The application of System Dynamics to the management of a small firm?

A Case of Study of the wine industry: Cantine Settesoli

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Abstract

This paper analyzes a winery company using System Dynamics to investigate policies for sustainable development. The wine production sector and the world market show complex characteristics that limit real understanding of the behaviors generated. System Dynamics can be a powerful tool to improve understanding and find leverage points of complex management systems by supporting managers testing "what-if" scenarios and exploring what might have happened - or what could happen - under a variety of different past and future assumptions and alternative decisions. The company strategy for penetrating world wine market meets resistance factors - outside - in its competitors, but as well - inside - in its own structure.
This System Dynamics model improves understanding of the real factors limiting company performance and helps decision makers to overcome company constraints.

Introduction

Cantine Settesoli[1] is an Italian co-operative that produces red and white wines of different qualities. Its challenge is to increase market share in Europe and to penetrate USA and China markets. It sells about 50% of bottled wine in Sicily, 5% in Northern Italy and exports 45% to Europe. The model (see fig.1) investigates the relationships between the wine market and *Cantine Settesoli* on a side, and between the company and its partners on an other.

The market segment to which *Cantine Settesoli* belongs (holding a relatively low market share) is characterized by a high competition among producers and a fragmentation of offer. The firm sells its product both to distributors (who bottle and

[1] Due to confidentiality reasons, figures reported in this paper have been disguised.

re-sells it with their own trade mark) and to other producer firms who may need more wine to satisfy their market requests.

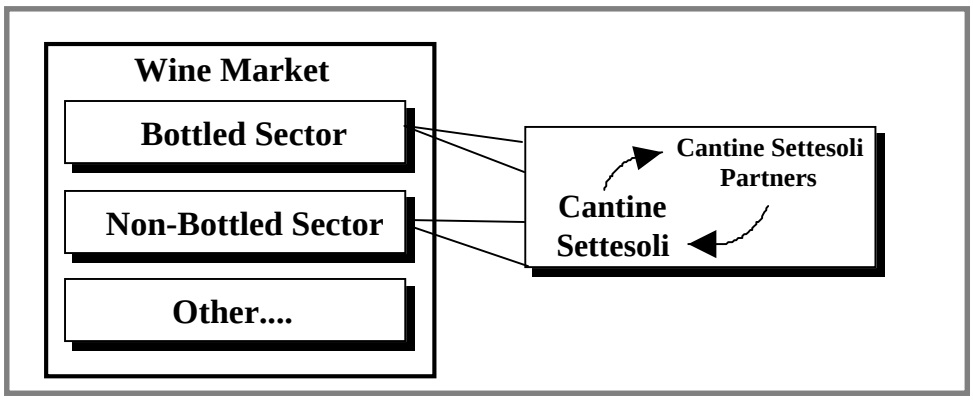


Fig. 1 - *Cantine Settesoli* model overview

Bottled wine is sold at a higher price than the non-bottled one.

The firm produces and bottles wine made from grapes supplied by several small farmers, who are its partners.

The average life time of its grape plants is fifteen years: this is a major constraint to be taken into consideration when business plans are drawn up.

Currently, land devoted to white wine production is significantly larger than the one for red wine production and total supply does not match market demand at all. The size of the co-operative and the "local environment" where it operates allows business decision makers to find a product mix that meets market demand. So, in order to match such demand, the firm is forced to invest more financial resources to buy a relatively expensive red wine or grapes from external suppliers. Such an extra-cost that the company has to sustain is perceived by the management as a significant constraint for future growth.

Problem Definition

A System Dynamics model has been sketched in order to analyze cause and effect relationships between relevant variables related to the dynamics of supply and demand, with a view to support land reallocation policies aimed at satisfying market demand. A main hypothesis on which the model has been built is that a higher grapes yield would accelerate land re-allocation policy by partners.

Should the company performance improve, if current production will be shifted from a 70% white vs. 30% red wine to a more balanced product-mix? *Which consequences could produce the above decisions on the partners' yield*?

Counterintuitive behavior of the system underlying such processes and perils related to a policy aimed at postponing such production shift, were the major reasons requiring the use a System Dynamics model.

Cantine Settesoli Model

Figure 2 illustrates system boundaries and the model's sectors.

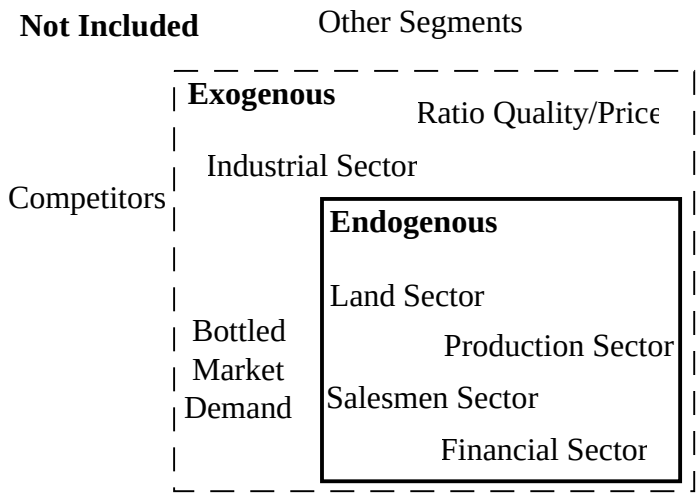


Fig. 2 - *Cantine Settesoli* model boundaries

The model consists of four main sectors:

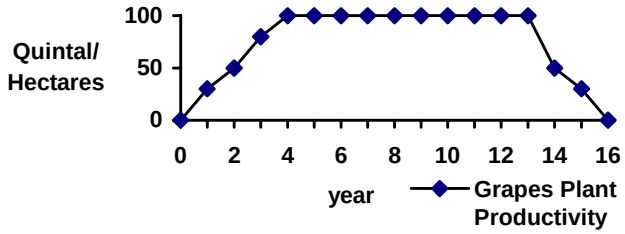
1. The *land* sector describes how total land available is devoted to the production of red and white wine. It shows the grape planting cycle (graph 1, page 4): every fifteen years grape plants die and need to be replanted. It takes three years to "regenerate" the land and, hence, to start with a new plant.
2. The *production* sector describes grapes transformation, aging time and bottling processes. The hectoliters of wine sent to the Bottling sector depend on Distributors Demand and Desired Inventory. If the quantity supplied from the company's partners is not enough to satisfy demand, as it happens for the red wine, top management decides to purchase wine or grapes outside.
3. The s*alesmen* sector describes the effectiveness of the salesmen in acquiring new distributors (clients) and how they maintain these relationships. In relation to company annual sales target, decision makers hire human resources to visit a

desired number of Distributors. The stock and flow structure to this sector shows how the distributor loyalty changes wine sales related each age class.

4. The *financial* sector shows the effects of different strategies on company revenues, and partners' yield. It displays industrial costs for processing and wine bottling, price-quality ratio, revenue and yield for the different varieties of grapes supplied.

The Land Sector

As previously referred, grape plants have an average life of 15 years. During the first three years production is relatively lower than normal; at the fourth year it reaches the maximum level, which remains steady until the 13th year. After that time, the harvest yield starts to decrease and then (two years later) plants are removed. It is necessary to wait for three more years to start with a new plantation.



Graph 1 - Grapes Plant Life Cycle

Figures 3 illustrates main feedback loops related to the white wine production and the land sector. The reinforcing loop R1 shows how each year the removal of those plants which are fifteen years old gives raise (after a regeneration time and according a given yield) to a white land replanting rate. Such replanting rate affects land assigned to white wine production, which is released after fifteen years.

The balancing loop B1 describes how each year an increasing in land released reduces the total land available to produce white wine.

A same structure has been used to describe the dynamics of the land devoted to red wine production.

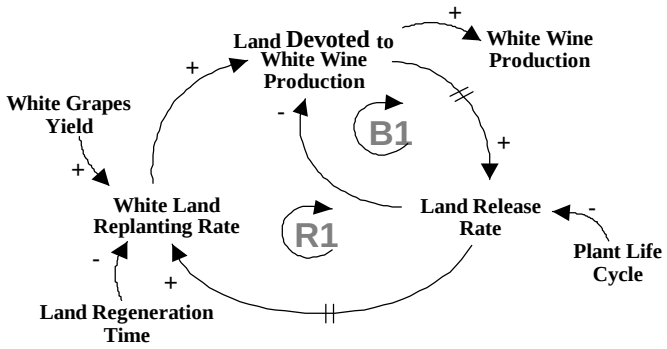


Fig. 3 - White Land Sector feedback relationships

Land Sector Re-Allocation Policy

The model aims to assess the robustness of a policy leading to a balanced product mix (i.e.: 50% red and 50% white wine).

Two scenarios have been particularly investigated:

1. *Partners resist to follow the Land Sector Re-Allocation Policy*.
2. *Partners are inclined to re-allocate their land because of the decision of Settesoli's policy makers to increase the "Red Grapes Yield"* (i.e. to allow them an increase in the price paid for red grapes supplied).

In the following pages the two above scenarios will be analyzed.

1. ***Partners resist to follow the land sector re-allocation policy.***

Fig. 4 shows main feedback loops related to the first scenario.

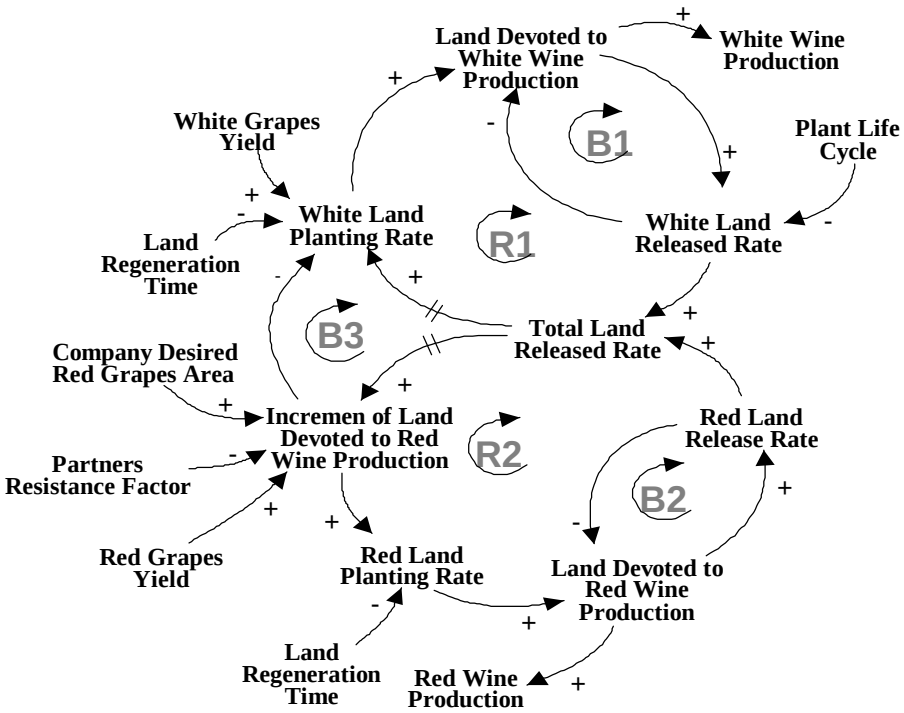
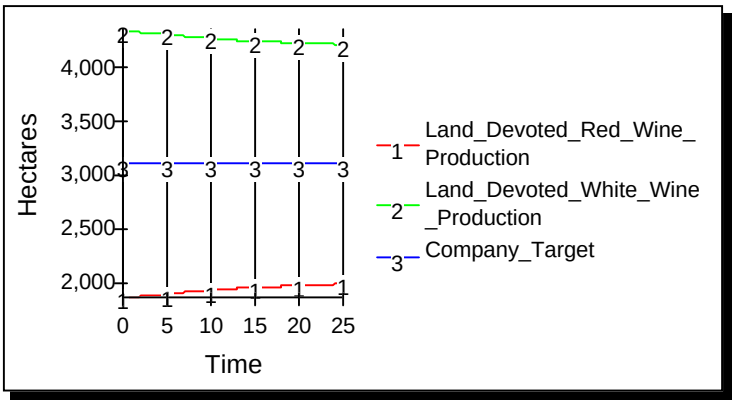


Fig.4 - Land Sector feedback relationships

Feedback loop **R2** shows how the company desired red grapes area and partners resistance factor are two parameters which strongly affect the increase in red wine production. In fact, only if the values of such parameters increase, the land devoted to red wine production will change and, hence, red wine production will increase too.
Such a scenario, that is related to an unchanged red wine yield, shows the weak and slow increases of the land devoted to red wine production. Graph 4 shows how land devoted to produce red and white wine does not reach the company target.

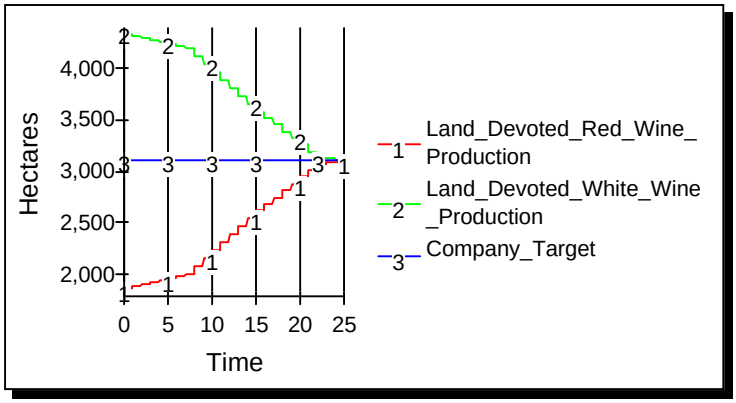


Graph 4 - Land assigned to Red and White Production.

From a combined analysis of the above structure and behavior, it is possible to observe how the dominant loop is R1. In fact, maintaining the *status quo* implies that a higher percentage of land is always devoted to white grapes (i.e. loop R1 is fed according to the same amplitude) and a smaller size of production is devoted to red grapes. In other words, loop R1 prevails on loop R2.

2. *Partners are inclined to re-allocate their land because of the decision of Settesoli's policy makers to increase the "Red Grapes Yield".*

The second scenario shows how the behavior of the two curves related the two kinds of production is the same as in the previous simulation, as only in the 7.5th simulation year[2], the company policy makers decide to increase *red grapes yield*. Consequently, the company's partners perceive such an yield more as profitable and, hence, start to shift their production mix towards white grapes plantation. Graph 5 shows how a higher red grapes yield facilitates a faster shift in production, which allows the firm to meet the 50% target in about 23 years.



Graph 5 - Land assigned to Red and White Production.

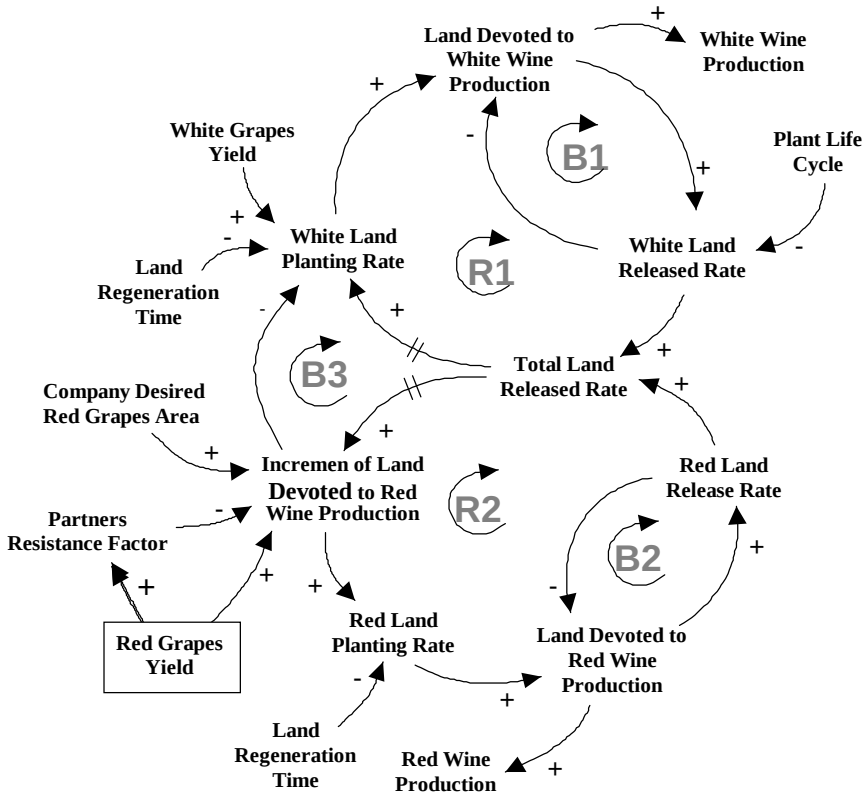


Fig. 5 - Land Sector feedback loops including Management Lever

The rise in red grapes yield, decreasing the partners resistance factor, facilitates the increment of the land devoted to red wine production. The higher red grapes yield shifts the feedback loop dominance from **R1** to **R2.**

[2] Another simulation, that has not been included in this paper (due to a page limit), shows how if the company starts to foster such a shift in plantation since the first simulation year, an even better performance is achieved.

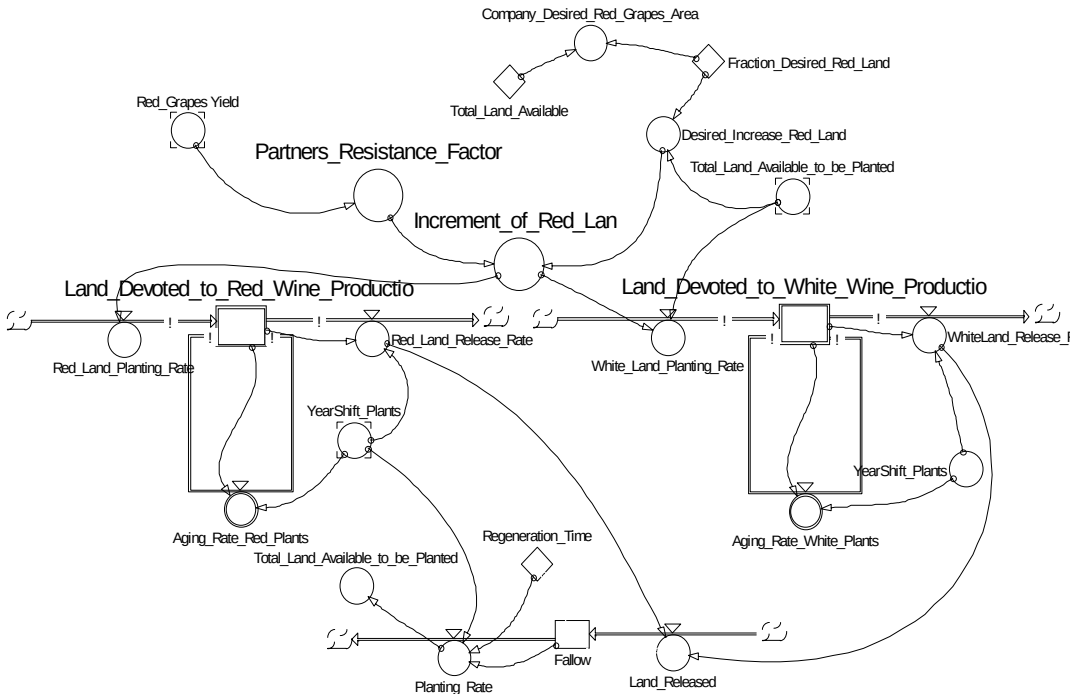


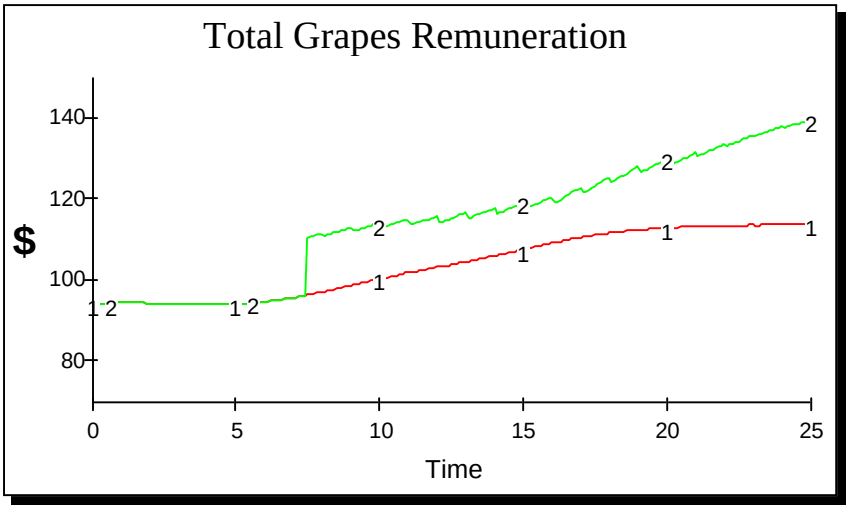
Fig. 6 - Stock and Flow Diagram Land Sector

Figure 6 shows the land sector stock and flow diagram. It particularly portrays how the two stocks of the land devoted to red and white wine production are affected by:

- the planting rate;
- the release rate,
- the aging rate of plants,
- partners resistant factor (affecting the increment of red land),
- red grape yield (affecting partners resistance factor),
- total land available.

Main financial outcomes related to the two scenarios

Financial consequences of these above two scenarios are shown in graph 6, which displays the different pattern of grapes yield. The higher value of curve 2 demonstrates how the second scenario leads to a higher total grapes yield. In fact, an increase of red wine production allows the company to reduce red wine purchase costs from outside suppliers and, as a consequence, partners may earn a higher yield.



Graph 6 - Total Grapes Yield

Legend:

Line 1 shows partners yield in the case of resistance to the re-allocation policy.

Line 2 shows partners yield in the case in which policy maker increase the red grapes yield to facilitate the re-allocation policy.

Conclusions

From the above considerations it emerges how System Dynamics may give a major support to a better understanding of interconnected relationships between the different company systems and policy making.

“The behavior of complex systems is very often surprising, even when we are fully aware of the basic interdependencies within ..... systems”(Forrester 1971).

A holistic view allows top management to plan and test “correct” policies (including time and necessary resources to invest) for the business system, so facilitating the achievement of company target.

This paper brings together insight and contributions of many people. But a special note of thanks goes to prof. Carmine Bianchi and prof. Paal Davidsen.

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