Supporting the Decision Making Process of a Brazilian Apple Producer – A Challenge for the Owner

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Key Words

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Abstract

Our purpose with this work is to present and discuss an application of the System Dynamics method in a Brazilian agricultural company, discussing the challenges, benefits, problems and results of a consultancy project aimed to support the Company's strategic and operational decisions. Using Group Model Building methodology and the software Ithink two models were built, and an important change in the planning process was finally implemented. The first model, representing the production and debt structure of the Company was created to support long term investment decisions. The second model showing the Company's financial structure in detail was created to support the annual planning, budgeting activities and to test commercial decisions. The results achieved show how System Dynamics can be used to improve the decision making process and to support the management's and the owner's learning processes.

Introduction

An apple producer from southern Brazil wants to improve the Company's annual planning and budgeting process. Decisions involving investments, and disinvestments, must be implemented considering its long term effects and the short term financial pressures. The methods and tools that were used in the past to support the planning process were based on expert opinions, formal interaction, fragmented views, and tools that tried to *predict* the future. This project was conducted in two phases during the years of 2004 and 2005, it is based on the Group Model Building approach and the System Dynamics methods and tools.

An Apple Introduction

Located in the "cold" lands in the south of Brazil this company was founded in the 50's by a group of farmers emigrating from France. Despite of all the uncertainties and technical challenges faced at that time these pioneer farmers, like some few others that emigrated to the south of Brazil, believed that apples could one day be produced in commercial scale in that region. Nowadays, the Brazilian apple production is a business of US$360 millions per year[1] with a planted area of more than 32,000 hectares and a total

[1] Data from the Brazilian Association of Apple Producers.

production of 700,000 tons. The Brazilian production is sold mainly for fresh eating in the national markets, exports represent 20% in value; apple vinegar, apple juice and apple chips represent only a small part of the total revenue.

The Apple's Orchard Time Frame – Considering the main varieties planted in Brazil (gala and fuji) and the way they are normally handled, an apple orchard, as shown in Figure 1, has a maximum productive life cycle between 22 and 27 years.

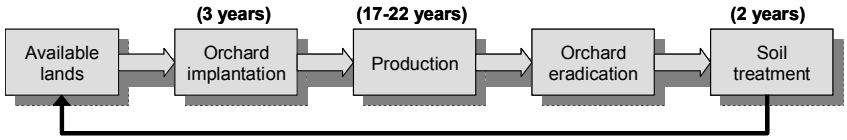


Figure 1: Orchard time frame

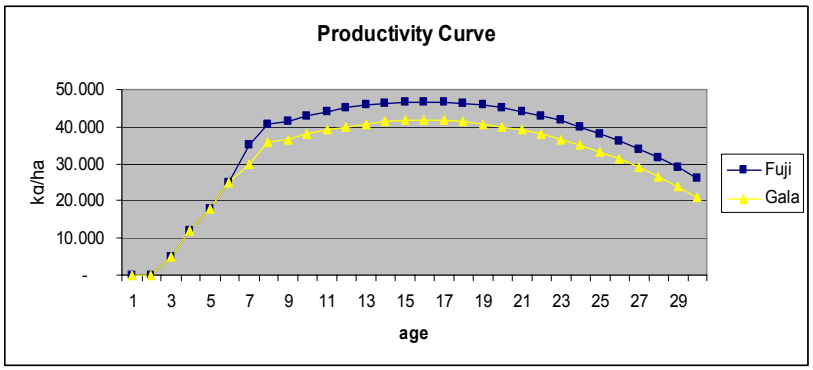


Figure 2: Average productivity by age

The productivity depends on the age of the apple trees; a typical potential productivity curve is shown in Figure 2.

Annual Production Cycle - The annual production cycle begins in June with the cold days of the winter, when the apple trees loose their leaves, rest and prepare their energy for the blossom of spring and for the growth of their fruits that will be harvested in March and April. The quality and quantity produced each year depends upon the weather conditions of each season: rain, number of cold days in winter, temperature in spring, frost and hail are all variables affecting the production. A cyclical effect called "variation" seems to affect the production levels. Even in years when the weather is considered excellent the production levels may be very low. The "variation" effect means that a production level extremely high in one year may cause low levels of production in the next one or two years, this seems to be caused by the depletion of the plant resources. Handling techniques used by some farmers seems to avoid the "variation" effect by the elimination of the excess of blossoms and fruits (mechanical and chemical techniques are used). These effects combined can cause an orchard to produce 0 to 60 tons of apples with commercial value per hectare per year.

Market and Prices – The national production is concentrated in only 3 months of the year, the prices can rise and fall more than 20% during a year. Depending on its variety, quality and internal characteristics, the apples can be stored for almost 12 months using refrigerated and controlled atmosphere storage. The national storage capacity, owned by different farmers, is estimated in 540.000 tons (280.000 tons of regular refrigerated storage and 260.000 tons of controlled atmosphere storage). Variables affecting the prices include: total national production, fruit quality (volume produced per category and fruit durability), imported and exported volumes, exchange rate, general economy conditions (unemployment level, average income).

Initial Situation - 2004

With more than 50 years of experience, this company is one of the major players in the Brazilian market. In the 1980s the company used to represent 10% of the entire national production. Facing financial problems since 1992, the company was forced to sell 50% of its orchards over the last years to pay part of its debts. Now with 980 hectares of planted area the Company has an average total annual production of 32.000 tons and a total storage capacity of 40.000 tons. Depending on market conditions, this extra starege capacity is used with apples bought from other producers.

This project initiated at the end of 2004 as part of the annual planning and budgeting activities. Planning for the owner and managers of this company used to mean "a formal budget forecasting activity that *must* be conducted every year". Using spreadsheets in Excel to support the planning process, they could simulate monthly the next two years production, revenues, costs and profits. The Strategic Committee was responsible for the decisions formulation, and one expert was responsible for the simulation of those decisions using the Excel file. Several days could separate the Strategic Committee decision from the final results. During one entire month all sort of calculations were made by the different specialists of the Company, the best guesses were used to predict the next year crop and a document showing the budget in detail was created and presented to the owner of the company.

The Excel file used in this process was growing year after year, with approximately 80Mbytes and 128 different worksheets, it had to be split in 3 different files to be run. Only one person was allowed to work with this tool, and the results of the simulations were used as an input to the budgeting meeting. The complexity (of details) made it difficult to identify errors within its formulas, changes could take days, and the entire responsibility for the results was in the hands of one single person. And as this specialist says "it was possible to simulate everything that the managers wanted, even things that we already knew that were physically unfeasible, the spreadsheet could be used to confirm the management expectations". The ever optimistic results of the simulation were used as an input to the Company budget, and the day to day "external" surprises were always responsible for the changes that had to be made in the budget, frequently transforming an expected profit into a "surprising" loss.

After several years of forecast and frustrations using this "method of planning", the managers and the owner of the company built a strong assumption about the planning process: "in our business, planning is an act of faith". In their minds, the uncertainties about the weather and market conditions, exchange rate and economic conjuncture, made it impossible to plan for the future. The annual planning process had been transformed into a formal obligatory document that had to be presented to the owner of the company, showing that the *managers were in control* (at least of some internal variables).

The Challenge

Tired of this situation and trying to turn the Company again into a profitable business, the owner invested in several initiatives, making internal process changes, restructuring the administration, and rethinking the planning process.

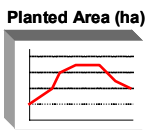
Our intervention, supported by the owner, was designed to meet some specific objectives:

- Restore the importance of and the confidence in the planning process;
- Transform the tacit knowledge held in the managers minds into a explicit knowledge base and an ongoing conversation that could be shared and accessed;
- Develop a better tool and methods to support the planning, decision making and budgeting activities;
- Have practical results in two months.

Phase I – Understanding the Company Main Dynamics

Using an approach based on the Group Model Building method we invited the owner of the company and the managers to participate in a process of appreciation of the main dynamics of the company. An introduction to System Dynamics was made and helped to establish a common ground for the development of the project. Meetings based on dialogue and open participation were used to explore the company system characteristics and behavior; data gathering was used to test the assumptions that were being revealed.

Behavior Over Time Graphs (BOTs) – *BOT* is a simple but valuable tool to reveal the main dynamics of a system, expanding our perceptions from events to patterns of behavior. Using the group knowledge and historical data the variables considered as "key resources" and "key results" were identified and their BOT graphs were traced. A sample of these variables and its logical description is shown next:



Starting with only few hectares the company used special governmental credit programs and bank financing to expand the planted area. The total planted area reached 2,000 hectares (ha) by 1985, but the combined effects of years of low profitability, high interest rates and management problems made the debts increase beyond the company's capacity of payment.

Trying to recover its financial health a tough decision had to be made, the old orchards were sold and the money was used to pay the debts. Although lands were sold to pay the debts the company was not able to reduce significantly its debt ratio. Now with only 980 hectares the payment of interest is still draining the company's operational profitability.

The Company's production level shows an oscillatory pattern; changes in the orchards handling methods seem to be reducing the oscillations and the "variation" effect, raising the average volume produced per hectare and improving the fruit quality. These changes and a strategy of having

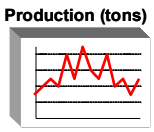


Figure 3: Example of BOT graphs

the orchards not concentrated in one single region are producing an important consequence: in years of low national production the company has more and better fruits than the average producers, and in years of high national production (when the prices are considerably low) the orchards are not being exhausted.

The first dynamic issue that emerged from these meetings was the balance between the debt structure and the production structure. This structure is depicted in Figure 4. An initial investment virtuous cycle (*R1*) was not able to generate the speed of growth wanted by the Company. A financed growth alternative was used (*B1*). The financed capital used to promote growth within the company was now a threat to its survival (*R2*) representing a debt vicious cycle. The reduction of the planted area and the process of selling lands were not being able to reduce the debt. Moreover, without new investments in new planted areas the orchard's average age was going up, and this short term financial orientation would put in risk the future production capacity. It is important to remember that a debt vicious cycle in Brazil can be extremely destructive since the interest rates are amongst the highest in the world.

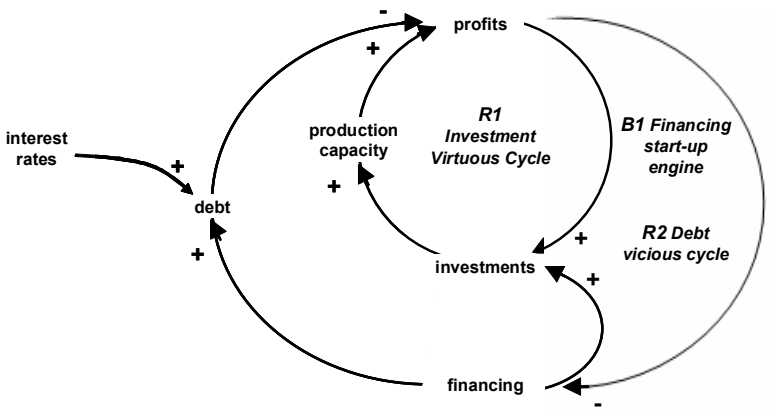


Figure 4: Debt and production structures

Decisions involving investing in new orchards or selling the old ones are crucial to the future of the Company; these decisions should consider at least a 22 years time frame (orchard's productive life cycle) and would give better answers to questions like: Will it be possible for the Company to escape from this perverse vicious cycle? What is the best investment policy?

Modeling and Simulation to Support Investment (disinvestments) Decisions – Our first modeling initiative tried to promote a better understanding of the production and debt structures of the Company. An interactive simulator was built to support the investment decision making process.

The orchard structure was represented by an *arrayed aging chain* – Figure 5. Using this structure every block (a planted area is divided by blocks) could be represented showing its location, number of hectares, age and variety planted.

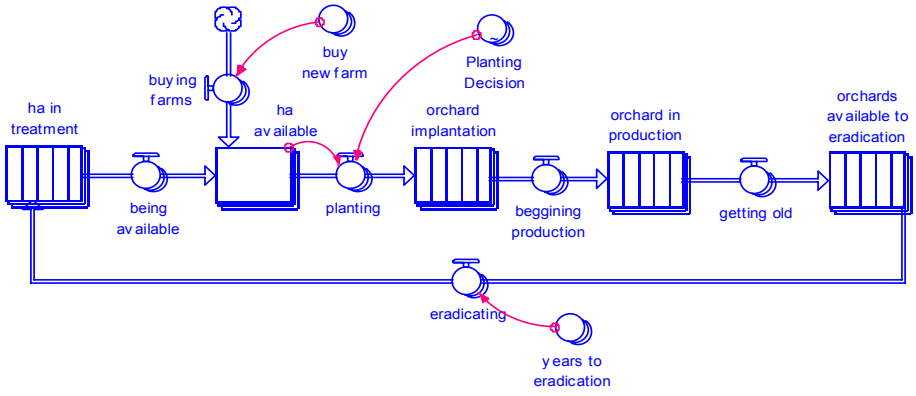


Figure 5: Orchard structure representation

The impact of investment and disinvestments decisions could be simulated. The debt structure was represented by an arrayed stock and flow structure with a reinforcing feedback loop. This array was used to represent different lines of credit with its own credit limits and interest rates. The actual debts and schedule of payments were represented by known values; new demands for financing were represented as a logical function.

The model that was built considered as exogenous variables: Interest rates, exchange rate, land prices, implantation and production costs, weather conditions, imports, international prices. The total national production and the domestic market prices are calculated considering the total planted area, imports and the weather conditions.

The control panel of the simulator presents the main results, inputs and the decision variables. The situation of the orchards, quality of the fruits (fruits per category), quantities produced and the financial results are plotted in different graphs and tables.

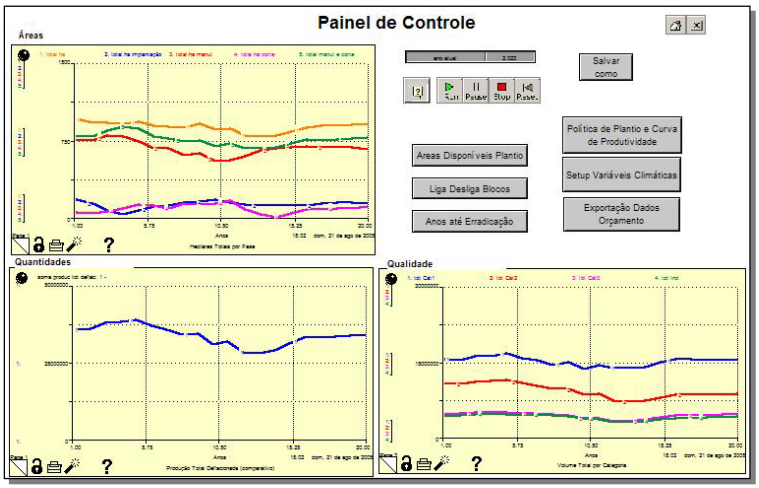


Figure 6: Control panel sample

A Matter of Confidence:
Initially, the management group decided to include in the model, as an input, all the climate variables that were known to affect the quantity and quality of the apple fruits produced (for example: rain, frost, hail, temperature); and these inputs were set considering each season, each apple variety and planted area (block). Eight years of historical data records were used to build the relations between these inputs and the final quality and quantity produced for each variety. A control panel with 98 input devices (sliders) was built. Tests proved that the model was able to replicate past crops with high precision.

Although we believed that this capability had a limited use and could be replaced by two or three input variables, it was implemented into the model with a specific objective: to build the confidence in the model and in the methodology used. Later on it was proved that the most important decisions that could be supported by the model didn't rely in this kind of detail complexity representation and in the "prediction capability".

***Running the Base Case*:** The base case simulation was run considering the potential production curves without the effect of the climate variables. For our surprise even the base case simulation showed unexpected results, and gave us the opportunity to improve the manager's decisions.

A pre-defined schedule of implantation of new orchards was used as an input in the base case simulation. The management intention with this schedule was to maintain constant the total production level in the next 20 years. But, the simulation results, Figure 7, showed that the total production would suffer a 19% decline in the next 12 years due to the aging of the orchards and the delayed planting decision. This unexpected result may show some kind of misunderstanding in the dynamics of the orchard aging chain structure and the use of inappropriate tools to represent this dynamic.

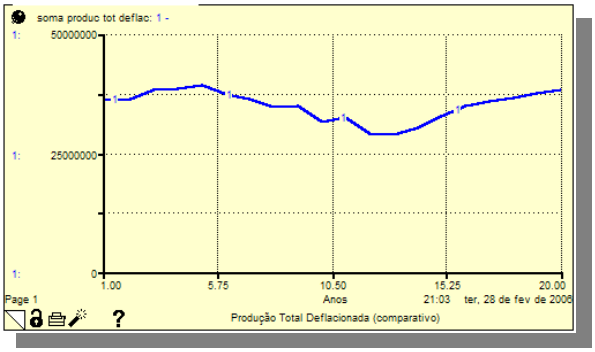


Figure 7: Base case total production level

Valuable Results and an Unexpected Side Effect – The model developed was considered highly reliable by the managers. Different set of decisions were tested with the model. Adaptations and changes could be rapidly implemented. In the owner and managers opinion this methodology and tool brought some important benefits to the planning process:

- "It is participative, we all know how the model works";
- "Friendly, easy to use, easy to implement changes";
- "Faster to be created and changed";
- "We can trust in the simulation results";
- "We can represent multiple variables with multiple causal relations, and it's not hidden in complicated formulas".

One of the most important changes created with the adoption of this method was a clear transformation in the type of dialogue and explorations that took place during the planning meetings. The focus of the management group, and even the language used, changed from the formal discussion of events and points of view to the analysis of causal relations, elicitation and test of hypothesis, and certainly, the discussion of some tough financial issues.

However, an unexpected side effect surprised the managers and even the project consultants. The owner of the company, considering the simulator as a strategic tool, literally locked the final version of the model in a room that could only be accessed by him or by an authorized person. This behavior certainly represented a rupture in the team confidence and disposition to a participative and open dialogue.

This fact restricted the use of the model, hypothesis and scenarios could not be tested with it, and the company management team went back to the dark ages of the formal, Excel based, and "one single event" planning process. In our perception the main motivation that the owner had to act this way was the fear of exposing somehow his strategy and vulnerabilities to its competitors (all the main competitors are in the same region and the employees have relatives working for different companies).

Phase II – From the Dark Ages to a System Dynamics Mastery Path

It took almost one year before the owner of the Company realized that the model had to be updated and actually used frequently. At this time he reconsidered his decision, and a new approach was designed. Following our recommendations three managers were "trained on the job" to use the System Dynamics approach and the Ithink software.

This training program lasted for two months, and a new and detailed model to support the budgeting process and commercial strategies was developed. One of the analysis supported by this new model is the timing for the fruit commercialization, a very important investigation that was never done before. The first model was updated and now can be used by them. And, the good news is that the managers were finally developing their own modeling and simulation capabilities, and seem to be in control of their own learning process.

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