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Ten Years later: A Comparison of Results of Simulation Scenarios under a Systems Dynamic Approach and the Actual Economic Performance of Small-Scale Agro-industries Supported by Brazilian Agro-industrial Development Programs

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ABSTRACT

Agro-industrialization promotion is a policy option to aggregate value to a primary product and increase revenues for small farmers. However, experience has shown the vulnerability of small-scale agro-industries (SSAI) when facing a competitive environment under the constraints of several technological, institutional and managerial bottlenecks. A system dynamics model was built to simulate the financial performance of agrifood processing enterprises promoted by Brazilian SSAI development programs after the mid 1990s. Under different optimistic, conservative and pessimistic hypotheses related to SSAI operations and their business environment, model simulations allowed the identification of conditions for long-term financial sustainability. Ten years after the modeling exercise, the results of this analysis could be confirmed through a comparative assessment of the financial performance of selected enterprises supported by two of the promotion programs. The results of the original SD model could be mostly corroborated by the comparison between simulations and the observed enterprise performance. The relatively high SSAI survival rate over the ten-year period analyzed suggests the strong potential of these programs for agribusiness development promotion

Keywords: system dynamics; food processing; agro industry; small and medium enterprises – SME; rural non-farm economy - RNFE

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1 Introduction

Small-scale agro-industrialization is a policy option for small farmers to add value to a primary product and increase their revenues. However, experience has shown the vulnerability of small agro-processing enterprises to the pressures of their competitive environment: many fail in their early years of operations. As proposed by Wilkinson and Rocha (2009), agro-industry comprises post-harvest activities involved in preparation, preservation and transformation of agricultural, fisheries and forestry raw materials for intermediary or final consumption. Within agro-industry, food-processing and beverages are by far the most important sub-sector in terms of added value, accounting for more than 50% of the total formal agro-processing sectors in developing countries (FAO and UNIDO, 2009).

Since the 1970s, official bodies, international governmental and non-governmental organizations raised their interest in small rural enterprises. Many development agencies established a variety of programs and pilot projects with a general concern about the lack of income distribution and the need to improve livelihoods, particularly targeting the rural poor (Fernandes, 2004; Haggblade, S. et al., 2002). Experiences in Brazil, Chile, Kenya, Mexico, South Africa, Taiwan and Thailand have demonstrated the potential of agro-based small and medium enterprises - **SME** for improvement of farm and non-farm income and the living standards among rural poor more generally (FAO and UNIDO, 2009).

Moreover, programs designed to promote food security, poverty reduction and sustainable development in rural areas often include activities supporting the creation and consolidation of **small-scale agro-industries - SSAIs**.

While the promotion of agro-industries can serve several development objectives, the constraints that hamper their development need to be addressed - the degree of risks associated with SSAI should not be underestimated. Indeed, research evidence from Brazil indicates failure rates of up to 50% for SMEs in their first five years of operation. Since agro-industries are a high-risk but relatively low-margin segment of the economy, their success always requires innovative and flexible ways of hedging against risk (FAO and UNIDO, 2009; Kjöllerström, 2004). Therefore, the need to ensure competitiveness and long-term sustainability constitutes a particular challenge for small and medium scale agro-industrial enterprises and family farmers.

The long-term economic sustainability of SSAIs is a key issue for attention when the promotion of these types of enterprises is included in governmental policy agendas. Potential investors and their financers must consider a number of cost-benefit issues and several inherent sources of risk and uncertainty, in order to minimize the likelihood of enterprise failure. Promotion programs and policies providing funding for investments in SSAIs thus typically require potential beneficiaries to submit business plans for technical and economical assessment as part of the financing decision process.

The classical project investment analysis examines the enterprise´s cash flow and calculates standard financial evaluation indicators such as net present value (NPV), internal rate of return (IRR), payback period (PBP) and break-even point (BEP). According to Da Silva et al. (1998), before calculating a project's cash flow, a cumbersome process for the estimation of investment, costs and revenues must be performed. Data must be gathered on the items that compose each of these categories, and appropriate tables must be built grouping fixed investments and working capital estimation, cost and revenue estimation and financing alternatives. Economic-engineering methods are then used to calculate the financial evaluation indicators.

In order to facilitate the financial analysis of prospective investments in SSAIs, Da Silva et al. (1998) developed the concept of "interactive agro-industrial profiles". These are computer-based decision support systems (DSS) that present technical information on several types of SSAIs, each of which being associated with economic–engineering models which allow users to tailor the basic profile data so as to reflect the specific conditions of their prospective investments. Once the basic data is adjusted, the DSS calculates the financial indicators and performs a sensitivity analysis considering variations on parameters associated with investments, running costs and revenues. When originally developed, the profiles covered 15 systems comprising a wide array of SSAI projects in areas such as fruit and vegetable processing, milk processing and meat processing, to name a few. The Brazilian National Program to Strengthen Family Agriculture - PRONAF used the profiles in their initiatives to promote investments in SSAIs (Da Silva and Fernandes, 2000).

Lourenzani and Da Silva (2003) conducted a study of these 15 interactive SSAI profiles in order to investigate the issue of risk and uncertainty in these types of investments. As shown in Annex 1, the results indicated that under standard, conservative assumptions on costs and revenues, all enterprises were considered financially attractive. Yet, a sensitivity analysis revealed the high degree of uncertainty associated with changes in key project assumptions, particularly the ones related to raw material costs and product prices. For some types of enterprises, even slight variations on these parameters would render the investments unfeasible. Recognizing the limitations of the comparative static approach of the sensitivity analysis method, the study argued that Monte Carlo simulation models considering probability distributions and correlation coefficients between chosen parameters could in principle improve the analysis. Even so, the aspects of interdependence among costs and revenue parameters, among others, and feedback information over time are not taken into consideration in either of these two methods. The authors concluded proposing a systems approach to ensure a better comprehension of the structure and behavior of SSAIs, considering the intrinsic dynamics of the elements that ultimately define their long-term sustainability.

Experience has demonstrated that even with well-designed business plans, after start-up SSAIs are subject to sources of risk of uncertainty that are particularly challenging. The difficulties faced by these businesses include the limitations of their small scale of production, as well as technological, institutional, managerial and marketing constraints. They often find problems in procuring inputs in small quantities and many of them are not able to meet the quality standards required by the buyers of their products (Fernandes, 2011). Typical problems of SSAIs comprise also the lack of conformity (attendance to quality standards and sanitary rules, homogeneity of raw material and products); irregularity in raw material supply; inappropriate logistics and cold-storage chains; short product shelf life; weaknesses in labeling and product's image and low portfolio diversification, among others.

SSAIs typically begin operations by accessing local markets and gradually expand their business and broaden their geographic coverage. When attempting to access more demanding markets however, the small scale of these enterprises tends to limit their opportunities to sell to larger buyers such as the fast growing supermarket chains. To cope with this type of challenge, SSAIs may engage in collective actions such as joint acquisitions of raw materials and group sales, as well as the creation of a common brand. They may also focus on niche markets based on quality attributes, geographical indications of origin or fair-trade (Markelova et al., 2009).

Mindful of the challenges faced by SSAIs, policy makers increasingly acknowledge that successful investments in these enterprises must be paired with technological and business management assistance, including the promotion of access to value-added business networks (Kapila & Mead, 2002). Moreover, as seen above it is important that the agro-industrial enterprise is understood as a system, in which each component affects and is affected by other related components.

To assess the financial feasibility and operational dynamics of SSAIs operating under different scenarios, Fernandes (2004) conducted a study under a system dynamics (SD) approach. The analysis considered not only internal plant operations, but especially the linkages between the processing function with input suppliers, consumers, managerial and technological issues and the wider institutional and market environment.

A decade has passed since this study was concluded. Some of the investigated SSAIs succeeded and others failed, a fact that raises a question on which of their strategic actions were successful and which were not. To investigate this issue, the present study compares the original simulation results with the current situation of some of the investigated SSAIs.

2 Objective

The main objective of this study is to compare the results of a SD simulation of selected SSAIs with the actual performance of these projects after ten years of operations. The article is organized as follows: an outline of the methodology of the SD study is presented in section 3, which briefly revises as well some Brazilian SSAI development programs that were implemented since the mid 1990s. Section 4 presents an overview of three selected case studies, followed by the comparison among the main results of their original SD simulations and their current performance. Section 5 concludes the discussion highlighting critical factors that impacted the survival of SSAIs supported by agroindustrial development programs.

3 Methodological approach

A comprehensive analysis was needed to understand the operational dynamics and to identify success factors for the long-term financial sustainability of SSAIs targeted by the development programs that took place in Brazil after the mid'90s. Acknowledging the complexity of reaching a successful SSAI's survival rate, the investigated promotion programs comprised one or more strategic actions addressing elements such as the institutional environment, the organizational structure, funding, legalization aspects, technological and entrepreneurial capacity building and commercialization and marketing.

Armendàriz *et al.* (2015) discuss how a complex systems perspective can shed light on the analysis of complex food-systems. Aragrande & Argenti (2001) also called attention to the peculiarities of food systems, which should be seen as "*complex combination of activities (production, handling, storage, transport, process, package, wholesale, retail, etc.) operated by dynamic agents […]*". We subscribe to these views and consider SSAIs both as components of complex food systems and as complex systems themselves.

As discussed above, the traditional financial feasibility evaluation of projects does not take into consideration the interaction between variables used as basis for building financial cash flows, nor between them and the business competitive environment (Lourenzani, 1999; Fernandes et al., 1999; Avellar, 2002; Fernandes, 2011). In particular, they do not consider the possible mechanisms of *feedback* and *delay* (time gaps) as results of the business actions in their relation with procurement and distribution systems, nor the mechanisms related to internal operations (technological choices; operational procedures, etc.). A system dynamics (SD) approach instead can encompass not just internal plant operations, but especially the linkages between the plant and input suppliers, consumers, managerial and technological issues and the wider institutional and market environment. In comparison with other complex system methodologies (e.g., agent-based models, social network analysis), applying SD while dealing with food supply and distribution systems is a worthwhile approach for policy evaluation, providing an assessment of long-term effects. It is also a useful approach for the understanding of a phenomenon based on causation among variables (Armendàriz et al. (2014); Giraldo et al. (2011)).

Following SD concepts and procedures (Hannon & Ruth, 1997; POWERSIM CO., 1996; Richardson, 1996; Sterman, 2000) and a classical agro-industrial system conceptualization, the sub-systems of supply, processing and distribution, as well as their relation to the competitive and institutional environment were considered (Austin, 1992). In brief, the original SD study followed the basic steps presented in Figure.1.

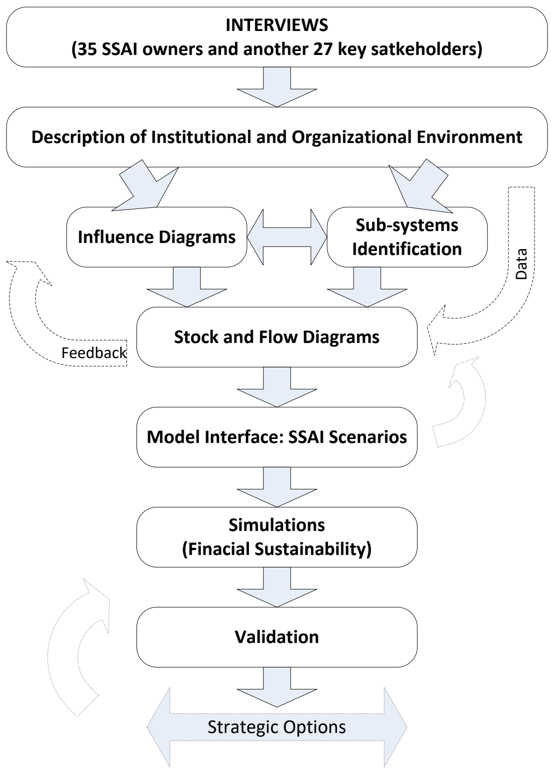

Figure 1. Methodological steps

3.1 STEP 1: Capturing Mental Models (Interviews)

The main contribution of *systems thinking* is enlightening, testing and improving *mental models,* allowing a better comprehension of reality (**Cover, 1996**). *Mental models* comprehend here the assumptions, convictions, values and experiences accumulated by each individual (**Forrester, 1994**). Therefore, the formalization of *mental models*, in the shape of influence diagrams (see item 3.3), allows the analysis of where, how and why such models diverge among them, which becomes the first step to build, among stakeholders, a shared vision of a complex agro-industrial system.

To capture the *mental models of stakeholders in SSAIs promotion programs,* a rapid appraisal was conducted involving structured interviews with 35 owners of targeted SSAIs and another 27 key stakeholders at different Brazilian regions (South, Southeast and Center-West). It brought out the diversity of the institutional environment around each case, showing how an earlier concept of "*verticalization of small scale agricultural production – PROVE-DF*" (Carvalho, 2001; Sulzbacher, 2009; Fernandes, 2004; Gellynck & Kühne, 2010), experienced in the city of Brasilia in 1995, evolved and was reproduced by promotion programs in many Brazilian regions.

By the time of its original development, the study covered 10 state or regional programs, but presently most of these no longer exist. We review some of them next, in order to show how different initiatives and program structures could affect the survival rate of SSAI in different ways.

3.2 STEP 2: Overview of Brazilian Agro-industry programs — the Institutional Environment

Realizing the benefits of agro-industrialization and its challenges, Brazil launched in the 1990s a number of programs with a specific approach to promote SSAIs, focusing on their peculiarities. Created in 1995, the pioneer program PRONAF - the "*National Program to Strengthen Family Agriculture*" encompassed an investment credit line targeting SSAIs. In 2003, a larger program for SSAI promotion with several specialized actions was launched under the umbrella of PRONAF: the first "*National Program of Agro-industrialization for Family Farmers Production*" (PRONAF Agro-industry) (Wesz Jr., 2009; Bianchini, 2015).

Beyond the specific financial credit line for SSAI, the actions of "PRONAF Agro-industry" comprised:

- a strategic review and national discussion of the legal framework for these enterprises;
- the provision of guidelines, documents and technical project profiles to promote new investments; the provision of capacity building and training for multiplier (extension) agents;
- the development of appropriate technologies; and,
- the promotion of markets for products from family agriculture (market development), as well as a number of program management activities.

In addition to "PRONAF Agro-industry", another federal program that had shown great impact in the experiences investigated in the late '90s was the **"Appropriate Technology Program" - PTA**, driven by the *National Council for Technological and Scientific Development, CNPq*. The PTA program supported social and appropriate technology development to enable *Local Innovation Systems* (SLI) as clusters. The PTA goals included the increase of access to technological information, productivity enhancement support, research, extension, training and credit by small entrepreneurs.

Often, agro-industrial development initiatives integrate actions of national and state agencies (e.g. the Brazilian Micro and Small Enterprise Support Agency – SEBRAE) with municipal counterparts and direct action from international organizations (e.g. Inter-American Foundation – IAF; United Nations Development Program – UNDP) or through technical cooperation with non-governmental organizations - NGOs. Moreover, some state level programs complemented public financial resources with funds from international agreements (e.g. World Bank; Inter-American Development Bank - IDB). State programs, such as "***Desenvolver***", in the state of Santa Catarina (SC), and "***Fábrica do Agricultor***", in the state of Paraná (PR), grouped strategic components and provided qualified professional services and knowledge support to SSAIs, in partnership with state level rural extension agencies, agricultural research agencies, and universities, among others, as shown in **Table B** and **C** in the Appendix.

Overall, the Brazilian interventions usually involved investment loans, technical support regarding the legal framework (regulations on sanitary, tributary and environmental issues, among others), research and technological assistance. They were implemented not only by a single institution, but often aggregated a variety of actors through agreements between national, state or local governments, councils, NGOs, training and rural extension agencies (EMATERs; EPAGRI; etc.). The establishment of credit cooperatives within the scope of these programs has also counted with the active participation of NGOs.

Another feature of these programs was their ability to build **innovative networks** in a broad sense (Gellynck & Kühne, 2010; Deiters & Schiefer, 2012). Deriving from the debate about the similarities between industrial district and clusters, the concept of *Local Production Systems* (LPS) emerged. An LPS can be defined by a set of productive units, technically interdependent, economically organized, territorially agglomerated, or as a ***network*** of enterprises of same activity or specialty, which cooperate in certain territory, or even as geographic groups of enterprises linked by the same activities (CNDRS, 2002).

A network can be classified as hard or soft (**Rosenfield, 2001**). A ***hard network*** requires strong commitment from member wishing to be part of it, such as contractual agreements sharing functions and resources to reach determined goals. A ***soft network*** admits an open participation based in agreements determined by the majority of members, in cooperative actions aimed to share resources, reduce costs or any kind of collective promotion. The selected cases presented in section 4 cover both network types.

3.3 STEP 3: Influence Diagrams

Based on the collected data in the filed interviews, *causal looping diagrams* (also referred to as *influence diagrams*) were designed to shed light on the dynamics of a SSAI operation. Special concern was given to the relation between financial variables and hypothesized critical success factors for the determination of SSAI sustainability over time. The success factors included strategic decisions on **production mix diversification, product differentiation, level of production capacity utilization and networking**, among other determinants of competitiveness.

The example of figure 2 illustrates a reinforcing loop (R) concerning the relation between sales force and revenues, while a balancing loop (B) shows that product differentiation can increase revenues with higher prices, but can also reduce product attractiveness and consequently sales and revenues. Several influence diagrams such as this one were built and were cross-linked in order to provide an overall conceptualization of the SSAI system, representing its components and the interactions among them. The detailed diagrams can be found at Fernandes (2004).

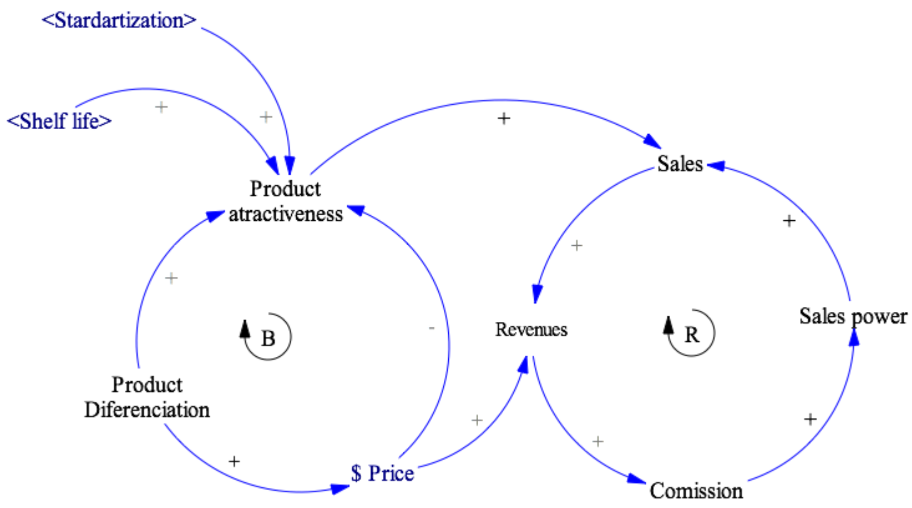

Figure 2. Influence Diagram – Product differentiation and Revenues

3.4 STEP 4: Stock and Flow Diagrams

The stock and flow diagram depicted in Figure 3 represents the production dynamics of a SSAI, as conceptualized in the original study. It shows how production costs are affected by the choice of distribution channels, the raw material production system adopted (conventional or alternative methods such as organic or hydroponic systems, among others) and way of raw material procurement (produced by SSAI owners themselves, purchased through a SSAI network or acquired from other suppliers).

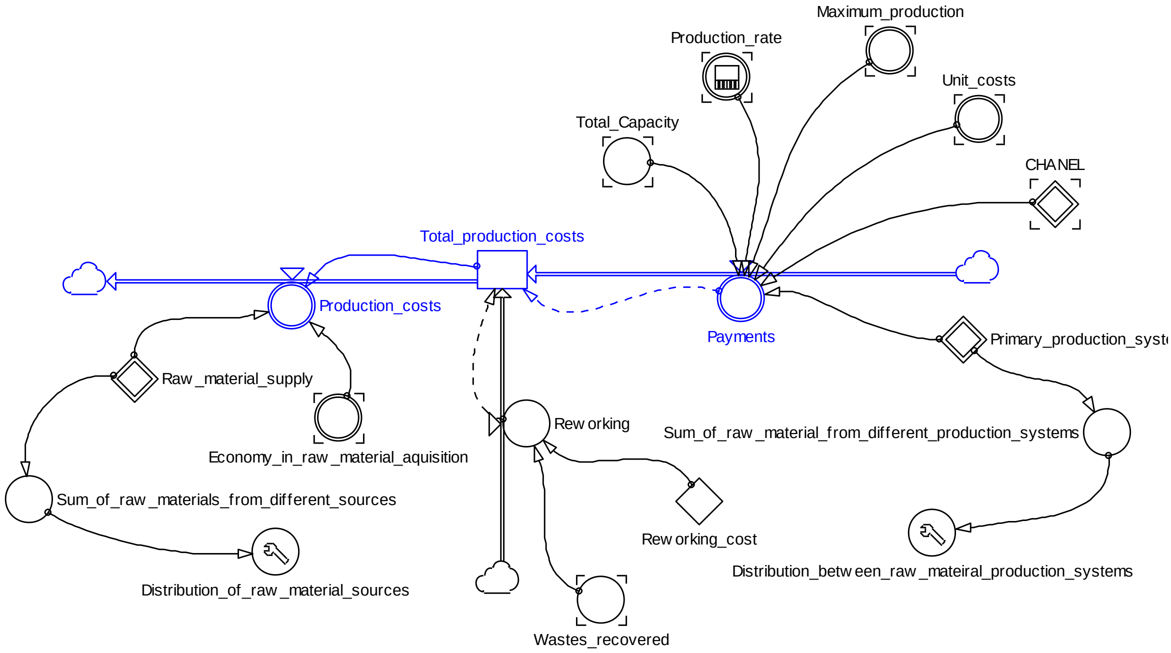

Figure 3. Production Dynamics – Stock and Flow Diagram

The boxes represent accumulated stocks, whereas the flows are indicated by double arrows (tubes) with control valves (balloons) representing the rate of change in a stock. The cloud symbol marks the boundary of the model. The circles denote an auxiliary variable used to combine or reformulate information, whereas the arrows connect variables. The diagram has no standard form; it represents an algebraic formulation of any combination of levels, flow rates, or other auxiliary variables and parameters. The "production costs" stock in Figure 3 is connected to other stock and flow diagrams in the overall model that simulate investments and cash balance over time, as well as the physical production levels. For more details on the symbology of stock and flow diagrams, readers are referred to the user guide of Powersim Co. (1996; 2003).

It would be beyond the purpose of this paper to delve deeply into the description of the simulation model and its stock and flow diagrams. The intention here is simply to illustrate the representation of a conceptualization of how some critical variables related to raw material production, among other variables, could be associated with traditional models of financial analysis, as they affect the SSAI payment capacity and its sustainability. Details on the specific variables considered in the model, as well on its structure and formulation, are presented in Fernandes (2004).

3.5 STEP 5: Simulations

The model was used to simulate the system behavior under alternative scenarios through a dynamic data exchange connection to a worksheet containing specific, real-world agro-industry data and configuring the initial state of the system to simulate each SSAI in a case-by-case basis. Its interface consisted of a number of user-friendly panels. Each panel disposes control buttons and sliding bars, which can be used to change parameters and define different variable levels to build scenarios to simulate the SSAI financial behavior. The model interface allows users to simulate scenarios by introducing shocks in variables such as "production capacity utilization"; "sales planning"; "raw material supply planning"; "product differentiation"; " level of production and sales"; "diversification of production mix"; "incremental investments and capacity acquisition"; "fiscal and credit incentives"; and "institutional incentives".

3.6 STEP 6: Validation

The initial simulation tests were compared with reference models showing the past system behavior, taking into account actual data on two years of monthly production and earnings. This procedure allowed the fine-tuning of the model by calibrating its parameters and reviewing assumptions on relationships among its components. After validation, a series of simulations under different optimistic, conservative and pessimistic scenarios related to the operations and business environment of a selected SSAI allowed the inference of key conditions for the long-term financial sustainability for each of the cases tested.

Some of the main insights brought about by the simulations done in the original study can now, ten years after the modeling exercise, be contrasted with the current situation and trajectory followed by of some SSAIs, as we discuss in the next section.

4 Presentation of selected case studies

The system's behavior was tested for three SSAI case studies, being two of them (A6 and A12) from the Agreco SSAI' network supported by the "*Desenvolver*" program (Appendix, Table B). The third one was an independent SSAI (A26) implemented by a farmer association in Paraná State with support by the "*Fábrica do Agricultor*" program (Appendix, Table C). The selection was based on available data and on the critical success factors that could be compared and tested (diversification, differentiation, market share, etc.).

A6 and A12 are embedded in the same institutional environment, but they were designed to process different raw materials and products (vegetables and milk, respectively), with a central administrative unit serving the entire Agreco SSAI' network. A26, in turn, is similar to A12 in size, investments and raw materials used (both are milk processing firms), but under different institutional environments. A26 has its own administrative sector, which is independent from any other SSAI network.

Cases A6 and A12 consisted of enterprises managed by distinct groups of small farmers previously associated to Agreco, an agro-ecological association from a mountain region of the state of Santa Catarina in Southern Brazil, which assembled 211 family farmers in 1999. Between 1998 and 2000, the "*Desenvolver*" state program (designed with resources from the earlier mentioned PTA program) provided business development service (BDS) to support the "*Inter-municipal Modular Agro-industries Network Project*" (PIAMER). The program enabled farmers to access funds from the federal program PRONAF, particularly targeting young professionals with support to design and improve their agro-industrial investment projects. PIAMER also had a contribution from the local municipal government, which provided building materials during the stage of SSAI construction. As a result of PIAMER, Agreco started a SSAI network grouping 27 enterprises (hereinafter called Agreco Network), which included firms processing milk, meat (poultry and swine), honey, eggs, vegetables and sugar cane. PRONAF financed all of them. Each SSAI was owned by a farmer group varying from 5 to 10 members.

Soon after most of these SAAIs started up their operations, the "*Desenvolver"* program discontinued, but Agreco established a partnership with SEBRAE in order to receive strategic, tactic and operational business management support, as well as financial support to cover the costs of their administrative personnel. Initially, the Agreco SSAIs would market their products through direct sales, but with the gradual expansion of their business, the network opted to establish two specific SMEs to access market outlets and access SIMPLES – a special taxation scheme for small businesses. The Agreco SSAI Network also promoted and interacted with other rural non-farm activities (RNFA) such as a credit cooperative named "CrediColônia" essential to guarantee microcredit for small farmers, and an agro-tourism association ("Acolhida na Colônia"), another symbiotic activity to promote their SSAI products. The Agreco Network products adopted an "*Agreco Quality of Life*" seal, which was instrumental for them to be later organic certified.

The **A26** enterprise enrolled 24 milk producers associated to the Rural Workers Association of Alto Alegre (APRUAL). Before its installation, there was no tradition in commercial dairy farming in this group. Dairy was essentially a female activity, with production destined to family consumption only. With the establishment of A26, other local producers started to deliver to its processing unit, instead of supplying to cooperatives and large industries. With the support of the "*Fábrica do Agricultor*" program, A26 became part of a ***soft network (as introduced in section 3.2),*** being allowed to use the geographic indication seal of "Southwest Tastes" from the state of Paraná. A26 established an own commercial structure, including vendors in the State capital, Curitiba, its major market.

Next, we summarize a description of the initial conditions for each of the selected SSAI:

A6: an SSAI integrated into Agreco network with a production capacity of 48 tons/year of minimally processed vegetable (MPV). The A6 project (Total investment = BRL$ 38,500) was funded by PRONAF covering 100% of investments in equipment (BRL$ 10 thousand) and 71% for construction (BRL$ 20 thousand). A6 was processing 28 different raw materials supplied only by its family farm owners (five brothers) obtaining 42 products in different weighted packs (salads and cuts). In 2002, A6 was using 25% of its production capacity but had reached levels of 68%, before facing the entry of strong market competitors.

A12: an SSAI integrated into the Agreco Network with a production capacity of 120 tons/year of "colonial" cheese (≈ 4,500 l/day of raw material). Three farmer brothers owned this SSAI and they adopted the "*Voisin System*" of rotational grazing management, which applies intensive management to forage crops on pastureland and is considered an ecological practice for milk production (Murphy at al., 1986; Schvarz Sobrinho et al., 2007). They provided 50% of their raw material needs and expected to obtain 50% from Agreco partners under an organic production network. The total investment was BRL$ 110 thousand. PRONAF financed 100% for equipment (BRL$ 60 thousand) and 30% of its construction costs (BRL$ 30 thousand). In 2002, A12 used 17% of its production capacity, but it had reached peaks of 38% in earlier months, due to seasonal effects.

A26: an independent agro-industry, out of the Agreco network, with a production capacity of 140 tons/year of dairy products such as traditional cheese, ricotta and buttermilk (≈ 4,800 l/day of raw material). A26 total investment was BRL$ 110 thousand, being BRL$ 55 thousand from a PRONAF refundable loan and BRL$ 35 thousand from a non-refundable grant from the "Paraná 12 meses" program, supported by the World Bank. The local municipality provided an older school building to be transformed in a processing unit and an additional BRL$ 10 thousand for working capital. This SSAI started procuring 24% of their raw material needs from its 24 associated farmers and the remaining from non-associated local producers. In 2002, A26 used 83% of its production capacity, but achieved full capacity utilization before one year of operations.

Table 1 summarizes the initial investments, production capacity and the situation of the three-selected SSAI in 2002 and Table 2 shows the main support actions received and key issues for project financial analysis affected by them.

Table 1.
Initial SSAI investment and production capacity (2002)

SSAI	Farmer Owners	Initial Investment (BRL$)	RM Supply	Raw Material RM/Day	Products	Total Production Capacity (Tons/year)	Production Capacity Use	Sales (tons/ year)	Revenue (BRL$)
A6	5	38,250	100% Owners	500 (kg)	Minimally Processed Vegetables	48	25 %	12	28,000
A12	3	110,000	50% Owners 50% Agreco Network	4,500 (l)	Cheese	120	17 %	20	86,000
A26	24	110,000	22% Associated 78% Local producers	4,800 (l)	Cheese, Ricotta, Buttermilk	140	83 %	116	385,000

Source: Adapted from Fernandes (2004).

Table 2.
Main support actions received by the selected SSAI (A6, A12, A26).

PROGRAM/AGENCY	Level	A6 and A12 (Main Support)	A26 (Main Support)	Key Issues
PRONAF – Agro-industry (Ministry of Agrarian Development - MDA)	Federal	Investment funding; Working Capital	Investment funding	Fixed Investments and Costs; Indebtedness;
Local municipality (donation)	Municipal	Building Materials	Building Donation	Fixed Investments and Costs; Indebtedness;
DESENVOLVER (EPAGRI, FUNCITEC with federal support of PTA -	State	BDS (project design, business model, technical assistance)	---	Variable Costs
Fábrica do Agricultor (EMATER, SEBRAE, etc.)	State	---	BDS (Technical Assistance;	Variable Costs
PATME - VRS (SEBRAE)	National	BDS (commercial support, business model)	---	Fixed and Variable Costs; Sales Force
INNOVATION PREMIUM (FINEP)*	Federal	Research and Development Project	---	Production Capacity; Product Diversification
FOOD ACQUISITION - PAA (MDA)	Federal	Institutional Market Access	---	Sales; Revenues
SCHOOL MEAL - PNAE (FNDE/MEC)	Federal	Institutional Market Access	---	Sales; Revenues
SC Rural Program (with international funds - World Bank)*	State	Incremental Investment	---	Production capacity; Storage
Paraná 12 Meses (with international funds - World Bank)	State	---	Initial Investment (Non-Refundable)	Fixed Investments; Indebtedness;
Universities and NGOs	Regional	Strategic Planning; alternative production systems (agro-ecologic; hydroponic; etc.); technological		Product Differentiation; Sales; Revenues

Source: Adapted from Fernandes (2004); Guzzati (2012) and Weber (2013). *Recent achievements.

5 Results and Discussion

The base conditions for each agro-industry were structured in a worksheet defining the respective initial system status and simulation tests were run for each of them separately. The model included time dependent variables in order to capture differences in the actual starting date of operations of the simulated enterprises, which varied in accordance with the specific project plans and the effective availability of financial resources from funding schemes.

Basic simulations run for ten years indicated a comparatively higher financial performance for A26. As seen above, this enterprise reached full capacity utilization in its first year of operations, as opposed to A6 and A12, which both had their businesses growing modestly and unstably over the simulated period. Figure 4 shows the "payment capacity" of each of the studied SSAIs. This variable represents the accumulated cash flow balance resulting from inflows and outflows of financial resources, eventually added of initial or incremental working capital investments.

Successive simulations tested the introduction of external shocks in the system. Initially, variations in selected parameters were inputted into the model in order to simulate the behavior of a real system working under uncertain conditions regarding variability in production and sales, seasonal availability of raw materials and its effects on procurement costs, and other circumstances affecting the operation of a SSAI, as specified in appendix Table D. In the initial tests, all simulated agro-industries showed a worse performance in terms of financial results when compared to the base case scenarios.

Additional model changes were then tested simulating management induced corrective actions, thus constituting optimized scenarios as shown in Figure 5. Appendix Table D shows the values of the model variables under the basic SSAI conditions and the modified ones assumed in the optimized scenarios.

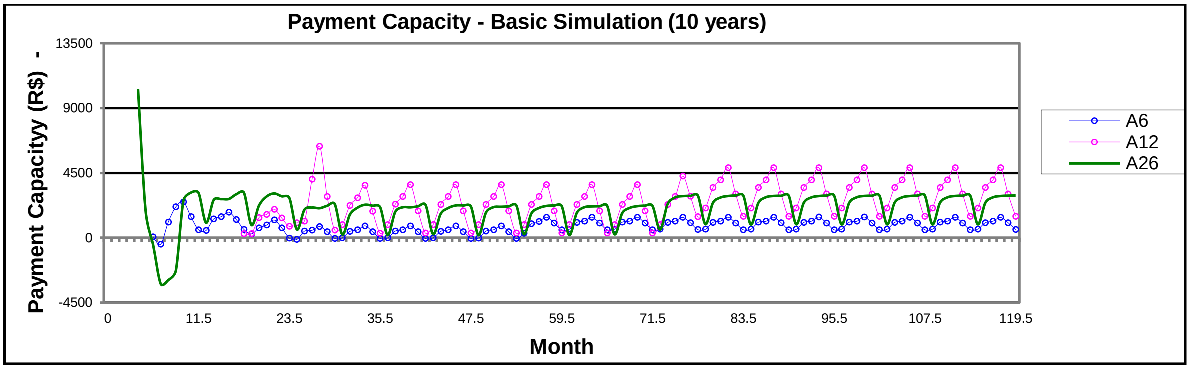

Figure 4. Payment Capacity Basic Simulations

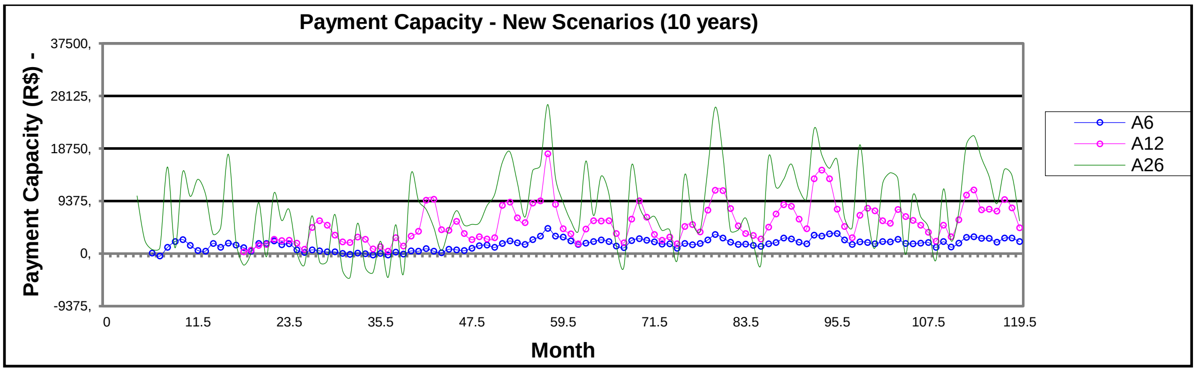

Figure 5. Simulation of Payment Capacity at Optimized Scenarios

In Figure 4, the basic simulation for A6 shows the system behavior defined through a participative strategic planning conducted by the agro-ecological association during the interview phase of the original study. At the time of the analysis, low production and large levels of product waste were occurring, because the firm was facing the entry of new competitors in their market. Moreover, the shelf life of their products was too short, causing frequent returns. The basic simulation showed that a sales orientation to institutional markets would not be sufficient to sustain the enterprise. An alternative strategy was to consider incremental investments in order to diversify operations. This included the introduction of a new product with an extended shelf life. The scenario optimization for A6 under this hypothesis considered a small incremental investment in the acquisition of one immersion tank to produce low cost vegetable conserves. Shelf life increased from an average of 5 days to one year, allowing access to quality demanding hypermarkets and independent chains, at the same time reducing sales seasonality. In Figure 5, the advantages of A6's optimized scenario came up even under uncertain conditions in the simulation scenario. The maximum payment capacity reached a peak of R$ 5,000 against R$ 2,000 found in the basic simulations.

The basic simulation for A12 considered the production of "colonial cheese", a traditional product produced without organic certification. Appendix Table D summarizes the elements of a diversification strategy into the new sale channels, including hypermarkets and independent chains, reducing the dependence of institutional markets and increasing direct sales to individual customers. A12's performance at an optimized scenario was satisfactory, even considering the higher quality control costs required to comply with federal sanitary regulations. Figure 5 shows that its maximum payment capacity was over R$ 15,000. Capacity utilization was still low, with a peak of 45% and an average of 17%.

A26's basic simulation confirmed a rapid escalation to its full production capacity. However, even considering the higher levels of revenue, A26's payment capacity compared unfavorably to A12. A26's optimized scenario considers a product differentiation strategy, which increased the costs of ingredients and product prices. To reduce administrative costs a possible strategy would be for A26 to become a member of a network. In this case, the optimized scenario would keep the initial distribution channels, but with a new raw material supply chain considering the participation in the network and the associated economies. In addition, incremental investments would allow amplifying the storage area, improving the laboratory structure and acquiring new processing equipment, all of which allowed an increase of 50% in production capacity. The simulation process also tested an increase in hours of technical capacity building support and business development services. Figure 5 shows that payment capacity reached values of R$ 25.000 and the production capacity utilization reached about 77%.

5.1 Main recommendations and insights from earlier simulations results

The basic simulations indicated a low level of sustainability for these three SSAIs if operations continued under their initial conditions. For A6 and A12, the slack in production capacity utilization was a major constraint. Distinctly, A26 reached its full capacity in one year of operation, but its production cost was comparatively higher, leading to seasonal impacts over its revenues. The adoption of strategic actions to overcome these barriers was imperative.

The simulations indicated a need for incremental investments to improve the cold storage capacity and the distribution logistics of A6. Moreover, it was advisable to acquire new equipment - an immersion tank - allowing the production of low cost vegetable conserves with extended shelf life.

In the case of A12, the formal networking for organic production was a challenge, but nonetheless essential to reach the minimum use of its production capacity and attain financial feasibility. Alternatively, A12 could increase its raw material supply by buying from other local producers, including non-associated to Agreco network.

A26 also could make incremental investments to have a more diversified product portfolio. Nevertheless, even working under full capacity the simulations showed the importance of product differentiation (quality standards, cultural value, innovativeness, etc.) to obtain a proper level of profits and secure its financial feasibility.

A26 was working with high costs and it was vulnerable to seasonal price effects. It needed to reduce its production costs by improving the productivity of its suppliers and enlarge its profit margins by searching for product differentiation and diversification of its product portfolio. Once it could improve sourcing for its raw material supply, the simulations showed A26 could make incremental investments at least to double its production capacity.

5.2 Real achievements of the selected SSAI: the situation in 2012.

The status of the three SSAIs in 2012 is presented in Table 3 below. It can be seen that A6 was not able to make the desirable incremental investments to increase its production capacity use and reduce wastes. The firm could not invest in cold storage and logistics, nor in diversifying production with the introduction of extended shelf life items. A6 thus had its operations discontinued and its owners returned to primary agricultural production.

A12 grew modestly, changing to conventional dairy products in view of the difficulties to obtain organic raw material. In this context, A12 made incremental investments, and started to buy raw materials from other local producers in order to increase its production capacity. It also changed its business model, working independently from the formal Agreco network.

A26, in turn, grew beyond expectations. A municipal program named “Bom Pasto” (Good Pastures) supported this firm, promoting improvements in milk production and quality. It is noteworthy to recall the fact that before this SSAI was implemented, local farmers used to produce milk only for self-consumption. Earlier, the milk sector was not seen as an attractive economic activity, because of the buying conditions offered by traditional dairies. Expanding their raw material quality and increasing purchases of milk after 2006, A26 accessed new funds from PRONAF, thus increasing in 30% its production capacity. This allowed the engagement of one thousand local milk producers in their raw material supply chain and the employment of 75 workers in 2008. A26 also adopted a diversified portfolio with 30 dairy products. In 2012, A26 was processing 100 thousand liters a day and 300 tons of dairy products a month, with 100 workers. By that time, there was an expansion project designed to process 250 thousand liters a day, which was approved by the Federal Inspection Service (SIF), allowing them to sell all over the country.

Table 3.
SSAI performance in 2002 and situation in 2012.

SSAI	CAPACITY (Raw Material/Day)		Status 2012
	2002	2012	
A6	500 (kg)	N.A.	Stopped Processing
A12	4,500 (l)	30.000 (l)	Incremental Investments.
A26	4,800 (l)	100.000 (l)	Incremental Investments.

Source: Adapted from Fernandes (2004) and data provided by recent interviews (2016).

Overall, the comparison of the current situation discussed here with the early simulation results mentioned in section 5.1 shows that the outcome of strategic actions taken by A12 and A26 managers revealed behaviors compatible with the expectations of the previous analysis and could produce even more satisfactory impacts than the insights provided by the simulation results. The achievements of A26 was mainly provided by the institutional arrangements in favor or raw material supply improvements and funding resources at low cost to allow investments in capacity expansion. Unfortunately, A6 didn't follow the recommendations and failed, confirming the low sustainability prospects revealed by the simulation exercise.

5.3 The SSAI network perspective and the institutional environment

As discussed in section 3.2, the selected cases illustrated two types of networks – hard and soft. A6 and A12 were linked to a hard network. The Agreco SSAI network requires strong commitment from its members, since its raw material production system follows strict principles of agro-ecology and quality of life, as well as directives for administrative operations, sales strategies and even profit margins. On the other hand, A26 had soft connections with other agro-industries benefited by "*Fábrica do Agricultor*", using the seal of "Southwest Tastes" and their sales infrastructure. Meanwhile, as an independent administrative unit, A26 had flexibility to make its own strategic decisions, choose the most appropriated business model and shield itself from the instability of public support programs.

In any case, as shown in Appendix Table D, the simulation process suggested positive effects if A26 had chosen a networking strategy to reduce administrative costs; its raw material supply planning would clearly benefit from networking economies. In fact, the state of Paraná attempted to promote the creation of an association of members of their "Fábrica do Agricultor" program. The goal was to generate networking economies from sales costs, transportation and joint marketing activities, but the initiative did not succeed. Yet, the simulation process showed positive results for A26 even without the networking economies, as seen in section 5.2.

The notion of sharing administrative and operational costs with multiple agro-industries to allow economies of scale was also hampered by tax regulations. The country has special rules for SMEs, which can benefit from a simplified taxation system (SIMPLES) depending on their annual revenues. When SMEs revenues grow over a threshold value however, their business category changes and a higher tax rate is applied. Usually, agro-industrial networks require that their small enterprise members leave the informal economy and register them to allow access to promotion programs and special policies, such as the SIMPLES taxation system. Yet, grouping agro-industries in a network that sells under a common brand and uses a single tax registration code may eventually raise the joint annual revenue to levels beyond the threshold of SIMPLES. In such cases, the tax benefits of remaining as an independent SME are lost.

The taxation issue was one of the motivations for Agreco to look for alternative business models, including a cooperative form of organization. The original network kept 22 active SSAIs comprising sixteen units focused on products with extended shelf life and certified organic production. However, six of the early SSAIs dissociated from Agreco and five others failed, all of these having worked with perishable products (minimum processed vegetables). Since 2009, Agreco established a cooperative ("CooperaAgreco"), increasing its capacity to cater to institutional markets (public bidding and public school meal programs) and traditional retail markets (Guzzatti, 2012; Weber, 2013). The institutional market grew with support from the national Food Acquisition Program (PAA), which promotes the purchase of products from family agriculture, and the National Program of School Meals (PNAE) that also favors the purchase of food from small farmers and rural SSAIs. In this context, A6 owners opted to deliver their primary production for local schools and trade fairs.

Table 4 summarizes the conditions of Agreco in 2002 in comparison with its situation in 2012.

Table 4.
Summary of Agreco network conditions in 2002 and in 2012.

Description	2002	2012
Business Model	Two Agreco SMEs and the “Credicolônia” (credit cooperative)	Agreco Organic Production Ltd. (SME) and the CooperAgreco
Family Farms	220	82
Farmers	500	177
Municipalities	4	9
SSAI	27	16
Product Portfolio	120	44
Annual Gross Revenue	BRL$ 777 thousand	BRL$ 2.778 thousand

Source: Adapted from Fernandes (2004); Guzzati (2012) and Weber (2013).

According to CooperAgreco’s commercial manager, “The supermarket chain is a more stable market than the school meals one. For school meals, the products are generally delivered “in natura” (fresh, without processing) comprising a large diversified amount with low added value and a high logistic cost. On the other hand, the retail market requires a product mix previously established with a regular delivery schedule”. To keep diversified market opportunities and benefit from tax advantages, the network kept two business models including the SME (“Agreco Organic Production Ltd”) and the cooperative (CooperAgreco).

Moreover, the Agreco SSAI network adopted strategic actions to reach greater sales flexibility, promoting extended shelf life products and improving its logistics and regular offerings. Seemingly, this has been in part a response to the problems faced by some of their SSAIs working in the minimally processed vegetables market. Agreco pioneered the production and marketing of these products in their sales area, but new entrants in the major urban market (the state capital) drove the prices down, in view of their economies of scale and proximity to the points of sale. As shown in Table 5, in 2002, there were six SSAIs designed to minimally process vegetables and most of them were working twice a week only, well below their installed capacity.

Table 5 also shows that both dairy SSAIs became independent of the Agreco network. It is noteworthy the fact that already in 2002 the other dairy SSAI in the network was already dissociating from Agreco. Moreover, A12 was facing difficulties to induce new milk producers to adopt an alternative ecological milk production system (“Voisin system”, Murphy, 1986) and thus supply organic milk to their enterprise. A12 is still a member of Agreco for some territorial development actions.

This episode shows how value addition by product differentiation can be offset by low use of production capacity due to difficulties to source agro-ecological or organic raw materials within the network. Indeed, according to Gusatti (2012) 44% of Agreco farmers have 100% of organic production, while 35% produce in both systems (conventional and organic) and 21% are starting the conversion to organic production.

Considering the existence of 27 SSAIs in 2002, Table 5 shows a 60% SSAI survival rate within the Agreco network. This can be considered as a positive result, given the typically high mortality rate of these enterprises in Brazil. The sustainability of the 16 active Agreco SSAIs is a reflex of the strategic action followed by the network to promote value addition through extended shelf life of their marketed products.

Table 5.

SSAI Agreco Network – production and sales comparison from 2002 to 2012.

	2002					2012		
SSAI GROUP	**SSAI**	**Capacity Tons/Year**	**UC (%)**	**Sales**	**Value**	**SSAI**	**Sales**	**Value**
				Tons/Year	**BRL$ 1.000**		**Tons/Year**	**BRL$ 1.000**
Honey	3	27	37%	10,0	50	3	40	398
Sugar-Cane	4	50	26%	13,0	26	3	34	138
Pickles Vegetable	3	180	2%	4,0	22	1	103	413
Jelly, sweets jams	2	336	1%	4,0	27	1	58	291
Read to use products	---	---	---	---	---			
Tomato products and dried	1	N.A.	N.A.	N.A.	N.A.	2	26	260
Poultry slaughterhouse	1	N.A.	N.A.	0,5	2	1	4	31
Minimally Processed	6	598	25%	153,0	241	2	N.A.	1.247
Bakery and Pasta	3	72	39%	28,0	56	3		
Eggs (*)	1	180	6%	11,0	21			
Other products	---	N.A.	N.A.	100,0	176	N.A.		
Dairy products	2	240	20%	20,5	86	(**)	N.A.	N.A.
Pig slaughterhouse	1	86	7%	6,0	70	(**)		
TOTAL	**27**	**1769**	**---**	**350,0**	**777**	**16**	**265**	**2.778**
Annual Gross Revenue	**BRL $777.000**					**BRL $ 2,778,000**		

Source: Adapted from Fernandes (2004); Guzzati (2012); Weber (2013) and data provided by recent interviews. (*) In transition for biscuit production. (**) Dissociated from Agreco network.

Agreco prioritized efforts to reach full capacity utilization in some SSAIs while closing non-sustainable ones (e.g., pickled vegetable, bakery, jelly and sweet jams units). In so doing, it considered market demands and the raw material supply capacity within the network. Recently, the network adopted *retort pouch* processing techniques to diversify its portfolio with differentiated products, such as ready-to-eat beans. In addition, Agreco is making incremental investments to expand its logistic infrastructure with new trucks and improvements in the cold chain, including expanded storage capacity.

From an annual gross revenue in 2002 of around BRL$ 0.7 million, the “Cooperagreco” reached proceeds of BRL$ 2.8 million in 2012 (Fernandes, 2004; Guzatti, 2012). Recently, the network approved a project of BRL$ 406 thousand through the World Bank funded SC Rural program to expand its activities, including a new head office and the acquisition of freezing chambers, trucks, and other equipment (SC Rural, 2016). The expectation is to reach an annual growth revenue above BRL$ 5.0 million. In addition, funding for a “Formation Center” (CFAE) was granted by a Brazilian federal agency for science, technology and innovation promotion (FINEP). BRL$ 500 thousand were provided to conduct experiments with small farmers and develop the production chain for essential oils in the Agreco region (Heidemann & Lunardi, 2013).

In sum, over time the strategic options followed by Agreco´s SSAI network were consistent with the insights obtained in the original simulation study. Agro-industries that were similar to A6 ensured their sustainability by following the recommendations of diversifying the product portfolio with extended shelf life items and incremental investments in cold storage and logistics. On the other hand, although strong commitment to a SSAI network can favor sustainability, it is not an imperative condition for SSAI survival, as suggested by the cases of A12 and A26.

6 Lessons Learned and Conclusions

Agro-industrialization is a dynamic activity where several critical factors act simultaneously, demanding a streamlined decision-making process as a pre-requisite for sustainability. The higher the understanding of the agroindustrial system, the larger are the chances of successful decision maker's interventions leading to business survival and growth. Small-scale agro-industries - SSAI - are vulnerable to the pressures of their competitive environment and are specially challenged to reach financial feasibility. Nevertheless, institutional arrangements involving networking stakeholders as well as the adoption of certain strategic actions can create optimistic growth and sustainability scenarios.

The system dynamics approach proved to be workable in designing and testing alternative scenarios and managing the factors leading to efficient performance, avoiding pitfalls revealed when simulation long-term effects are indicative of undesirable outcomes. The comparison between early simulations and the 10-years-after situation of selected cases of SSAI has shown that there is no single approach to reach the sustainability of this particular class of agro-enterprises. Each case is embedded in a scenario in which behavior is based on the causation of multiple variables. Far from being exhaustive, the following critical success factors can nonetheless be highlighted, due to their stronger relevance and impact on SSAI sustainability:

- **Production Capacity** – being dependent on the raw material supply and the amount that the SSAI unit is able to process, the production capacity must be carefully defined in agro-industrial project design. There is a need to carefully identify the break-even point and ensure that underutilization is avoided by careful marketing and raw material procurement strategies;
- **Product Differentiation** – a product can be designed to target a specific group of customers by choosing a different package, taste, quality standards or incorporating technological innovations, among others. New market trends will eventually bring new competitors. Entrepreneurs must consider the costs and benefits of offering a new product and the SSAI ability to provide and sustain innovation in its production system;
- **Product Diversification** – a diversified product mix can bring over new contracts, but a portfolio that is over-diversified also can make management difficult. Decision makers need to define a portfolio that takes into account, inter alia, avoiding wastes before the expiration of shelf life and the ability to meet the needs of potential consumers.
- **Diversified Sales Channels**: a diversified distribution system increases the SSAI resilience and reduces the impacts of external shocks on sales. Institutional and retail markets, as well as special channels such as organic and fair-trade products, offer distinct profit margins and conditions. The sales policy should balance the pros and cons of different channels, bearing in mind that institutional markets can warrant a reasonable market security through their contracts, even with lower profit margins, while the retail and fair trade markets can be more profitable but require a better prepared, professional commercial staff.
- **Business Model** – the organizational structure, firm size and the legal framework into which the SSAI is embedded can favor its financial feasibility with advantages such as tax breaks and access to credit. The adoption of more than one business model can produce redundant administrative costs and tasks, while on the other hand it can offer more flexibility in commercial deals.
- **Networking** – the partnerships established by the SSAI owners or associated farmers can provide business advantages. Collective actions can affect in a beneficial way the investments, production costs, sales and other sustainability indicators. On the other hand, agro-industrial projects taking into account the establishment of new networks should be prepared to cope with greater complexity in organizational issues and a typically slower investment pay-back period.
- **Institutional arrangements** — the complexity of inter-institutional relationships is caused by factors such as the associated bureaucratic processes and the dependence between institutions supporting the SSAI activities. The partnership development may be emphasized with a clear definition of executive responsibilities, avoiding the duplicity of resources and effort requirements. Institutional development and good governance between partners should induce more simplified tasks and promptness in replying to SSAI requests.

Although the listed factors above may not be entirely unique for SSAIs, some being relevant as well for agri-food sector firms in general, it can be argued that they need to be particularly taken into account when considering investments in the types of small scale enterprises focused by this work. Given the particularly high sensitivity of SSAIs to uncertainties regarding factors affecting their cost and revenue streams over time, all of these critical factors need to be well balanced in project design and carefully assessed under different scenarios, before an investment decision is made. Indeed, this study has shown that a SSAI can be profitable and sustainable when a group of actions are well planned to overcome barriers through proper technical advice and institutional support.

Well designed and implemented small-scale agro industrial development programs with components covering some of the elements hereby discussed can thus undoubtedly play a key role in the promotion of sustainable SSAIs, particularly in developing countries.

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APPENDIX

Table A.
Agro-industrial Profiles (SAAFI): Financial Feasibility Indicators and Sensitivity Analysis

Interactive Profiles	Total Investment (BRL$)	IRR (%)	PBP (years)	BEP (%)	Sensitivity Analysis (Δ% TIR)
Minimally Processed Vegetables	225.302.75	62.49	1.79	19.48	± 92
Brown Sugar and "Rapadura"	264.921.22	55.81	2.06	20.32	± 61
Dried Banana	312,035.38	38,12	2,75	26,68	± 59
Pork Slaughtering and Processing	623,360.95	37,37	2,82	17,25	± 114
Cassava Flour (20 tons)	471.746.67	27.84	2.76	21.25	± 57
Sugarcane Brandy Distillery ("Cachaca")	659,099.25	27,14	3,6	21,26	± 96
Milk Cooling Center	13,378.93	27,03	3,54	19,25	± 25
Diversified Dairy	494,541.27	18,03	3,72	26,59	± 151
Goat Milk Cheese	97,021.38	18,03	4,87	51,51	± 167
Fruit Pulp	244,358.39	17,96	4,92	41,69	± 146
Poultry Slaughtering	93,123.20	15,61	5,36	45,44	± 222
Cheese Production	78,917.86	15,38	5,31	44,51	± 108
Cassava Flour (5 tons)	252.658.72	14.53	5.42	41.24	± 96
Soybean Meal and Oil	357,752.97	13,4	5,91	26,49	± 320
Cashew-nut Processing	69,899.93	12,62	5,97	47,81	± 121

Source: Adapted from Lourenzani (2003).

Table B.
Brief Description of the Desenvolver Program

***DESENVOLVER*-SC: PROGRAM FOR THE DEVELOPMENT OF FAMILY FARMING IN THE STATE OF SANTA CATARINA (SC) THROUGH THE PROMOTION OF VERTICALLY INTEGRATED PRODUCTION.**
Duration: 1998-2001
Characterization *DESENVOLVER* was funded under the PTA – Appropriated Technology Program – of Brazil´s National Council of Science and Technology (CNPq) which provided resources to the SC Agency for Research Support (FUNCITEC). FUNCITEC coordinated the program in partnership with regional NGOs (e.g. CEPAGRO) and some local municipal administrations (e.g. Blumenau and Joinville). It was also supported by: the Federal University of Santa Catarina (UFSC); the National Agency for Agriculture Research – EMBRAPA; Santa Catarina Enterprise for Technical Assistance and Rural Extension – EPAGRI; seven cooperatives of the west region of the state; the State University of Western Santa Catarina (UNOESC); the Municipal Foundation 25 of July (Joinville); the Regional University of Blumenau´s foundation (FURB). The PRONAF-Agroindustry program also had positive impacts over this program, especially concerning the availability of funds for SSAI promotion

• **Strategies** • Technical support and consultancy work for the promotion of value addition from family farms, from the production of raw materials to the commercialization of transformed products; • Support to the creation of new units or consolidation of agro-industries, including project design and financial feasibility analysis; • Generation and diffusion of appropriate technologies.
Resources: From CNPQ (0.5 million dollars); from municipality of Joinville (80 thousand dollars); municipality of Blumenau (120 thousand dollars); PRONAF directly supported beneficiary producers (amount not informed).
Target group (area of influence): The program targeted small-scale family farms in 41 municipalities of SC, distributed in 6 sub-region.
Examples of supported projects: a) ***AGRECO Network**:* "Inter-municipal project for a network of modular agroindustries", in sub-region 6, integrating 27 new agro-industries, referred as Agreco SSAI network. After the conclusion of Desenvolver, Agreco was supported by the "Sustainable Rural Life" program of SEBRAE – Brazilian Micro and Small Enterprise Support Agency. b) *APACO*-SC: support for the "Small Agroindustries Network", in sub-regions 1, 2 and 3 in the west of Santa Catarina; encompassed 30 agroindustries with more than 200 families participating in 14 different lines of production, in 14 municipalities of the west of Santa Catarina state. c) PROVE-Blumenau: Program for the promotion of vertically integrated production for the rural family farming population of Blumenau, (sub-region 4) and of agroindustries in Joinville (sub-region 5): 145 agroindustries were in operation in 2001.
Status: The program *DESENVOLVER* ended in 2001 and no other state government program is monitoring its supported agro-industries. Local institutions and NGOs kept their support. At the end of the program, there were **234 productive agro-processing units**, which offered 1371 direct jobs affecting 1076 families. It had remarkable impact in the technical quality of the agro-processing projects it supported, when compared to experiences in other regions of Brazil. This was mostly due to their multidisciplinary support team approach.

Table C.

Brief description of "Fabrica do Agricultor" Program

"*FÁBRICA DO AGRICULTOR*": AGROINDUSTRIES FOR FAMILY FARMS: THE RURAL PRODUCER FACTORY PROGRAM IN THE STATE OF PARANÁ STATE.
Duration: Started in 1999 until the present.
Characterization "*Fábrica do Agricultor*" consists of a governmental program developed to respond to a demand from the agricultural sector to aggregate value to primary products and bring agro-industrial development to the interior of state. The Agriculture Secretary (SEAB) of Paraná state promoted the program and was responsible for its general coordination. The Enterprise for Technical Assistance and Rural Extension of Paraná (EMATER-PR) responded for the technical coordination. Its implementation counted with partners from diverse state institutions, including : CODAPAR (Paraná Company of Agriculture Development); SEBRAE-PR (Brazilian Small and Micro Enterprise Support Agency); CLASPAR (Paraná Enterprise for Classification and Standards); IAP (Environmental Institute of Paraná); IAPAR (Agronomic Institute of Paraná); TECPAR: Technological Institute of Paraná; CEASA (Wholesale Supply Center of Paraná) and UFPR (Federal University of Paraná). The organizational structure of the program encompassed the creation of Councils at state, regional and municipal level. The program established the State Council, responsible for institutional arrangements, planning and evaluation, in 1999. In 2000, there were 19 regional councils.

Strategies:

- **Institutional Arrangements**: partnerships to optimize interdependent bureaucratic processes
- **Initial diagnosis**: mapping of existing agro-industries and diagnosis of constraints
- **Technological component**: development of professional expertise oriented to agro-industrialization
- **Marketing component**: identification of products with guaranteed quality through technical training of beneficiaries; identification of market channels, creation of regional brands such as "*Sabores do Sudoeste*" (**Southwest Tastes**) or optional use of the label "*Fábrica do Agricultor*"; exploring the potential of ethnical diversity in Paraná and preserving traditional forms of production. Creation of AFAGRI (*Association of Fábrica do Agricultor*) to share the costs of sales, transport and marketing in Curitiba (State Capital).
- **Component "Kit Agilidade"** (Agility Tool Box): to speed up the process of constitution, legalization; implementation through the creation of tools for individual assistance to business or organization
- **Component "Incentives":** to create and implement credit, tax and infrastructure tools.
- Monitoring and evaluation activities during implementation demanded the correction of actions, but without significant changes in its structure or basic assumptions.

Resources:
World Bank and State Development Agency, with an initial investment of 2 million dollars. PRONAF provided direct support to producers (amount not informed).

Target group (area of influence):
The program reached 250 municipalities. It initially focused on small and micro entrepreneurs associated or not to family farmers. Later, the program focused mainly on family farming. In 2002 there were 1262 units in operation, generating 6346 jobs and benefiting 825 families.

Examples of supported projects:

a) Individual agro-industries such as: "É da Pam" (jelly); "Bella polpa" (fruit processing); "Madre Pérola" (meat products; among others) and **Alto Alegre Dairy Products Plant** of Alto Alegre, managed by APRUAL – Rural Workers Association of Alto Alegre.
b) Pró-Caxias: Integrated Development Project of the Municipalities in the area of the Electric Power Plant of Salto de Caxias, in Southwest of Paraná.
c) UGERA – Central Management Unit of Rural Agroindustries from Bom Jesus do Sul, using the label FARBON for dairy products.

Current situation:
By the time of the original study, the Program "*Fábrica do Agricultor*" had supported more than 1600 agro-industries. From these, 700 units are projects implemented after the beginning of the program. In 2012 there were 1.320 active SSAIs benefitting from the program. It is still active, with multi-annual budgets.

Table D.
Shocks in critical variables grouped by success factors from basic to optimized scenarios.

SSAI			A6	A6	A12	A12	A26	A26
	Description	Unit	Basic	Optimized	Basic	Optimized	Basic	Optimized
Uncertain Conditions	Output reduction (production decline)	%	0	20	0	30	0	30
	Sales Oscillation Range	%	± 0	± 20	0	± 30	0	± 30
	Seasonal Effects Over Raw Material Costs	%	0	+ 5	0	+ 5	0	+ 20
	Raw Material Production Off-Season	%	0	80	0	70	0	80

Production Capacity	Production Capacity	kg	6000	=	11000	=	12000	18000
	Optimization of Production Capacity Use	%	26	+50	14	+30	58	=
	Production Capacity Expansion	%	0	=	0	=	0	+50
	Incremental Storage	%	0	=	0	=	0	30
	Incremental Investment	BRL$	0	3125	0	0	0	30208
Product Differentiation	Alternative Raw Material Production System	%	100	=	50	100	0	=
	Conventional Raw Material Production System	%	0	=	50	0	100	=
	Changing the Cost of Alternative Raw Material	%	0	=	-24	=	0	=
	Earnings with Product Certification	%	0	=	0	+25	0	=
	Basic Price Adjustment	%	0	=	0	=	0	10
	Competitor Price Impact Range	%	0	30	0	50	0	30
	Cost of New Package by Kg	BRL$	=	1.5	0	0	0	0
	Average Cost of Ingredients	BRL$	=	1.1	0	=	0.15	0.25
	Average Cost of Inputs	BRL$	0	0	0	0	0.17	=
	Changing Shelf Life	Un.	=	12	0	0	0	0
	Cost Increase of Laboratory Analysis	%	0	=	0	300	0.1	100
	Initial Investment in Control Quality	%	0	=	0	=	10	=
	Incremental Investment in Control Quality	%	0	=	0	=	0	30
Product Diversification	Number of Products in the Agro-industry Portfolio	Un.	42	=	1	=	3	=
	New Type (Group of Products - GP)	Un.	=	3	0	=	0	=
	New Products by Type (Group of Products - GP)	Un.	0	=	0	=	0	3
	Price of New Product	BRL$	0	5	0	=	0	=
	New Yield	%	=	70	0	=	0	=
	Waste Recovering	%	20	50	20	=	0	=
	Rework Cost by kg of Waste	R$	0.05	0.1	0.05	=	0	=
	Sub-product Price	R$	0	0.12	0	0.05	0	=

Networking and Business Model	Number of Agro-industries (SAAI) in the Network	Un.	30	=	30	53	1	30
	Number of Products Commercialized by the Network	Un.	136	=	136	=	3	16
	Administrative Costs (Without Network)	R$	0	=	0	=	1199.87	=
	Administrative Costs Shared in the Network	R$	371.98	0	159.42	0	0	743.24
	Increasing in the Number of SSAI to Network Strengthening	Un.	0	=	0	23	30	
	Adding Network Capacity of Diversification	GP	0	0	0	0	0	All GP
	Own Raw Material Supply	Un.	100	=	50	50	22	40
	Network Raw Material Supply	R$	0	0	50	50	0	40
	Third Raw Material Supply	%	0	0	0	=	78	20
	Economies with Own Raw Material Supply	BRL$	0	=	0.10	=	0.10	=
	Economies with Network Raw Material Supply	Un.	0	=	0.05	=	0.05	=
Diversified Sales Channels	Sales Commission	%	3	5	3	5	3	5
	Sale Channel - Hypermarket Network	%	0	20	0	25	20	=
	Sale Channel - Independent Supermarket Chain (< 5 stores)	%	30	20	0	25	30	=
	Sale Channel - Small Retailer (< 5 cashiers)	%	10	20	20	10	40	=
	Sale Channel - Institutional (Public Sector)	%	49	10	70	20	0	=
	Sale Channel - Fair Trade	%	11	20	10	20	0	=
	Sale Channel - Institutional (Private Sector)	%	0	10	0	=	0	=
Institutional arrangements	Incremental Working Capital	BRL$	=	2797	0	0	0	=
	Funding of Incremental Investment	%	0	1	0	0	0	60
	Increasing Technical Capacity Building Support	Horas	56	=	56	=	160	1236*
	Increasing BDS Support	Horas	190	=	190	=	320	1237*
Simulation Results Results	Accumulated Cash Flow	BRL$	56,116.87	498,669.90	150,552.00	1,237,069.00	165,257.60	789,605.70
	Pay-Back Period	Years	7	2.5	6	3.5	4	2
	Income/Owner (Associated Farmer)	BRL$/ Month	93.53	831.12	418.00	3,436.00	57.00	274.00

*Tested independently.