LocalSolver

Agricultural Planning Optimization

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LocalSolver

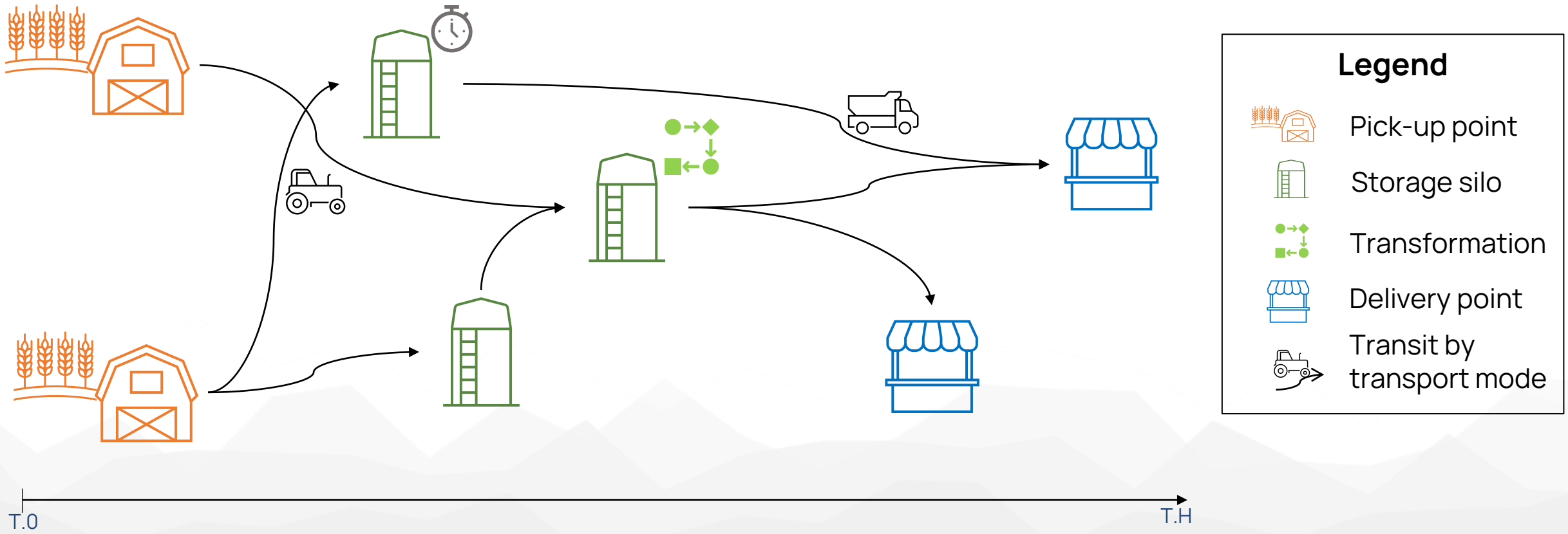
Optimization & Decision-Making Tool

- A generic, powerful solver
- 200 customers, 10,000 users, 25 countries
- Linear, non-linear and collection modeling
- Exact and heuristic techniques
- Quality solutions in seconds

Business problem
Agricultural Planning

Business problem

Plan the transport of grain between different locations and over several periods of time, in order to collect the grain produced and transport it to end customers.



Data

Grain collection

Several species of grain, each of which can be divided into several types

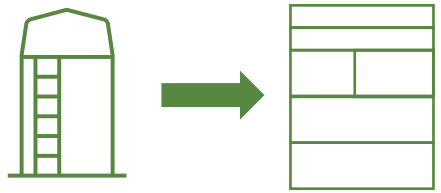
At a collection point: production of one type of grain in a certain quantity

Data

Storage & transformation silos

Storage of a certain type of grain in a certain quantity

- In silos, divided into several cells
- Only one type of grain per cell per period



Transformation: assets on certain silos, allowing one type of grain to be transformed into one or more other types of grain:

$$\alpha g_1 = \beta g_2 + \gamma g_3$$

Data

Delivery & transport

Delivery

Orders: grain types and quantities

Two modes:

- Internal: Delivery via transport modes
- External: The customer collects his order himself at the collection point (for a fee).

Transport

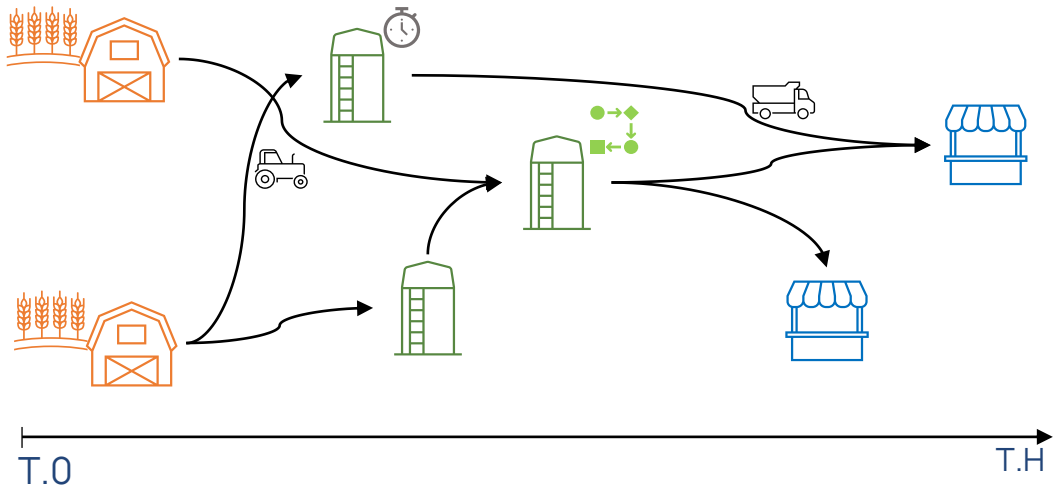
3 different transport modes

Different costs and capacities, according to the number and type of grain

Problem modeling

Decisions

- Quantity of each grain type transiting between each pair of points, and associated mode of transport
- For each cell, the type of grain affected
- For each silo, the transformations carried out



=› These decisions must be made for each period of the problem, a period corresponding to one or several months.

Problem modeling

Objectives

In order of priority:

- Maximize grain collection,
- Satisfy customer demand,
- Minimize transportation and transformation costs.

Issue: Ensure continuity between different periods of time

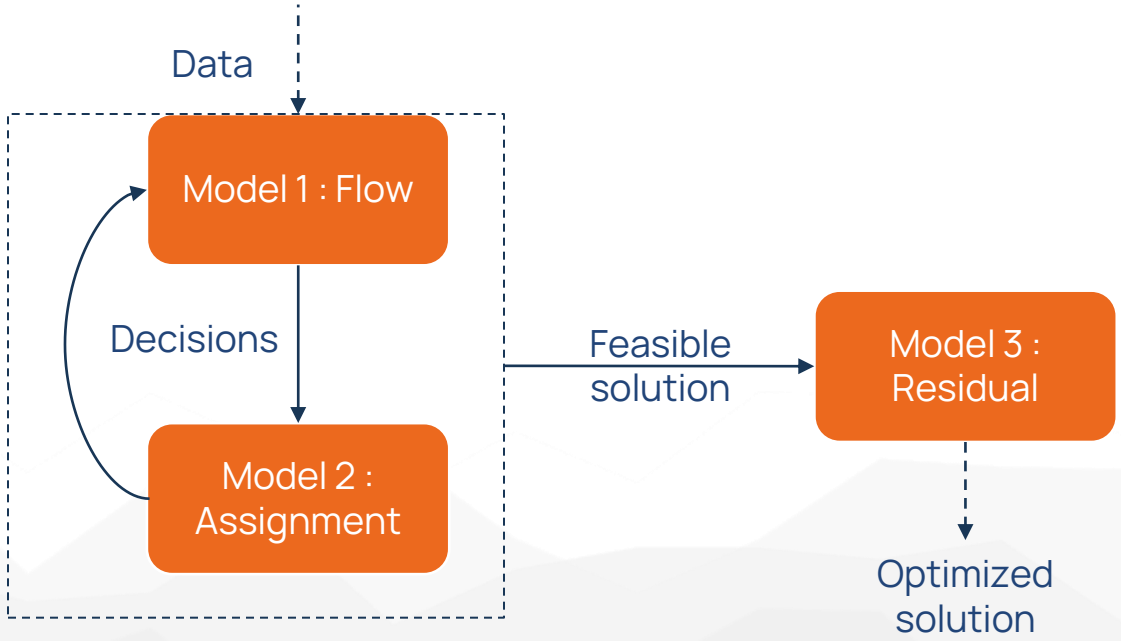
=› Anticipate demand and manage stocks

Our approach
Problem resolution

Approach adopted

As the initial problem was complex, it was decided to break it down into 3 successive models

- Allows decisions and constraints to be managed progressively
- High-quality solutions obtained, robust to the number of periods
- Acceptable resolution time for the customer (a few tens of minutes)



The resolution of the various models was performed with LocalSolver

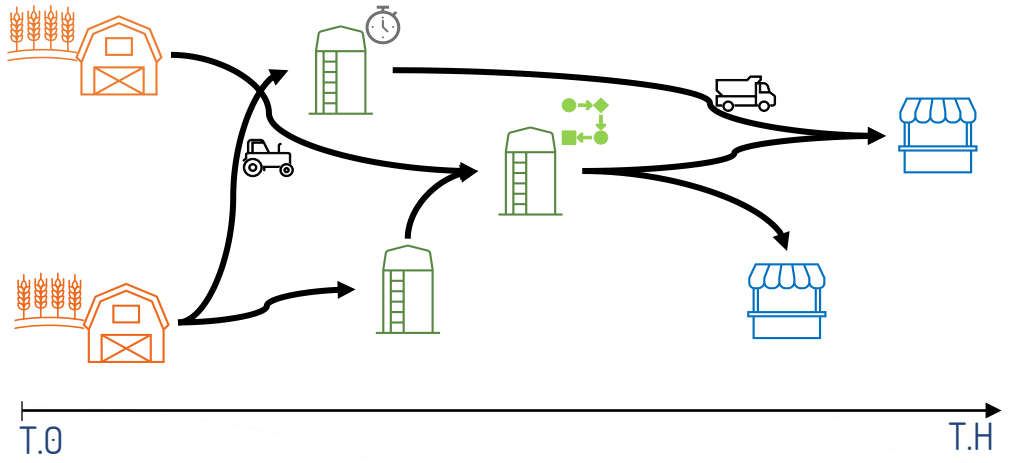
Model 1 : Flow

Flow of grains between each pair of points

Decisions

- Quantity of each type of grain transiting each period between each pair of points and the associated mode of transport
- Quantity transformed by each method at each silo in each period

Capacity constraints (collection, demand, transport)



Model 1 : Flow

Flow of grains between each pair of points

Storage constraints

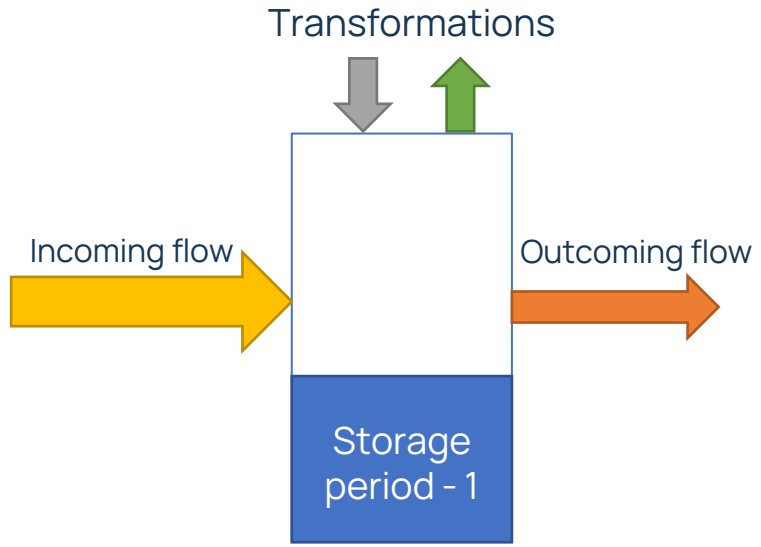
- Flow and capacity constraints (by grain type)

$$0 \leq \text{stored\_quantity}[p][s][g] \leq \text{max\_stored\_quantity}[g][s]$$

- Capacity constraint (on silo)

$$\sum_{g} \text{stored\_quantity}[p][s][g] \leq \text{max\_stored\_quantity}[s]$$

- **Relaxation of grain type / cell assignment constraints**



Model 2 : Assignment

Grain type assignment to each cell in each silo

Decisions

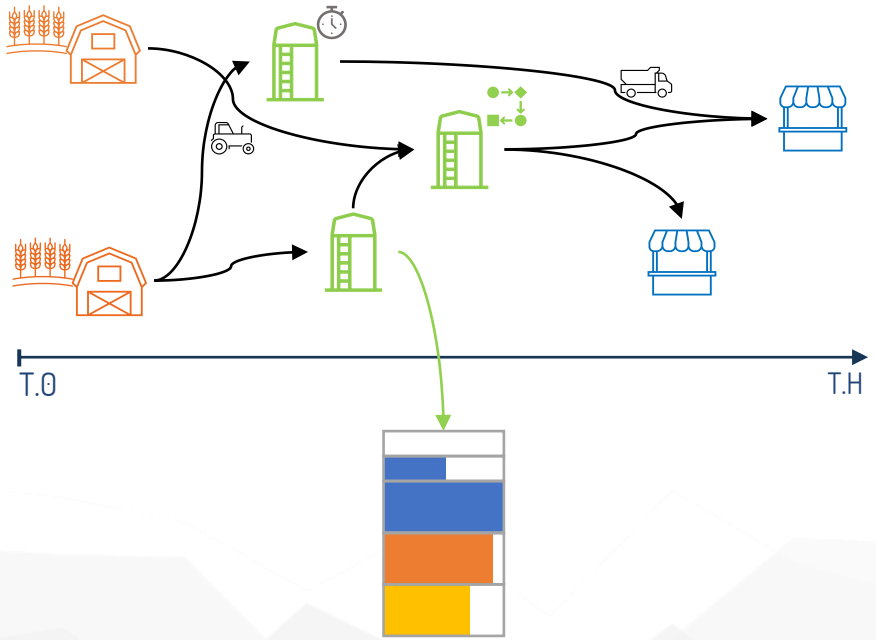
- Determine whether the cell is assigned to grain g in period p

Constraints

- 1 grain type per cell
- Continuity between periods
    - If a cell is assigned to a grain type in period p-1 with stored grain, it must also be assigned in period p

Objectives

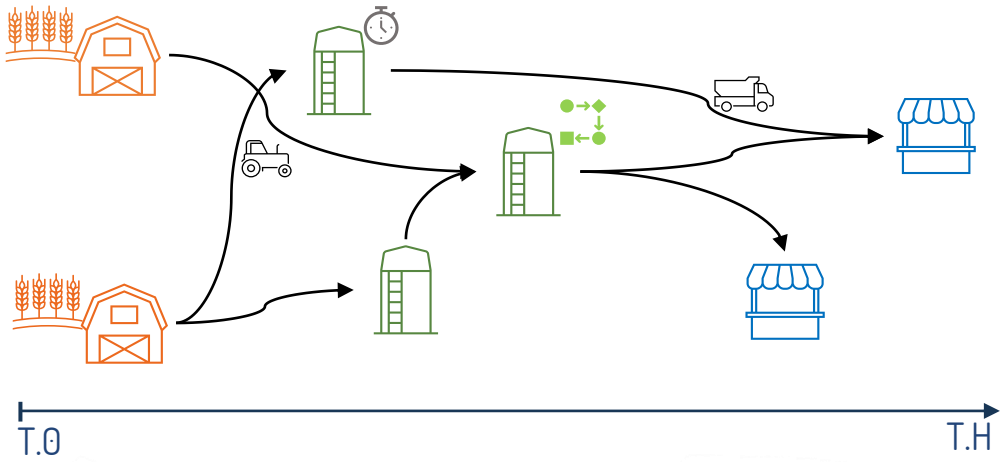
- Minimize the penalty for exceeding the capacity of each cell
    - Depending on the quantity of grain to be stored in period p according to the flow model
- Minimize the number of unallocated cells



Model 1 : Flow

Flow model restarted by adding cell assignment constraints

=›The type of each cell is set at each period according to the solution found by the previous model



1st feasible solution for the complete problem ✓

Model 3: Residual

Collect remaining grain and satisfy remaining demands

1. Fixes the solution found previously
2. Reduced flow and assignment model on remaining data
   - Possibility of modifying the type of cells that are empty during certain periods, to collect the last grains that could not be collected before due to rigid assignment constraints

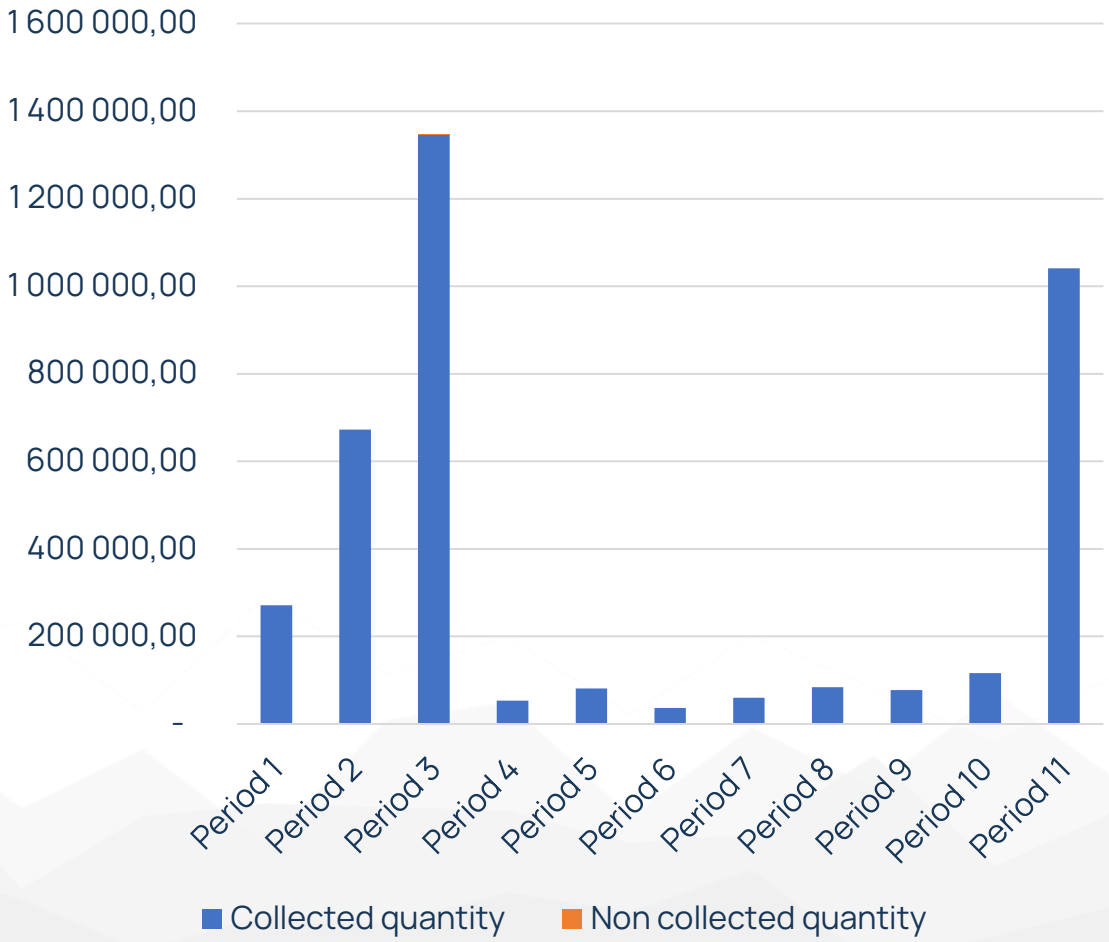
Optimized solution for the complete problem ✓

Results obtained

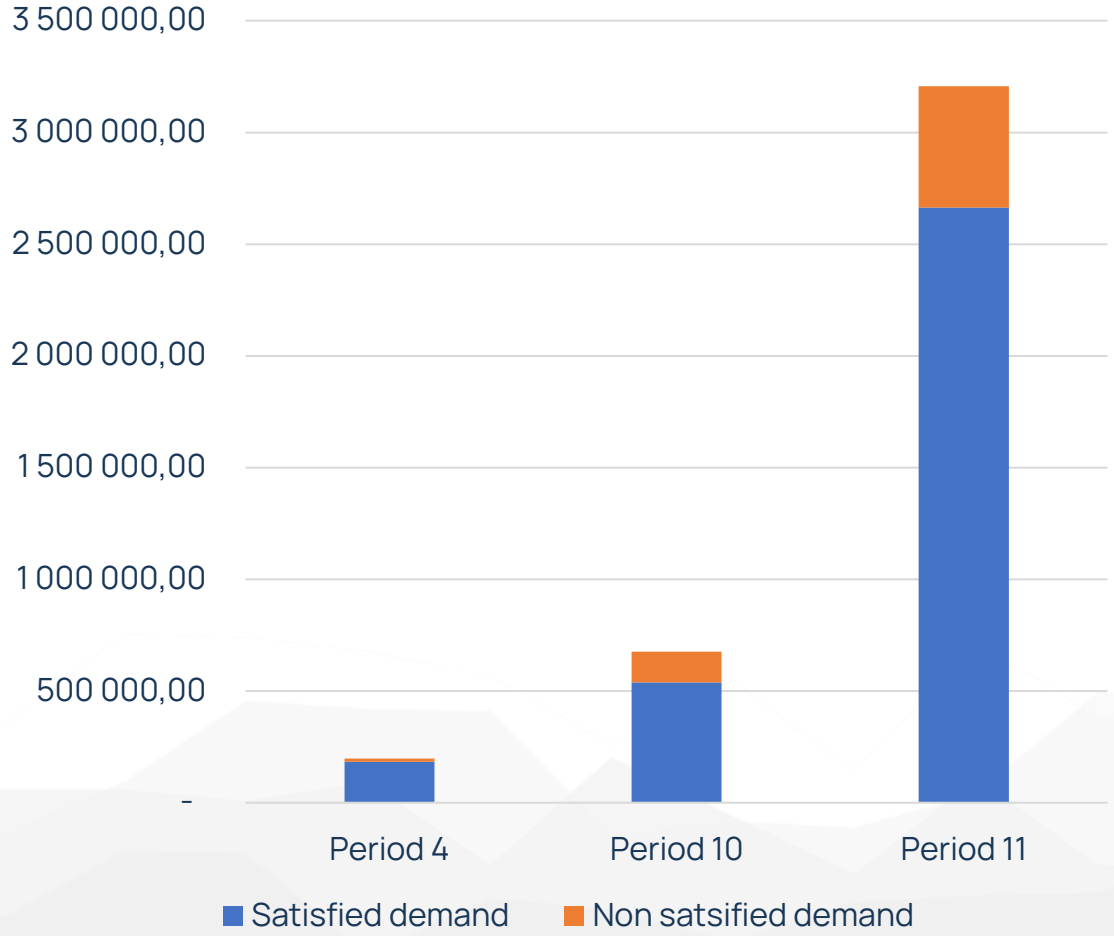
Results

11 periods

Grain collection



Demands



Conclusion

This approach enables us to obtain quality solutions in a reasonable amount of time, for different numbers of periods (robustness).

Nb periods	Collection	Demand	Cost	Running time	Storage saturation
3	100 %	84,8 %	~35,5M €	7 min	52,5 %
11	99,9 %	84,5 %	~37,5M €	15 min	60,6 %

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