 2023 year

We can also take a look to the graph bellow, where we can see the evolution of our series in a positive trend and some perturbation that refers to the existence of seasonality.

Figure 24: Semolina Sales forecast's graph



Source: Established by us using E-views

- **Forecast performance**

In this Part of our essay, we will use one of the performance measuring techniques (KPI) which is the MAPE (Mean Absolute Percentage Error) that we had already given its definition and how it will be calculated in the first chapter in order to clarify weather our Forecast results are performed or not.

Table 24: Forecast performance (MAPE)

<i>Date / Sales</i>	Real Sales	Sales_f	MAPE
<i>2023-01-01</i>	24736	23916	3.31 %
<i>2023-02-01</i>	26438	23768	10.09 %
<i>2023-03-01</i>	28204	24726	14.06 %
		MAPE	9.15 %

Source: Elaborated by us from EXCEL

After comparing the results of the selected model with the statistical series provided by the High Plateaus Grains Branch, we observed that the projected growth trend of Semolina sales volume is relatively close to the one observed in the provided statistical series and that can be proved by the result of the MAPE which generates a precision of over 70%. Therefore, we can conclude that the model used provides satisfactory results and can be used for sales forecasting.

Section 02: The Production Plan Application

In this section and based on the sales forecast results, we will develop a production plan. Above we can find the approach and the necessary steps for elaborating it.

1 The Production Plan Choice

Depending on the availability of the necessary data for our production plan application, we decided to choose the Sales and Operation planning process for our study.

This choice is the optimal one, it will help us to use the Sales forecast in a way that can assist the enterprise performance throughout the 2023 year and provide the beneficial scenario possible.

Observing all the data cumulated in this Essay, we can confirm that the S&OP is the best alternative possible for this study regarding on the following points:

- Diponibility of only Sales forecast of a family kind of product not a specific article itself (Semolina forecast).
- The Unit time of the Forecast Series is months, which makes it the adequate unit for elaborating the S&OP
- The forecast Horizon of one year (From 01-01-2023 till 01-12-2023) can be classed as a tactical forecast mostly utilised for planning a medium strategy. In the other side the S&OP used exactly for the same reason and it depends on that kind of forecast too.
- The Data collected in both The Upper Plateaus Cereals Branch and the industrial and commercial Complex are more appropriate to use in elaborating an S&OP rather than other production plan in its large process.

It is Important to mention that there are numerous scenarios possible for establishing a S&OP, the choice depends on two main criteria which are:

- The politic and the resources applied by the company for reaching a Fixed Objective.
- The cost of the scenarios

2 Data selection

This specific point can be resumed in the following table:

Table 25: S&OP DATA

Elements	Value
Security inventory (Units)	2000 Q
Initial inventory (Units)	4000 Q
Workforce cost / Month	40000 DA
Ratio EH / NH < 50 %	50%
Effective	50
Stockage cost / Unit / Month	200 DA
Hiring cost	25000 DA
Firing cost	10000 DA
Q production: xxx units / Month / Person	420 Q
Extra Hour cost (Comparing to normal hour)	150%
Inventory capacity	10000 Q
Production capacity	50000 Q /25000 Q

Source: Established by us from EXCELL

Every single one of these data was collected and calculated if needed on collaboration with the company personals in the appropriate function and department

- Collected data: Security inventory, Initial inventory, Workforce cost / Month, Ratio EH / NH, Effective, Effective, Q production, Extra hour cost, Inventory Capacity, Production capacity.
- Calculated data:
 - Stockage cost / Unit / Month: calculated based on the safety stock in the technical inactivity = (The sum of charges + scrap) / number of units to store
 - Hiring Cost: with the collaboration of the Human resources department, we have calculated this one based on this: Signing of the contract + insurance + work outfit + training formation...
 - Firing cost: With the same department we have calculated it based on: Hiring cost – training – work outfit.....

This information will be used to make an S&OP later.

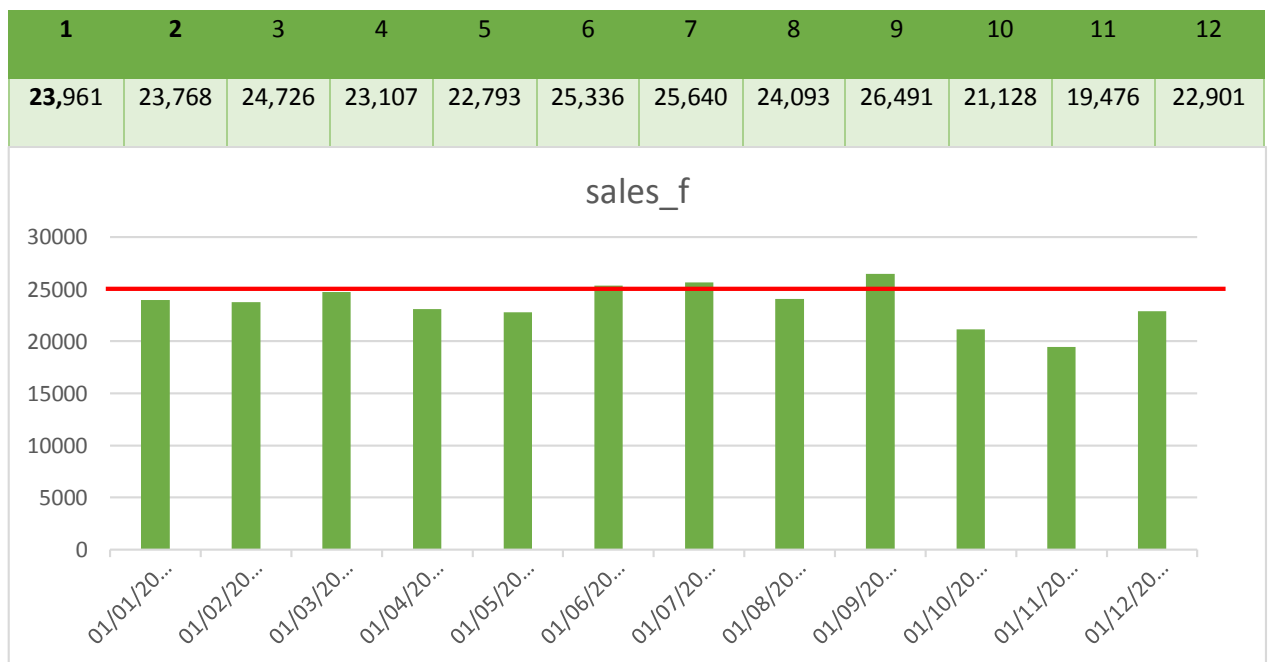
3 Application

Here we are going to put in place the sales and operation planning, and for that the following steps had been elaborated.

3.1 Data presentation

After making the Semolina Sales forecast for the 2023 year, we have established this table to present and clarify our S&OP choice.

Figure 25: Data presentation for planning S&OP



Source: Established by us from Excel

In the previous title, we have mentioned the capacity of production specified for the ICC of the high mills of Setif. This last one can be used along side with other resources as a born to estimate the maximum performance of the Complex when it comes for Semolina production.

This capacity has been identified by the personal of the complex based on their experience and the material situation without forgetting all the necessary resources that can be used in the production process. The capacity was estimated at 2500 Q/M.

Following this Bar graph, we can see that the majority of the quantity that have been forecasted are situated under the capacity line (over-capacity / Under-charge). The exceptions

are the 6th, 7th and 9th months (Under-capacity / Over-charge), in order to fix this excessive demand, the company can use multiple solutions such as:

- Out-sourcing the production in these two periods (Out-sourcing capacity).
- Capacity smoothing: trying to anticipate the excessive demand by producing more than expected in the previous months with an Under-charge of capacity.
- Make some investment to rise the capacity (Depends on the budget and the strategical plan of the company)
- Double the workforce team (Hiring, Extra hours....)

In the case of our company there are other strategies that can be used:

- Demand from other complexes the quantity needed to satisfy the market demand (Interview guide / question 10)
- Making a demand for more raw materials supply from the OAIC (Interview guide / question 10)

These solutions are all applicable. However, it is impossible to define which one is the best one to choose without making a planification using them. Here, in this specific point the importance of S&OP came.

3.2 Application of the S&OP

Before starting the S&OP application, it is important to define what kind of scenarios we have chosen for elaborating this last one.

Indeed, based on the politic and the resources applied by the company for reaching their Objectives. And based on the description of the planification of the production process within this enterprise. We have decided to make two S&OP scenarios:

- Constant production with Hiring option.
- Synchronised production with Hiring option.

The two scenarios respond to the politic and work method employed inside this firm. Indeed, the options mentioned above are simple to place and allowed a bigger control on the production process comparing with other scenarios.

These options will be analysed in order to determine which of them is the Best in term of performance and cost.

3.2.1 S&OP Constant Production with hiring option

	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
Demand (Client)		23,916	25,228	27,488	25,120	25,466	26,652	26,978	30,160	29,342	27,156	25,718	25,838	319,100
Plan (Production)		26,596	26,596	26,596	26,596	26,596	26,596	26,596	26,596	26,596	26,596	26,596	26,596	319,140
Previsional Inventory	4,000	6,680	8,047	7,155	8,630	9,760	9,703	9,321	5,756	3,010	2,449	3,327	4,000	

Capacity decision = (NUMBER OF WORKERS)

Capacity requirement (Charge)		63	63	63	63	63	63	63	63	63	63	63	63	63
Capacity available (Staffing)		60	63	63	63	63	63	63	63	63	63	63	63	63
Capacity addition		3	0	0	0	0	0	0	0	0	0	0	0	0
Capacity reduction		0	0	0	0	0	0	0	0	0	0	0	0	0
Extra hours (EH)														
Possible hours														
Initial Load/Capacity Gap		-3	0	0	0	0	0	0	0	0	0	0	0	0
Final Capacity		63	63	63	63	63	63	63	63	63	63	63	63	63
Ecart Charge/Capacité Final		0	0	0	0	0	0	0	0	0	0	0	0	0

Plan cost

Storage cost	1,067,950	1,472,650	1,520,150	1,578,450	1,838,950	1,946,250	1,902,350	1,507,650	876,550	545,850	577,550	736,850	15,571,500
Salary cost	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	30,394,050
Hiring cost	83,065	0	0	0	0	0	0	0	0	0	0	0	83,065
Firing cost	0	0	0	0	0	0	0	0	0	0	0	0	0
Overtime cost													
Total	3,683,920	4,005,555	4,053,055	4,111,355	4,371,855	4,479,155	4,435,255	4,040,555	3,409,455	3,078,755	3,110,455	3,269,755	46,049,500

Source: Elaborated by us using Excel

3.2.2 S&OP Constant production with Extra Hour option

	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
Demand (Client)		23,916	25,228	27,488	25,120	25,466	26,652	26,978	30,160	29,342	27,156	25,718	25,838	319,100
Plan (Production)		26,596	26,596	26,596	26,596	26,596	26,596	26,596	26,596	26,596	26,596	26,596	26,596	319,140
Previsional Inventory	4,000	6,680	8,047	7,155	8,630	9,760	9,703	9,321	5,756	3,010	2,449	3,327	4,000	

Capacity decision = (NUMBER OF WORKERS)

Capacity requirement (Charge)		63	63	63	63	63	63	63	63	63	63	63	63	
Capacity available (Staffing)		60	63	63	63	63	63	63	63	63	63	63	63	
Capacity addition														
Capacity reduction														
Extra hours (EH)		3	3	3	3	3	3	3	3	3	3	3	3	
Possible hours		30	30	30	30	30	30	30	30	30	30	30	30	
Initial Load/Capacity Gap		-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	
Final Capacity		63	63	63	63	63	63	63	63	63	63	63	63	
Ecart Charge/Capacité Final		0	0	0	0	0	0	0	0	0	0	0	0	

Plan cost

Storage cost	1,067,950	1,472,650	1,520,150	1,578,450	1,838,950	1,946,250	1,902,350	1,507,650	876,550	545,850	577,550	736,850	15,571,000
Salary cost	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	2,532,905	30,394,050
Hiring cost													
Firing cost													
Overtime cost	199357.1429	199357.1429	199357.1429	199357.1429	199357.1429	199357.1429	199357.1429	199357.1429	199357.1429	199357.1429	199357.1429	199357.143	2,392,212
Total	3,800,212	4,204,912	4,252,412	4,310,712	4,571,212	4,678,512	4,634,612	4,239,912	3,608,812	3,278,112	3,309,812	3,469,112	48,358,000

Source: Elaborated by us using E-views

4 Results conclusion

At the end of the 2023, the enterprise can end up with these two results

- Constant production with Hiring option = **31,977,550 DA with 4 months of non inventory performance.**
- Synchronise production with Hiring option = **28,123,310 DA with 0 months of non inventory performance.**

By analysing the two scenarios and making the necessary calculation, we have concluded that the constant production with hiring option generates less outcome in terms of cost and performance (High cost / less performance) than the Synchronise production with Hiring option.

Therefore, it is more beneficial for our company to adapt the Second scenario in order to minimise their cost and augment their performance.

Chapter conclusion

Via the examination of the data gathered from the executed tests, we have been able to come to certain findings through this chapter that allow us to verify our initial hypothesis.

We have Proposed a new Forecast technique that it has never been used by our company and it appears that it is a performant method referring to the results generating by this last one in term of accuracy. We can conclude that the Box-Jenkins method used in our experiments generate an accurate forecast that can be used for different planification within this firm.

Furthermore, we elaborated a production plan based on the politic applied by the enterprise and the available resources in addition of its future objectives. The S&OP was the appropriate tool in our study which has been used to describe the best production plan that this enterprise can follow for the 2023 year. Indeed, the Synchronise production with hiring option generate less cost and higher performance thus the best scenario.

It is also important to emphasize the significance of the methodology followed and the proper preparation of the model parameters before embarking on such forecasting experiments because of all the consequences that can be led by that.

General conclusion

General conclusion

The objective of our research work was to study the potential benefits that the High Plateaus Grains Branch could derive from implementing a quantitative demand forecasting method which is the Box-Jenkins as part of improving the production planning choices. The literature review in the first chapter provided us with a solid theoretical foundation regarding the basic principles of Bothe Sales Forecast and the production planning process and the sequence of their steps, as well as the data required for conducting these two variables.

While considering these theoretical aspects, we conducted demand forecasting experiments using the Box-Jenkins method on E-views 13 software based on sales data for the last 4 years (from 2019 till 2022). Then, by using the generating results we have proposed two Sales and operation scenarios that respond to the political and work method within this company.

The results of these two variables had been subject of a comparative analyse in order to conduct a conclusion confirming or rejecting our previously set hypotheses.

Based on that, the following conclusion were established:

- Hypothesis 01: The Box-Jenkins method generates accurate forecasts and can be used for planning production.

We confirm this hypothesis, because through our sales forecast experience we have made the 2023 prediction serie which had been compared with the real sales of the first trimester of the same year and we have concluded using one of the Key Performant Indicators (KPI) which is the Mean Absolute Percentage Error (MAPE) that our forecast accuracy is performant and can be used for planning production.

- Hypothesis 02: The S&OP constant production scenario with Hiring option generates better results than the S&OP synchronise production scenario with Hiring option.

After making the necessary calculation and analysing the two Sales and Operation scenarios, we have concluded that the S&OP constant production scenario with Hiring option generates less outcomes than the S&OP synchronise production scenario with Hiring option in terms of both cost and performance. This result led us to reject this hypothesis.

In conclusion, the Box and Jenkins method has considerable advantages. Despite of all the stages that should be completed before generating the results, this forecast technic realise accurate results that can be confirmed in our case. In addition of a production plan can be

elaborated based on the generated results. More advantages can include its speed of use and the low cost it requires, as it can be implemented using the available tool, E-views under a condition of a monthly or yearly non expensive subscription. When I come to the production plan, numerous methods can be propose depending on the politic and objectives of the companies and mostly the available data.

From our study experiments, we can propose the Box-Jenkins forecasting method as our managerial contribution to the production planning process of the company along side with the S&OP because of the accurate results that this method can provide in term of forecasting and contribution to the S&OP performance.

It is essential to mention that this method has its own limits and can't generate accurate forecast all the time. On top of that, our study does not use other time series which can generate better results and in addition, the non availability of data under confidentiality purposes can be concerned as a limit for conducting both forecast experiences and production plan processes.

Finally, it should be noted that our present study remains to be further developed, the field of Production planning, and demand forecasting are vast and cannot be fully explored in a single research work. Nevertheless, we hope to have contributed to this discussion, and we encourage other researchers to enrich our findings by pursuing these interesting research avenues:

- The contribution of demand forecast on the performance of the Master production Schedule.
- The impact of the sales forecasting on the overall performance of the inventory process.

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- Executive Decree No. 20-241 dated August 31, 2020

Annexes

Annexes

Annexe 1: Interview guide about the Forecast and production plan process within the Upper Plateau Cereals Branch

Interview Guide

Name of the interviewer :.....

Date of the interview :.....

Interview time :.....

As part of our graduation thesis, we are conducting a pragmatic study on the Planification of production process. We would be grateful if you would reply to our interview.

Question 1: Can you present yourself?

Question 2: what is your statue in this company, what are your functions?

Question 3: what is the method of prevision that your company use?

Question 4: How do you realise that kind of forecast technique?

Question 5: can you describe the process for establishing the Budget prevision?

Question 6: how do you put in place a Strategic plan?

Question 7: what are the competent of this Plan and Budget?

Question 8: what about the Tactical and operational planning?

Question 9: What type of production do your complex use?

Question 10: when do you use the first approach, and the second one?

Question 11: in your opinion, how can forecasts contribute on the performance of the production planning inside your company?

Question 12: is there any other functions that can have an impact on the performance of the planification of production?

Annexe 2: Order Letter from Agro-div General Direction



الشركة القابضة للصناعات الغذائية "أفرو ديف"
SOCIÉTÉ HOLDING AGRO INDUSTRIES «SPA AGRODIV»
Société par Actions au Capital Social de 10 261 000 000 DA

REF. N° 428 /PDG/AGRODIV/DP/2022

Alger, le 12 OCT. 2022

**Messieurs les Présidents Directeurs
Généraux et Directeurs Généraux des Filiales**

Objet : A/S du Budget 2023.

Messieurs,

Une bonne planification peut faire la différence en matière de croissance, elle permet de concentrer les ressources sur l'amélioration des bénéfices, la réduction des coûts et l'augmentation du taux de rendement sur investissement.

L'examen de vos indicateurs de gestion actuels et l'analyse des opportunités et menaces, réussites et échecs que vous avez connus vous guidera dans la détermination de vos objectifs clés pour l'année à venir.

Le budget de l'exercice 2023, traduction chiffrée de votre plan annuel, vous permettra de prendre les décisions financières adéquates et d'atteindre vos objectifs.

Les projets de développement devraient requérir une attention particulière en matière de leurs financements et les moyens à y mettre en œuvre.

En matière de stratégie commerciale, nous rappelons une fois de plus la nécessité d'élargir le réseau de distribution par l'ouverture de nouvelles infrastructures commerciales pour faire basculer progressivement la part de la clientèle grossistes au profit des autres types de clients (cibler 40% pour les grossistes).

Les budgets alloués aux projets d'investissement matériels et immatériels doivent être clairement définis et apparaître dans votre plan de financement 2023.

Le document portant budget de l'exercice 2023 et comportant les annexes déglobalisées mensuellement devra nous parvenir au plus tard le 20 Octobre 2022 et ce, avant de le soumettre à votre organe de gestion.

Salutations.

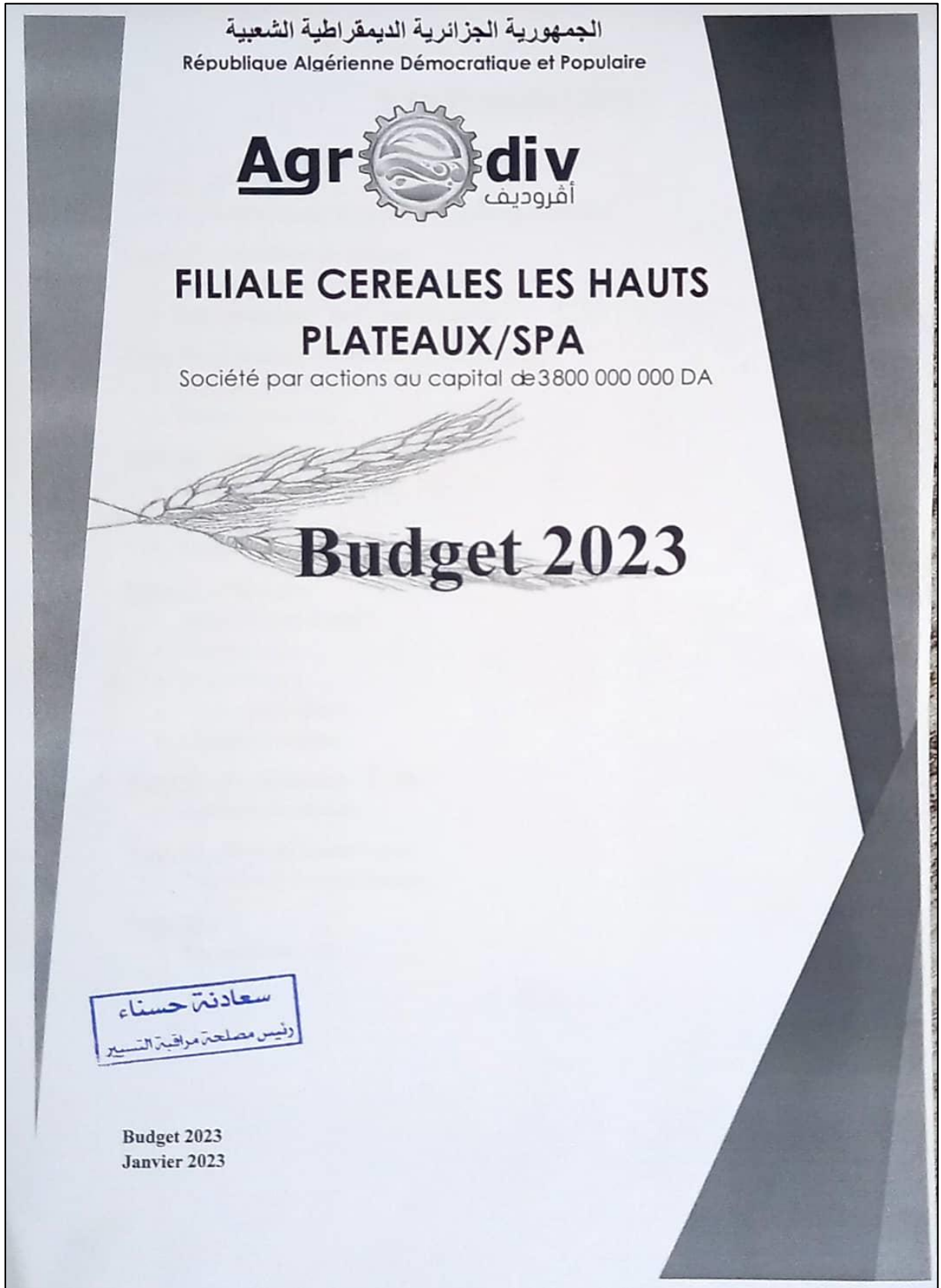


Directeur du Portefeuille P/ Le Président Directeur Général

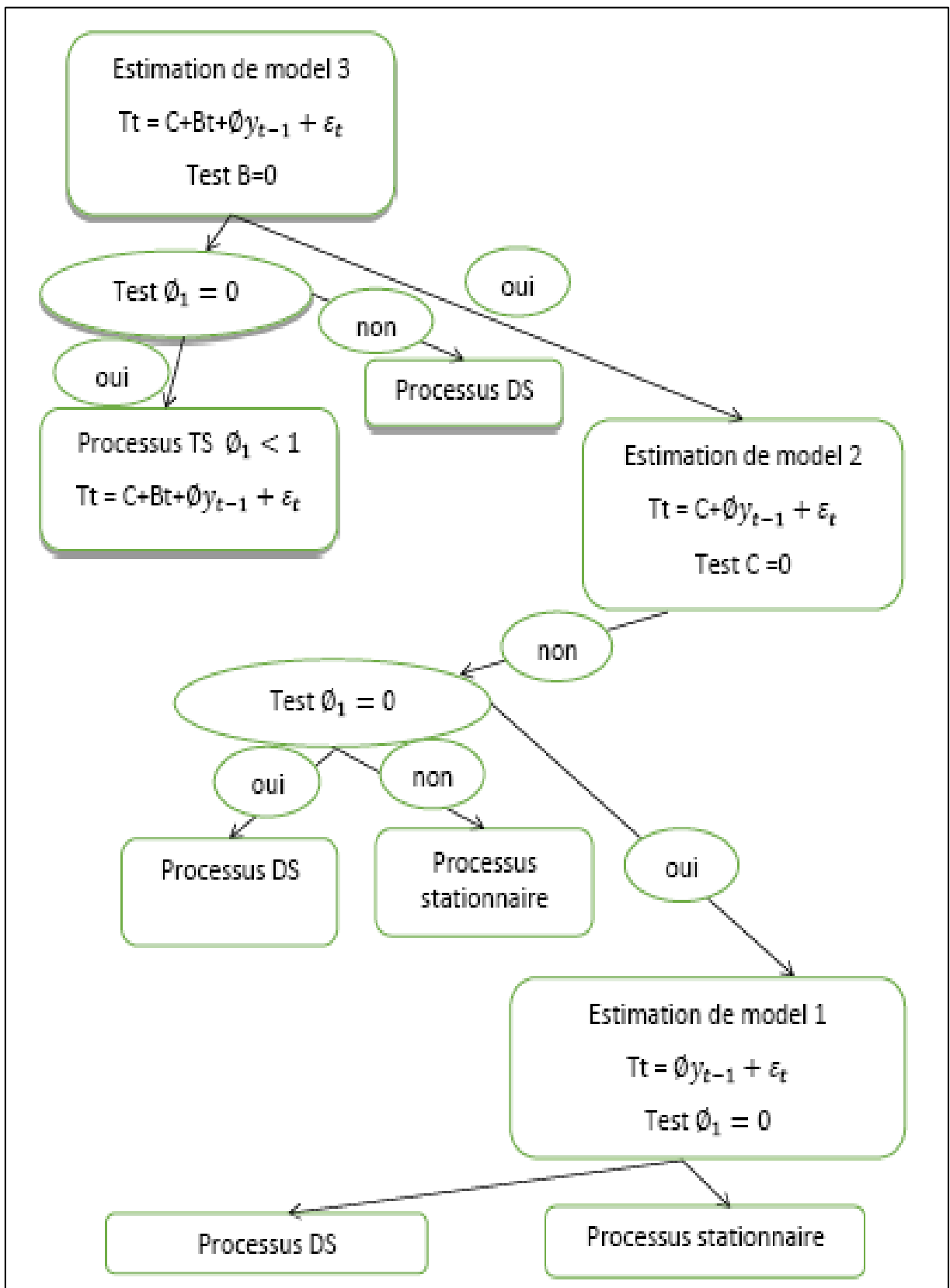
M.C. DELLOUE

Adresse 28 Avenue Colonel Bougara - Belle Vue El Harrach - Alger
RC : 02B0016957 - 16/00 / NIF : 000216001695773
Tél : 023 60 97 20 / 24 Fax : 023 60 99 24
Email : contact_groupe@agrodiv.dz

Annexe 3: The Plan and Budget established by the branch for the 2023 year



Annexe 4: Augmented Dickey Fuller Schema



Annexe 5: Khi-deux table

LOI DU KHI-DEUX AVEC k DEGRÉS DE LIBERTÉ QUANTILES D'ORDRE $1 - \gamma$

k	γ										
	0.995	0.990	0.975	0.950	0.900	0.500	0.100	0.050	0.025	0.010	0.005
1	0.00	0.00	0.00	0.00	0.02	0.45	2.71	3.84	5.02	6.63	7.88
2	0.01	0.02	0.05	0.10	0.21	1.39	4.61	5.99	7.38	9.21	10.60
3	0.07	0.11	0.22	0.35	0.58	2.37	6.25	7.81	9.35	11.34	12.84
4	0.21	0.30	0.48	0.71	1.06	3.36	7.78	9.94	11.14	13.28	14.86
5	0.41	0.55	0.83	1.15	1.61	4.35	9.24	11.07	12.83	15.09	16.75
6	0.68	0.87	1.24	1.64	2.20	5.35	10.65	12.59	14.45	16.81	18.55
7	0.99	1.24	1.69	2.17	2.83	6.35	12.02	14.07	16.01	18.48	20.28
8	1.34	1.65	2.18	2.73	3.49	7.34	13.36	15.51	17.53	20.09	21.96
9	1.73	2.09	2.70	3.33	4.17	8.34	14.68	16.92	19.02	21.67	23.59
10	2.16	2.56	3.25	3.94	4.87	9.34	15.99	18.31	20.48	23.21	25.19
11	2.60	3.05	3.82	4.57	5.58	10.34	17.28	19.68	21.92	24.72	26.76
12	3.07	3.57	4.40	5.23	6.30	11.34	18.55	21.03	23.34	26.22	28.30
13	3.57	4.11	5.01	5.89	7.04	12.34	19.81	22.36	24.74	27.69	29.82
14	4.07	4.66	5.63	6.57	7.79	13.34	21.06	23.68	26.12	29.14	31.32
15	4.60	5.23	6.27	7.26	8.55	14.34	22.31	25.00	27.49	30.58	32.80
16	5.14	5.81	6.91	7.96	9.31	15.34	23.54	26.30	28.85	32.00	34.27
17	5.70	6.41	7.56	8.67	10.09	16.34	24.77	27.59	30.19	33.41	35.72
18	6.26	7.01	8.23	9.39	10.87	17.34	25.99	28.87	31.53	34.81	37.16
19	6.84	7.63	8.81	10.12	11.65	18.34	27.20	30.14	32.85	36.19	38.58
20	7.43	8.26	9.59	10.85	12.44	19.34	28.41	31.41	34.17	37.57	40.00
21	8.03	8.90	10.28	11.59	13.24	20.34	29.62	32.67	35.48	38.93	41.40
22	8.64	9.54	10.98	12.34	14.04	21.34	30.81	33.92	36.78	40.29	42.80
23	9.26	10.20	11.69	13.09	14.85	22.34	32.01	35.17	38.08	41.64	44.18
24	9.89	10.86	12.40	13.85	15.66	23.34	33.20	36.42	39.36	42.98	45.56
25	10.52	11.52	13.12	14.61	16.47	24.34	34.28	37.65	40.65	44.31	46.93
26	11.16	12.20	13.84	15.38	17.29	25.34	35.56	38.89	41.92	45.64	48.29
27	11.81	12.88	14.57	16.15	18.11	26.34	36.74	40.11	43.19	46.96	49.65
28	12.46	13.57	15.31	16.93	18.94	27.34	37.92	41.34	44.46	48.28	50.99
29	13.12	14.26	16.05	17.71	19.77	28.34	39.09	42.56	45.72	49.59	52.34
30	13.79	14.95	16.79	18.49	20.60	29.34	40.26	43.77	46.98	50.89	53.67
40	20.71	22.16	24.43	26.51	29.05	39.34	51.81	55.76	59.34	63.69	66.77
50	27.99	29.71	32.36	34.76	37.69	49.33	63.17	67.50	71.42	76.15	79.49
60	35.53	37.48	40.48	43.19	46.46	59.33	74.40	79.08	83.30	88.38	91.95
70	43.28	45.44	48.76	51.74	55.33	69.33	85.53	90.53	95.02	100.42	104.22
80	51.17	53.54	57.15	60.39	64.28	79.33	96.58	101.88	106.63	112.33	116.32
90	59.20	61.75	65.65	69.13	73.29	89.33	107.57	113.14	118.14	124.12	128.30
100	67.33	70.06	74.22	77.93	82.36	99.33	118.50	124.34	129.56	135.81	140.17

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