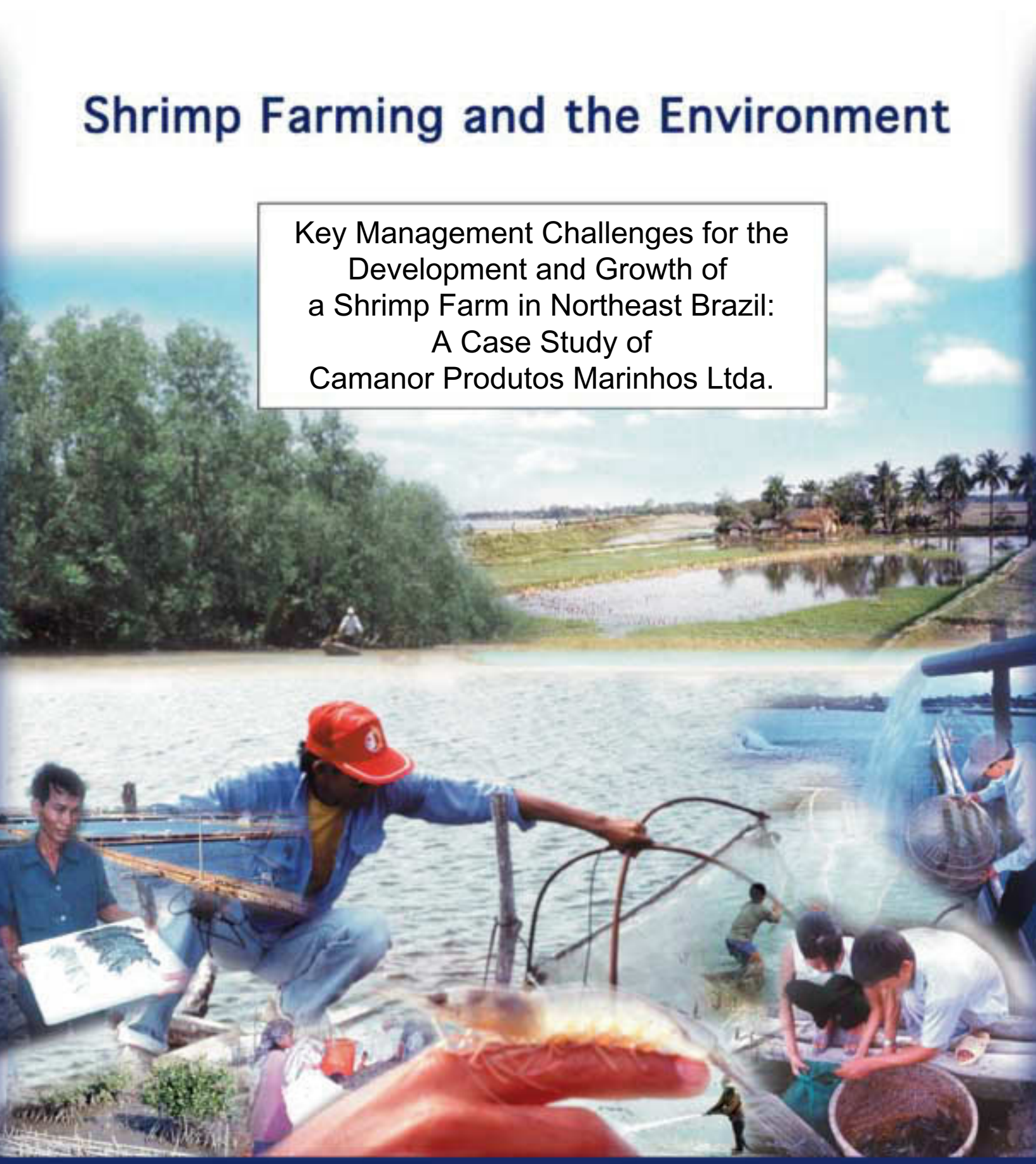
Shrimp Farming and the Environment

Key Management Challenges for the Development and Growth of a Shrimp Farm in Northeast Brazil: A Case Study of Camanor Produtos Marinhos Ltda.



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KEY MANAGEMENT CHALLENGES FOR THE DEVELOPMENT AND GROWTH OF A SHRIMP FARM IN NORTHEAST BRAZIL: A CASE STUDY OF CAMANOR PRODUTOS MARINHOS LTDA.

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Preparation of this document

The research reported in this paper was prepared under the World Bank/NACA/WWF/FAO Consortium Program on Shrimp Farming and the Environment. Due to the strong interest globally in shrimp farming and issues that have arisen from its development, the consortium program was initiated to analyze and share experiences on the better management of shrimp aquaculture in coastal areas. It is based on the recommendations of the FAO Bangkok Technical Consultation on Policies for Sustainable Shrimp Culture[1], a World Bank review on Shrimp Farming and the Environment[2], and an April 1999 meeting on shrimp management practices hosted by NACA and WWF in Bangkok, Thailand. The objectives of the consortium program are: (a) Generate a better understanding of key issues involved in sustainable shrimp aquaculture; (b) Encourage a debate and discussion around these issues that leads to consensus among stakeholders regarding key issues; (c) Identify better management strategies for sustainable shrimp aquaculture; (d) Evaluate the cost for adoption of such strategies as well as other potential barriers to their adoption; (e) Create a framework to review and evaluate successes and failures in sustainable shrimp aquaculture which can inform policy debate on management strategies for sustainable shrimp aquaculture; and (f) Identify future development activities and assistance required for the implementation of better management strategies that would support the development of a more sustainable shrimp culture industry. This paper represents one of the case studies from the Consortium Program.

The program was initiated in August 1999 and comprises complementary case studies on different aspects of shrimp aquaculture. The case studies provide wide geographical coverage of major shrimp producing countries in Asia and Latin America, as well as Africa, and studies and reviews of a global nature. The subject matter is broad, from farm level management practice, poverty issues, integration of shrimp aquaculture into coastal area management, shrimp health management and policy and legal issues. The case studies together provide an unique and important insight into the global status of shrimp aquaculture and management practices. The reports from the Consortium Program are available as web versions (http://www.enaca.org/shrimp) or in a limited number of hard copies.

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[1] FAO. 1998. Report of the Bangkok FAO Technical Consultation on Policies for Sustainable Shrimp Culture. Bangkok, Thailand, 8-11 December 1997. FAO Fisheries Report No. 572. Rome. 31p.
[2] World Bank. 1998. Report on Shrimp Farming and the Environment – Can Shrimp Farming be Undertaken Sustainability? A Discussion Paper designed to assist in the development of Sustainable Shrimp Aquaculture. World Bank. Draft.

Abstract

This case study discusses the main lessons for management practices learned at the shrimp farm Camanor, in Rio Grande do Norte (RN), Brazil. Since it was founded in 1982, the Camanor farm has yielded data that allow the knowledgeable observer to draw lessons and make insights. The lessons learned should be considered when addressing future development potential and the challenges of the shrimp aquaculture industry. This process is extremely important in Brazil and elsewhere, as new producers are likely to repeat the mistakes of others rather than learn from them unless the lessons learned are documented. This case thus attempts to document the most important lessons by Camanor during the past 18 years. The most important challenges before the shrimp aquaculture industry involve developing better practices and implementing industry wide standards that are more sustainable.

The case study is divided in two main parts: first, From Past to Present: Camanor's Development, and second, Perspectives for the Future. The first part is based on data available from the farm and on the experience of the owner and manager, Werner Jost. The second part is also based on Camanor data but includes projections of results from implementing certain sustainable management practices.

Camanor, like other shrimp producers in Brazil, is increasing its production rapidly. Besides the current operation, three more farms are under construction, some of which are beginning production. This expansion leads to new challenges in processing, administration, and overall management of the farm. The description and analysis of the past development of Camanor give some idea of the preconditions needed to support the current expansion.

Content

Abbreviations and Acronyms

ABCC	Associação Brasileira de Criadores de Camarão (Brazilian Shrimp Farmers Association)
BRL	Brasilian Real (1US$ = 2.34 Real (Feb. 2002))
FAO	Food and Agriculture Organization of the United Nations
FCR	Feed Conversion Rate, kg of feed used per kg shrimp produced
g	Gram
GAA	Global Aquaculture Alliance
ha	Hectare
HP	Horse Power
Inv-LTA	Investments in long-term assets
kg	Kilogram
kwh	kilowatt hours
LTD	Long-term debt
m^2	Squaremeter
MT	Metric tons
NACA	Network of Aquaculture Centres in Asia-Pacific
PL	Post-Larvae
RN	Rio Grande do Notre
ROS	Return on sales
US$	American Dollars
VC	Value of company
WB	World Bank
WWF	World Wildlife Fund

Introduction

An Overview of Camanor's Main Features and Development

This section gives a quick overview of the farm's current operations (in June 2000). All statements made in the following chapters are based on assumptions valid for this farm and reflects the situation of Camanor Produtos Marinhos Ltda. only. In Table 1 some key figures for the Camanor farm is given.

Table 1. Camanor's basic production information.

Production system	Semi-intensive
Species	*Litopenaeus vannamei* (Pacific white shrimp)
Density	20-25 post larvae (PL) per m^2
Water exchange rate	Average 5% per day, no aeration
Production cycles	90 days, 2.8 cycles/year, 2,000 kg/ha/cycle
Land	120 ha in production at site of parent company (Cana Brava) and an additional 15 ha for hatchery operations, 20 ha wetland, 70 ha mangroves (protected); sites of 150, 220, and 400 ha under construction (by 6/00, 50 ha of these in production)
Marketing and distribution	Mainly domestic market; in 2000, start exporting frozen shrimp

Figure 1 shows the production increase as well as production technologies used on the farm. Major changes have included the introduction of the exotic species *Litopenaeus vannamei*, the hatchery, and the processing plant.

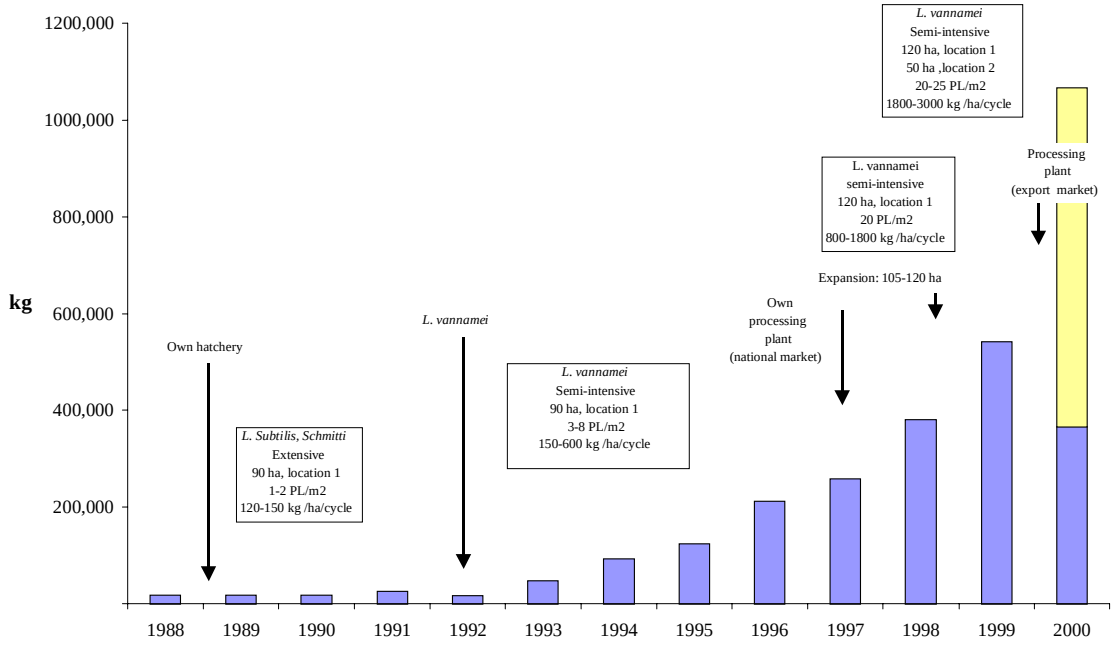

Figure 1. Key Points in the development of Camanor. Note that the production for latter half of 2000 (in lighter shade) is estimated. (Source: Camanor database, 1988-2000).

Brazil's Shrimp Aquaculture Industry

The shrimp aquaculture industry in Brazil is relatively new; the first operations began about 20 years ago. While the wild-caught shrimp industry exists throughout the south of Brazil, aquaculture is located primarily in the northern states. Shrimp aquaculture operations began in Bahia and gradually moved farther north. The first Brazilian shrimp farms tried to imitate the practices of farms in Ecuador, Panama, and Taiwan, Province of China, without taking into account important Brazilian differences in culture, land ownership, labor, infrastructure, domestic markets, and other factors. The imported models did not work and, consequently, many farms that were built in the 1980s closed a few years later. Currently, Rio Grande do Norte (RN) is the largest shrimp aquaculture producer, with more than 30 percent of national production (see Figure 2).

Figure 2. Map of Brazil. The black arrow indicates the placing of the Camanor farm.

High temperatures all year long, flat terrain, the use of old salt mines, the presence of commercial hatcheries and some bigger farms that developed technologies (which smaller producers were able to adopt in their operations) are the main reasons for the expansion of shrimp aquaculture in RN.

During the initial development of the industry, heavy subsidies and credits of more than US$22.4 million were made available by government agencies. The subsidies were credits with fixed interest rates (a relatively low 40 percent, during a period of high inflation). Sixteen shrimp farms were established with this support between 1982–1984 (CIRM 1988 as quoted in Wainberg and Camara 1998). These pioneering operations cultivated *Penaeus japonicus* under extensive conditions (1.3 shrimp/m^2 with no supplementary feed) and produced average yields of less than 500 kg/ha/year. By the middle of the 1980s most of these projects had closed down. In RN, for example, 70 percent of the total grow-out area of 1,646 ha was no longer operational by the mid–1980s. Poor production methods, limited tolerance of *P. japonicus* to salinity, high inflation rates, lack of reliable sources of PL, and poor farm design and site selection were the main reasons for the farm failures (Rocha et al. 1989 as quoted in Wainberg and Camara 1998).

The growth of shrimp aquaculture in Brazil occurred primarily after 1997. Growth has been stimulated by new export possibilities as a result of currency devaluation. International markets also opened somewhat due to the production collapse in Ecuador (due to White Spot Disease). In 1997, Brazil's annual shrimp aquaculture production was 3,654 metric tons (MT), in 1998 7,260 MT, and in 1999 15,000 MT. It is estimated that production in 2000 will double again, to around 30,000 MT (Rocha 2000).

By 2000 the growth potential, improved currency valuation policies and international market prices have made shrimp aquaculture very attractive for new investors many of them Brazilian. These investors generally have no knowledge about or previous experience with shrimp aquaculture. In addition to these Brazilians, investors trying to flee the conditions in the Ecuadorian shrimp industry are getting involved as well as those from other parts of the world.

Input Supplies and Processing

Post-Larvae (PL)

The availability of high-quality PL is one of the most important factors in shrimp aquaculture. The first shrimp species used in aquaculture in Brazil was a local species *Aztecus* (today called *P. subtilis*) and the imported species *P. japonicus*. In the mid-1980s, *L. vannamei* (Pacific white shrimp) was introduced, together with the support of foreign technical expertise in Bahia State (Faria 1993 as cited in Waiberg and Camara 1998). Even though the introduced species *L. vannamei* showed much greater tolerance of conditions and better production results, in 1990 some 71 percent of the total PL produced in Brazil were native species (*P. subtilis* and *P. schmitti*), and only 23 percent were *L. vannamei*. The hatchery that initially produced *L. vannamei* belonged to a shrimp farm, which did not in general sell PL to the market (only overproduction that it did not need). The relative shortage of *L. vannamei* can be explained by the lack of expertise with the species as well as the availability of broodstock. However, two years later *L. vannamei* accounted for 79 percent of the total Brazilian PL production (Maia 1993 as quoted in Wainberg and Camera 1998).

In 1999 Brazil legally closed its borders to imported live crustaceans (including shrimp). The motive behind this legislation was to avoid importing diseases in general, and the White Spot Virus in particular. This moratorium might well lead to a shortage of PL in the next few years if the industry continues to expand at its current rate. In fact, shortages could well lead to the illegal importation of PL or broodstock, which could threaten the future of the industry.

The growth of the Brazilian shrimp industry itself is likely to contribute to a shortage of PL. Production is usually enhanced either by increasing the area of production or increasing stocking densities. No programs supported either by the government or an industry association exists to promote the creation or expansion of hatcheries. To date, all hatcheries in Brazil are still associated with individual shrimp farms. Even though some hatcheries sell to other farms, the competitiveness of the PL market is limited. If demand increases, however, there will be market incentives to increase the production of PL—but there will be a lag between higher demand and supply. This shortfall could well be the excuse needed by newcomers to import from other hatcheries (including foreign), whether it is legal or not.

Feed Supply

In the 1980s basic shrimp feed existed in the Brazilian market. Ralston Purina (today Purina Agribrands), a US-based feed company operating in Brazil, produced shrimp feed in São Paulo. The main problems with feed at that time were irregular supply as well as demand. By the mid-1980s, Purina Agribrands stopped production and only started again in the early 1990s. After 1994 feed supply was no longer a problem in Brazil.

Today, four shrimp feed producers supply the Brazilian market. Purina Agribrands, still dominant, controls about 80-90 percent of market share. Beside Purina, Socil, Sibra, and Burris Mills also produce shrimp feed. With the exception of Burris Mills, the other companies produce their product in Brazil.

One of the main problems that producers have with shrimp feed suppliers is that the latter will not reveal the precise ingredients in the feed. The suppliers feel that this information is proprietary. However, this means that while producers may know the protein content they do not know the fishmeal percentage of the feed. Experience in other parts of the world suggests that high fishmeal content can cause deterioration of pond water and stress on animals.

Processing

Processing has not been an important factor in Brazil, as virtually all shrimp production was sold fresh on the national market. However, processing became much more important at the beginning of 1999 with the possibility of exports. Abandoned processing plants have been reactivated. To date, most processing plants are not connected to a specific farm but buy product from several operations. At this time several producers, including Camanor, have invested in processing plants and freezing equipment to enter into the export market for frozen shrimp. Existing operations have increased their capacity for processing while others have built processing capacity from scratch to add value to their on-farm production.

In 2000 the processing capacity in Brazil is about 24,000 MT of shrimp from aquaculture. About 50 percent of this production is intended for export (Mr. Arimar, personal communication 2000).

Marketing

Marketing and selling shrimp are mainly determined by market demand and by factors such as government policy on currency exchange rates. Prior to 1999 Camanor sold all of its production within Brazil, mainly to wholesalers in Rio de Janeiro and São Paulo. On the Brazilian wholesale market, all shrimps are sold head-on. With the devaluation of the currency the Brazilian shrimp industry became competitive on the international market. This trend was accompanied by devastating production problems in Ecuador (due to White Spot Virus) and an increasing demand for shrimp on the world market. On the international market, Brazilian shrimp are sold head-on as well as headed. Head-on shrimp are sold to the European market, where the prices and profits are higher. Headed shrimp are sold to the US. (As of June 2000).

Decreasing prices for shrimp on the US market do not really hinder the overall expansion of the Brazilian shrimp industry, but they do reduce profits and may give investors a more realistic impression of the shrimp sector.

Founding of an Industry Association

The formation of the Brazilian Shrimp Farmers Association (ABCC) in 1984 was a response to the crisis facing the industry. At that time, the industry was already growing but had little or no experience with different species used in aquaculture systems, no shrimp feed, no technical expertise available for the operation of a shrimp farm, and other problems. After its creation, ABCC began fighting for political, financial, and technological support for the industry (Wainberg and Camara 1998). The political power and public acceptance of the Brazilian shrimp industry are increasing with the activities of ABCC.

In 1999, ABCC and the Brazilian Agricultural Ministry started a national program for the development of the Brazilian shrimp aquaculture industry. This program involves developing the social and economic benefits of the industry as well as supporting projects intended to increase production area from the actual 6,000 ha in early 2000 to an estimated 35,000 ha by 2003. Such an increase means that annual production would be around 105,000 MT by 2003. Such a production level would make Brazil almost equal to Ecuador in 1998 (130,000 MT) before the country was hit by White Spot (Department of Fisheries and Aquaculture 1999). While the program is not yet implemented, there is increasing pressure from several sources to do so.

The role of ABCC is to bring together the interests of companies and organizations represented in the association. It initiates scientific programs to obtain more knowledge about shrimp production in Brazil, financed from a “feed fund.” Each producer pays a tax of Real (BRL) 0.02 per kg. All feed suppliers including importers take part in this program. Feed was chosen as the point of leverage because of its importance for a shrimp operation (everybody uses feed), the small number of suppliers, and the ease of recording and tracking the tax data. The tax to fund research will be reduced to BRL 0.015 and then to BRL 0.01 per kg once the programs are up and running (and as feed consumption increases). The programs to be funded by the tax are mainly production oriented scientific research projects at universities. Examples of study titles include “Evaluation and use of artificial substrate to increase the availability of natural feed in *L. vannamei*, semi-intensive culture,” “Application of genetic markers to improve the development of the Brazilian shrimp sector,” and "Monitoring to detect the white spot virus in commercial shrimp operations.” In addition to these three projects, there are four others that evaluate the viability of cyst and artemia production, genetic markers, smoked shrimp, and certification of the Brazilian shrimp industry (ABCC 2000).

In many states including Bahia and Ceará, shrimp producers are very well organized. Small producers (generally of 30 ha or less of semi-intensive production ponds) are usually “under the control” of larger ones (generally of 150 ha or more) that supply feed and buy the shrimp produced. Brazil has a longstanding tradition of “production under contract” within the intensive animal feeding industries. This is true not only in shrimp farming but also in the chicken and pig industries where this practice is common as well. The dependence of smaller producers in this type of system can mean that larger ones control or monopolize the small ones. On the other hand, the transfer of known technology and management practices, the identification and adoption of new technologies, and the availability of working capital (in cash or in kind) provide small producers with benefits that they could not otherwise have.

In the state of Rio Grande do Norte, however, where many small producers exist, there are no overarching organizations or beneficial connections to big farms. A small farmer cooperative is working to purchase feed in bulk, but attempts by the same cooperative to create a processing plant have failed. Some of the small producers are connected to processing plants that handle the processing and marketing of the shrimp and finance expensive resources such as feed and PL. However, this dependence does not guarantee a transfer of more efficient and better management practices from the big farms to the small ones. Even if the big farms wanted to disseminate information of this type, it is not clear that better practices from larger operations are always appropriate on small farms.

Several differences in shrimp aquaculture that currently exist among Brazilian states are due primarily to history and tradition. Most of the small producers in Rio Grande do Norte were fishermen who already had a basic infrastructure for salt ponds. (There were no large shrimp farms in this state.) The local availability of PL after 1993 allowed farms to increase their shrimp operations. As a result, their development was more independent than that of small farms in Bahia or Ceará, where big farms had already invested in infrastructure for processing plants, hatcheries, and so on. The big farms needed more shrimp for their processing plants. In addition, buying feed in bulk allowed them to get better prices on their own feed. For these reasons, the large farms promoted the development of small farms that produced under contract to them. This allowed larger farmers to use their capacity more efficiently while allowing smaller producers to simply enter the industry.

From Past to Present: Camanor's Development

Typical Development Phases of a Company

The preceding introduction describes the circumstances of the Brazilian shrimp industry. As worldwide demand for seafood products is growing and the wild-caught shrimp supply is limited, aquaculture is one effective way to fill this gap. The Brazilian shrimp industry is still very new and relatively unstable. Pioneers such as Werner Jost, owner of Camanor, can play an important role in the development of the industry during this critical time of expansion. Their technical expertise and experience can assist newcomers as they enter the sector and expand the total area of operations.

Some crucial aspects of management during this period of expansion of the shrimp aquaculture industry are identified and discussed in this chapter. Table 2 presents and organizes the primary stages of organizational growth of a shrimp farm. This overview focuses on the main points that are relevant to the development of a farm.

Corresponding to this table, the developmental stages of Camanor are analyzed. The figures in the following chapters show the development in the production methods, human resources and organization of Camanor. The column "Opportunities for and Threats to Sustainability" lists the biggest challenges for all companies and organizations involved in the shrimp aquaculture business in Brazil. There are many examples of fast growing shrimp sectors worldwide. Lessons leading to more sustainable practices have come slowly, however. The challenge for Brazil will be learning how to sustain growth.

Camanor was founded in 1982 by five Swiss living in Brazil. The farm was constructed on a 175-ha site (its 23 ponds today sit on 120 ha) in Barra do Cunhaú, Canguaretama, in the State of Rio Grande do Norte (Northeast of Brazil). Camanor's production in the early years is poorly documented. Some letters, data and diary notes give an idea about the difficulties in which Camanor started. Some of the main difficulties are highlighted in the following paragraphs.

Table 2. The stages of organizational growth.

Phase	Main Challenges for Management	Indicators for a Shrimp Farm	Opportunities for and Threats to Sustainability
New Venture Realize the entrepreneurial idea	• Identify and define markets and customers. • Find the right sites for production. • Develop products. • Meet the technical requirements for production. • Focus on "getting the operation running".	• Low overall production. • Low productivity (150-200 kg/ha/cycle). • Lack of critical expertise about the construction and running of a shrimp farm. • Few customers. • Low costs, low technical expertise. • Few standards for processes and products. • Expertise and leadership concentrated in a single person.	• Site evaluation: short-term economic evaluation of investments in soil, water quality, topography and infrastructure. • Design and construction: pumping station, channels for intake water and drainage, pond size, etc. • Availability of inputs/resources: capital, labor, and other inputs as PL, feed and fertilizer. • Need to fight for acceptance in a new region and local community (especially if a foreign investor).
Expansion Mastering growth	• Acquire and secure critical resources (labor, expertise, land, capital, basic materials, etc.). • Make the right investment decisions. • Find new and better ways to sell the products (new markets, new products, new customers, new ways of distribution). • Develop operational systems to improve efficiency (reduced inputs and waste, increased feed conversion rate (FCR), increased survival rates, increased labor productivity, etc.). • Changes in leadership and management structure. • Focus on economies of scale.	• Fast growth of production and sales (>15% per year). • Shortage of critical know-how. • Very high need for capital. • Difficulties addressing increasing complexity in the operation. • Organizational difficulties: more employees with responsibilities, management responsibilities concentrated among a few people. • Administration and controlling become more important. • Value added vertical integration from PL to processing.	• Rapid growth: ecological damage possible from site evaluation and construction (see Phase 1). • Social difficulties: not enough qualified labor; training and education of the local community may be delayed growth. • Financial risks due to rapid growth: profitability versus liquidity and security. • Currency fluctuations affect export potential. • Creation of jobs and occupational skills. • Involve local community, municipal and state governments in decisions when possible.
Professionalization & Consolidation Professional management with entrepreneurial spirit	• Develop management systems (planning, organization, management development, controls). • Optimize cost controls. • Maintain entrepreneurial spirit while developing professional management capabilities. • Manage the corporate culture. • Focus on productivity and efficiency.	• Flattened growth of production and sales. • Focus on efficiency and productivity. • Diversifying management duties to many people. • More formalization in the organization (processes, management etc.). • Establishing controls but curbing bureaucratic tendencies.	• Organize the operation for self-regulation (establish rules, train employees, etc.). • Influence the industry's development on a higher level by committing to sector organizations. • Address difficulties when local culture clashes with efficiency and productivity. • Strive to maintain long-term sustainable development of the region.

Sources: Flamholtz and Randle 2000; Pümpin and Prange 1991; and data from Camanor.

Site Evaluation and Design

The siting of the Camanor farm was not optimal. Because the farm was situated at the mouth of an estuary, the water quality was very poor. The fertilizer and feed input were high. The site of the farm is just above the high-tide sea level. As a consequence, the harvesting process was difficult and complicated. Lack of expertise as well as financial limitations contributed to the shrimp farm's poor design. For example, to reduce construction costs, a former salt mine was used as the structure for the shrimp ponds. As a consequence, the ponds were not optimal in shape, size, or water movement. Water exchange and feed management were inefficient. The ponds were not deep enough, so harvesting was difficult. Collectively, the design and siting problems caused difficulties in production and subsequent losses. Greater investments were required than initially planned.

During the first ten years, after many painful experiences, a number of adaptations were undertaken to improve the operation's overall performance. A new sluice model was developed and introduced for better water exchange and harvest control. The depth of the ponds was increased. Several small ponds were installed to divide the production into two cycles and to increase total production, among other changes. Over the years, it became clear that an expansion of the farm would help by reducing the fixed costs of the operation.

Production Results

Post-larvae and feed are two factors critical to an efficient shrimp farm operation. During the first ten years, both resources were in short, sometimes nonexistent, supply. While Camanor struggled and survived during this period, many other farms failed. Table 3 shows how the importance of these two resources changed over time.

Table 3. Production Results in 1986 and 1999

Year	Final density (animals/m^2)	Survival rate (%)	Final weight (Per shrimp)	PL costs as % of total[3]	Feed and fertilizer costs as % of total
1986	1.25	50%	17.0 g	75%	25%
1999	15.8	61%	10.3 g	34%	66%

Source: Camanor partner report 4.1.1986; production database and internal account 1999.

These numbers show that even with 12 times higher density in 1999 than in 1986, the relative PL costs decreased from 75 percent to 34 percent. And even with lower average per animal in 1999, the feed and fertilizer costs are relatively higher than in 1986 (66 percent instead of 25 percent).

Post-Larvae

In 1983 *L. japonicus* was the only PL available in Brazil. It was an introduced species that adapted slowly to Brazilian conditions. Even though the reproduction of this species is possible, results are poor. The main problem producing *L. japonicus* occurred during the transfer from the nursery ponds (see abbreviations and definitions list) to the ponds. The animals dug into the mud and died from lack of oxygen. This species was also very sensitive to stress. The transfer could only be undertaken successfully during a new moon. The native species *P. subtilis* was also problematic. It grew slowly and had a high mortality rate.

In 1984 Camanor had their first success, at least compared with the earlier results, with the native species *P. schmitti*. The muddy soil turned out to be much better for this species (unlike for *P. japonicus*). Due to good fertilization, successful transfers, and short periods in the ponds, *P. schmitti* shrimp achieved good growing rates. For example with the stocking rates in 1986 of 25 PL/m^2 in the nursery ponds (until 6g), and 1–1.5/m^2 in the grow-out ponds until 18g, growing rates of 2–3g/week/animal were reached.

[3]The base of 100% includes the costs for PL, feed and fertilizer.

However, reproduction of *P. schmitti* was very difficult, and the mortality rate was very high during the transfer.

During the initial years, production on the farm was dependent on wild-caught PL or on the availability of PL from other hatcheries. The wild PL was cheaper and therefore reduced the average cost. With 50 percent wild-caught larvae, the costs for PL could be reduced by nearly half. In addition to the ecological harm caused by using wild-caught PL (primarily, the decrease of natural stock in the area and the extensive by-catch), however, supply was extremely variable.

During the early years, one hatchery in the state of Bahia supplied PL to Camanor on an irregular basis, including introduced species such as *P. monodon* and *L. vannamei*. Difficulties during transport or cheating on the PL count resulted in huge losses. These difficulties showed clearly that to ensure a constant production of shrimp, Camanor needed its own hatchery. The company thus built Aquatec with a partner (biologist Ana Carolina de Barros Guerrelhas) and PL production started in 1989.

Feed

The lack of balanced feed on the market was another initial difficulty. At first, Camanor substituted more readily available fertilizer to increase the production of natural feed (algae), particularly when feed was scarce. However, lack of experience in controlling this process led to instability in the ponds. There was either too much fertilizer and too much algae, or the rain and the sun reduced the oxygen so much that the whole system broke down.

The lack of adequate feed was reflected mainly in poor growth during the first phase of production, in the nursery ponds. The development from PL to juveniles was very difficult to obtain without balanced feed. At first Camanor tried to use chicken feed. The main problem was not so much the formulation but rather the quality consistency of this feed. By the mid-1980s however, Purina Agribrands began to develop special feed for shrimp. In addition to the difficulties Camanor experienced in obtaining this product regularly, the company needed to change its management and application of feed. Over time, the company came to concentrate feed by using feeding trays. Another development in feed management was the continuous application of fertilizer. With this technique, algae bloomed constantly, and a steady supply of feed was produced in the pond's water column. In 1989, experiments were conducted using polychaetes in the ponds as shrimp feed. With the introduction of the omnivorous *L. vannamei*, it was easier to utilize balanced feed because animal protein was not as essential. The availability of real shrimp feed on the Brazilian market in 1994 resolved most of the feed problems.

In sum, the limited supply of inputs greatly determined production methods. The lack of larvae led to lower stocking densities and longer production cycles. The lack of feed led to increasing reliance on natural feed, the use of more fertilizer and the shift to omnivorous species for cultivation.

Summary of Early Experiences

Camanor's overall operation and production during the first 10 years can be divided into three phases (Werner Jost, personal communication 2000):

1983–1988:
Experimentation with different species, stocking densities, and feed; and with the site evaluation (soil) and design aspects (depth, sluices, etc.) was done. The production process was very unstable because of limited and erratic supplies of inputs, mainly PL and feed.

1989–1990:
Constant supply of PL (from the company's own hatchery) and increase of feed input resulted in significant production increases, through costs, including additional employees (a biologist, a mechanic

and administrators) also increased. Reducing the size of ponds led to better control and management of the grow-out process.

1990-1992:
Plano Collor (Collor Plan)[4]: Financial difficulties resulted from runaway inflation and instabilities in production. Even with a substantial reduction in production costs and an increase in production quantity, the financial difficulties almost caused the farm's ruin. Paying back debts and decreasing prices (from increasing competition in the sector) were factors that weighed heavily on management.

For the first 10 years of operation, financial survival was the main challenge for the owner of Camanor.

Availability of Leadership, Labor and Technical Expertise

From a socioeconomic point of view, northeast Brazil is a typical underdeveloped part of the country with an unemployment rate of about 50 percent. The literacy rate in the rural area is about 60 to 70 percent. As a consequence, it is very difficult to find qualified labor. On the other hand, the opportunity to educate labor is very high.

Leadership Phases

1982–1993: Owner Management
The formation of the group of investors and defining the project and its objectives were the first steps in founding Camanor. Selecting a director/operations manager of the project was the next step. All five initial investors were Swiss. Even though they all lived in Brazil, they had neither the connections nor the technical expertise of a typical Brazilian starting such a business. After the company was founded, it was difficult to find the necessary expertise for the construction and start-up of the farm. The operations manager himself performed many jobs. The fact that the investors 90 km from the farm, in Natal, the state capital, made it impossible to control the daily decisions on the farm. By the same token, all the communications, financial, and state officials were in the capital. It was essential to have a trustworthy person on the farm to conduct daily operations; without such direction, a lot of stealing and cheating took place in the first years of the operation. This was one of the reasons that Camanor almost went broke by the end of the 1980s.

1993–1998: Daily Control by a Trustworthy General Manager
Stealing and cheating on the farm ended when a highly professional and trustworthy general manager was hired. This general manager replaced almost the whole management and operational team on the ground (see Figure 3) and implemented strict business controls. Administrative tools such as limited access, employee checks, and inventory and stock controls were initiated. With these changes, Camanor achieved a positive cash flow for the first time.

1998–2000: Growth Through Professionalization
The next challenge was to decentralize decision-making—from two leaders, the owner and the general manager. In order to expand production, Camanor had to hire new, highly qualified people and implement efficient administration, professional production methods, and competitive processing.

An organizational structure was established. Definition of responsibilities, and evaluation of competence and abilities had to be more transparent and communicated better to all employees. Teamwork, confidence, and management guided by stated objectives became more important and had to be encouraged through appropriate incentives.

[4]Plano Collor is named after the Brazilian president during this period, when the inflation rate was around 80% a month and the government incurred huge debts. To stabilize this situation, President Collor froze all accounts and fixed credit rates. This, in effect, dried up all sources of capital. In a brief time, debts almost disappeared because of the high inflation rate.

Changing Employee Levels

Figure 3 shows the number and annual fluctuation rate of employees at Camanor, including employees who worked only a few months on the farm.

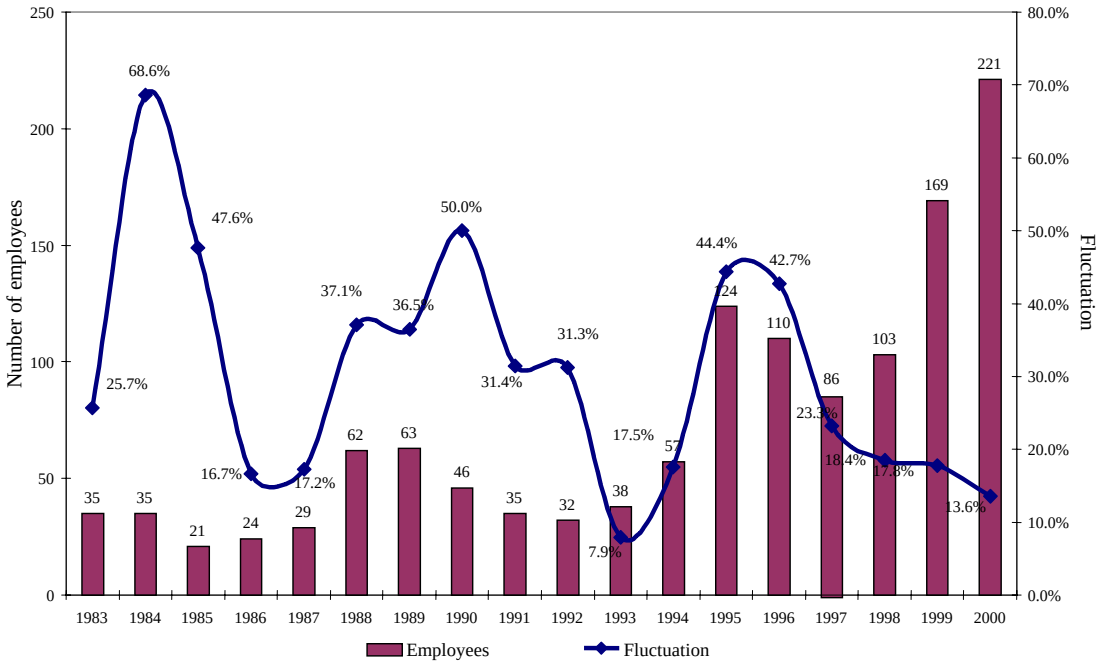

Figure 3. Average number of employees at Camanor and annual fluctuation rates (Source: Camanor database 1983–2000)

From 1983 to 1993, the labor situation at Camanor was unstable. Senior management had not been carefully screened, and many apparently robbed the farm. Their attitudes had a negative impact on the whole team of employees. Each time the owner discovered that he had been robbed, he fired senior management as well as some employees. Due to bad production results and acute financial difficulties, which were not unrelated to broader labor problems, Camanor was also forced to reduce the number of employees from time to time.

In 1993, the new general manager started to replace a large portion of the team (see fluctuation rate in 1995). Only after this shakeup did the labor situation on the farm became more stable. Even with an ever-increasing number of employees, the turnover rate decreased.

Financial Management

Five Swiss citizens who each invested in the project founded Camanor. Even though there were state and federal programs to encourage investments in aquaculture projects in the northeast of Brazil it was very difficult to get access to such capital. Because of production difficulties during the first years and a lack of access to government financing, all the partners invested more money than they initially planned in the company. Bank credit was available only for specific projects, and obtaining it required undertaking a tedious and bureaucratic process. Because of the high inflation rate and a small monetary correction factor, credit was relatively cheap. The aquaculture sector (including shrimp) had not yet produced financial return in the short term, so it was still considered a high risk business. There was only short-term experience with the sector in Brazil. After the initial construction was completed, Camanor obtained a loan for the construction of another three ponds, a new pumping station, and other activities. These were long-term loans obtained from different institutions. The debts accumulated over the years. Until

the early 1990s, about US$1.4 million had been invested in Camanor. The portion of equity owned by the partners was estimated at around 45 percent of the total (Werner Jost, personal communication 2000).

Figure 4 shows some financial data for the period 1989 to 2000. The financial difficulties in the 1980s and the pressure and insecurity about whether Camanor would survive and be able to pay the salaries and interest on the loans over the next months were formative experiences for both the manager and the owners of the farm. By 1992 another two active and important partners had left Camanor, and Werner Jost stayed and assumed sole responsibility for overseeing the farm. After investing so much time and money over the previous 10 years, he decided that the only thing he could do was to protect his investment. The psychological pressure and stress from the debts, employee problems and the ever-present danger of bankruptcy made running Camanor very difficult. This stress probably accounts for all debts being paid off as soon as Camanor started to earn money. By 1998 Jost's equity in the company had increased to 90 percent. The decrease in owner equity after 1998 is the result of new investment funds obtained to expand the operation in 2000. Cash flow and profits are measured as a percentage of total sales.

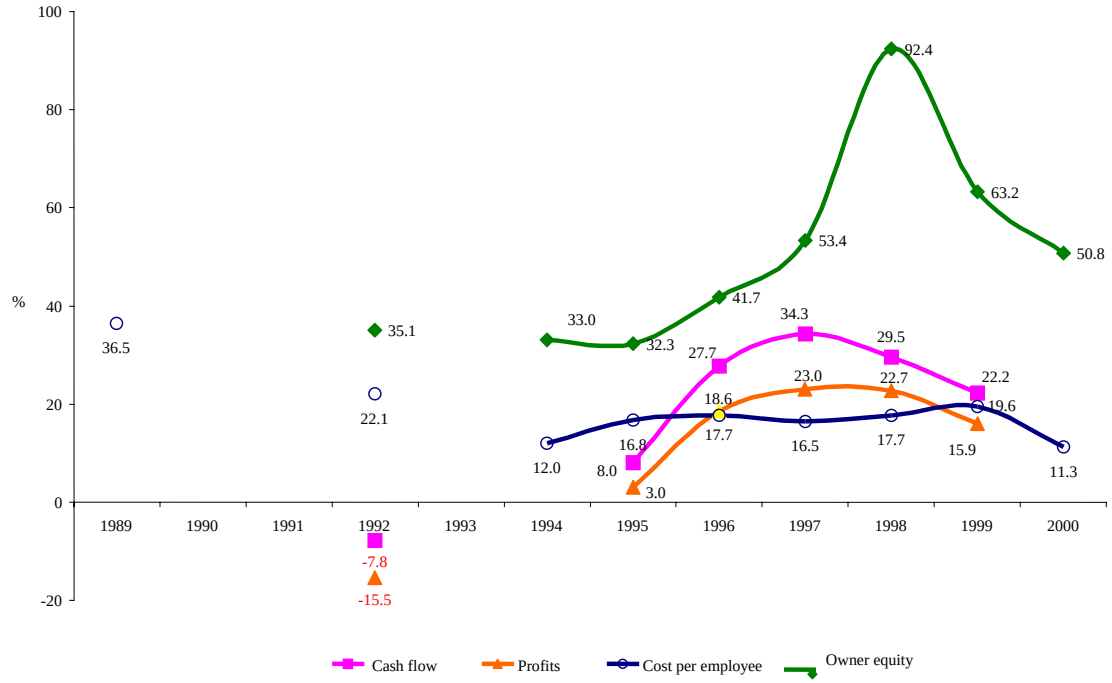

Figure 4. Financial indicators from 1989 to 2000 (Source: Camanor database 1989–2000).

The development of profits and cash flow at Camanor is typical of a start-up company. In the first years, the profits and even the cash flow are negative. This in combination with unstable production and indebtedness leads to a high risk of failure. The rise in Camanor's profits and cash flow at the beginning of the 1990s reflects management's increasing mastery of the production system as well as the ability of the company to sell its products. The decrease in profits and cash flow after 1997 can be explained by some crucial changes in the company, including making major new investments. Camanor started its own processing plant and began producing new products in an effort to start a new growth period. The shrimp market also deteriorated slightly. Although the Brazilian currency declined in value, a change that tends to help exports, this occurred before shrimp exports could be competitive in the international market.

The curve "cost per employee" shows the labor costs as a percentage of total sales. This is also an indicator of the efficiency of labor use, but it can be influenced by factors other than management. Labor costs depend, to a certain extent, on policies regarding the minimum wage, taxes, and other issues, as well as production and processing decisions. On-farm processing and the vertical integration of the

production process adds complexity and can result as well in higher costs (per unit of sales) initially, though these costs should decrease as each of the new production systems becomes more efficient.

The main challenge in the first phase of Camanor's expansion was control over the liquidity of the company. Because access to credit was difficult, internal financing was very important for the start-up and first expansion phases of Camanor.

Detailed Production Data From 1988 to 2000

This information comes from a farm software database. Figure 1 showed total Camanor production each year, in kg. Figure 5 shows the farm's productivity in kg/ha/production cycle.

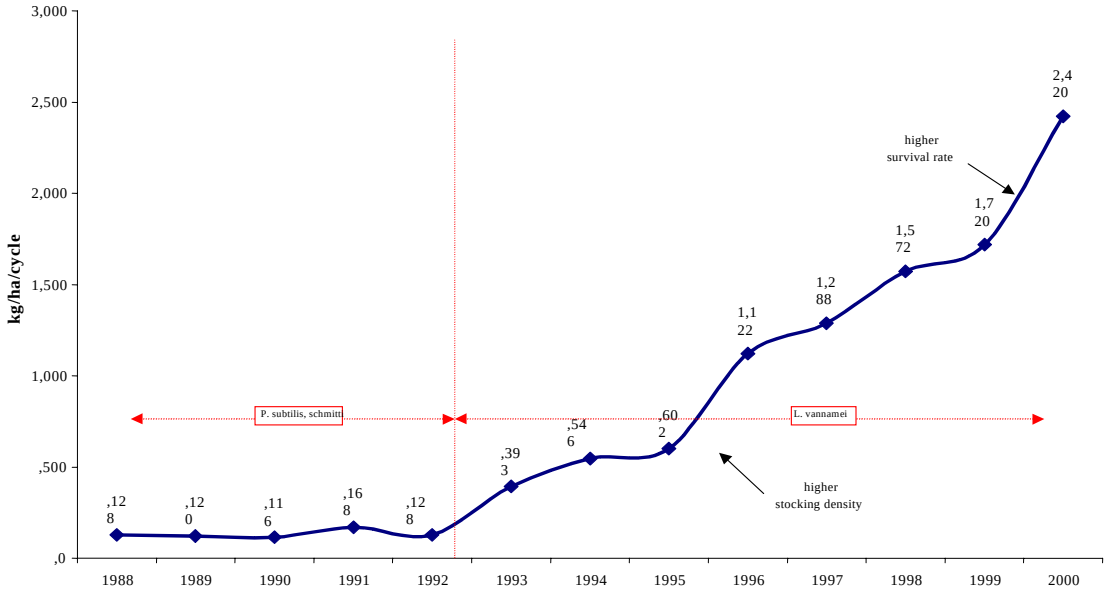

Figure 5. Productivity development from 1988 to 2000 (Source: Camanor database, 1988–2000).

The productivity number for 2000 is based on the productivity average of the first six months of 2000. Figure 5 shows that with the introduction of *L. vannamei* in 1992, productivity began to increase. Another dramatic productivity increase occurred between 1995 and 1996. This growth can be explained by an increased stocking density (50%) and by a slight increase in the survival rate. The steady increase from 1996–99 is explained mainly by increased stocking densities. The increase from 1999–2000 is due primarily to a higher survival rate.

Figure 6 shows development of initial stocking density (PL/m^2) and survival rate. From 1988 until 1992 the stocking density of the species used *P. subtilis* and *P. schmitti*, remained constant. With the introduction of *L. vannamei* and the improved availability of PL, the stocking density increased steadily. By the end of 1999, the survival rate had increased greatly, resulting in much higher densities throughout the production cycle. As a consequence, stocking density was slightly reduced.

Until 1994 Camanor used a system of small nursery ponds: small tanks or ponds used in the first phase of growing shrimp (about 45 days). Using nursery ponds gives managers more control over the first phase of the grow-out. In 1994–95, Camanor was hit by the Taura Virus. The shrimp in the nursery ponds were

already infected, and a larger proportion did not survive the transfer from the nursery ponds to the grow-out ponds. As a result, the system of the nursery ponds was eliminated.

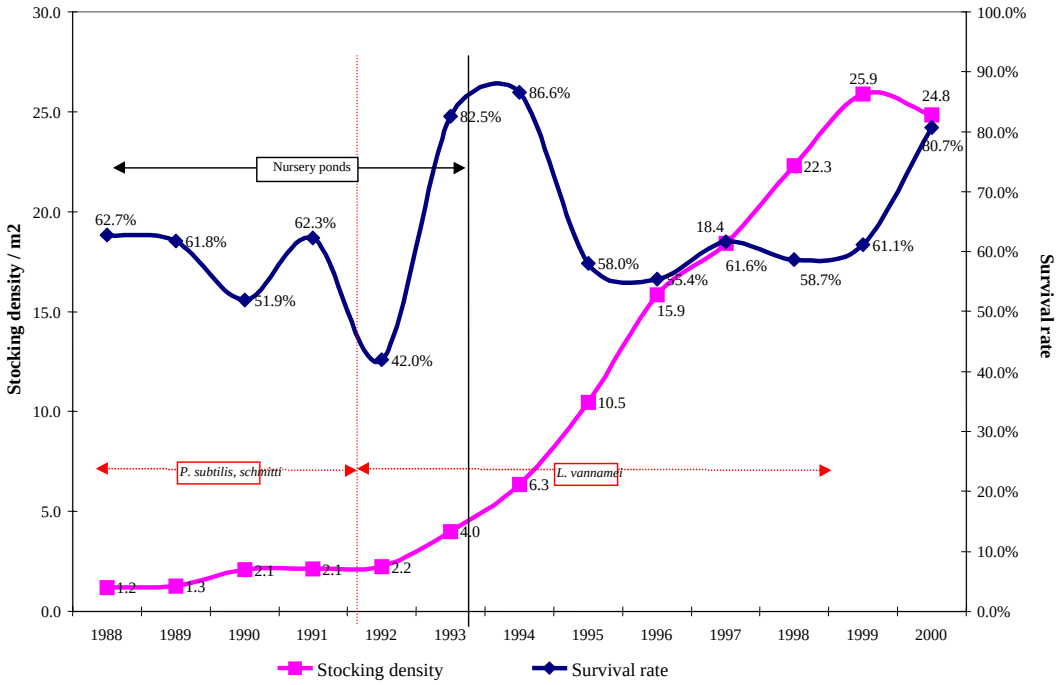

Figure 6. Stocking density and survival rates (Source: Camanor database, 1988–2000).

The transfer from nursery ponds to grow out ponds caused stress. *Penaeus subtilis* and *P. schmitti*, susceptible to such stress, had a high mortality rate after the transfer, contributing to the low survival rate of these two species during the grow-out phase. Because of better stress resistance during transfer *L. vannamei* reached survival rates of more than 80 percent within one year.

After the Taura infection and the elimination of nursery ponds, the survival rate declined somewhat. However, much of this decline can be explained simply by different methods of measuring the survival rate, either after direct stocking from the hatchery or transfer from nursery ponds, where earlier mortalities may have occurred. The survival rate measured by direct stocking measures the total mortality (rather than just mortality after transfer to ponds). However it is measured, shrimp mortality seems to be concentrated in the first 45 days of a cycle. Between 1995 and 1998 the survival rate remained almost constant, even when the stocking density was more than doubled. The almost incredible increase in the survival rate from 1999 to 2000 can be explained mainly by a new hatchery system using raceway designs. The raceway system improves the adaptation of PL by using open tanks (water temperature, light, salinity, etc. are unstable) that are simulating the grow-out ponds. This system creates conditions similar to those existing before on the farm, with the nursery ponds.

Besides these technical factors, the knowledge and experience of the employees and the managers on the farm are also positive factors contributing to the improved performance of the operation. Management factors are hard to measure, but they can be evaluated through interviews and analysis of employee qualifications. For example, Camanor hired a highly qualified production manager in the end of 1998. His changes in daily operations might only begin to show results a few months later, at the earliest.

Figure 7 shows the productivity (kg/ha/day) and the feed conversion rate (kg feed/kg shrimp). The feed conversion rate stabilized after 1994. The variation between 1988 and 1994 can be explained by shifting production systems (e.g. the use of nursery ponds), varying feeds, lack of feed supply, and mistakes in

measurement. Higher productivity is linked to increases in stocking density and survival rate, but also to better production management practices. The decreases in production/ha in 1995 and 1999 reflect increasing difficulties in the ponds. This can be assumed because productivity (kg/ha/cycle, see Figure 7) is increasing over the same period. In 1996 the feeding-tray system was introduced. Allowing much better control over the feed applied as well as uneaten feed. Feeding trays were a key factor in reducing waste in the ponds.

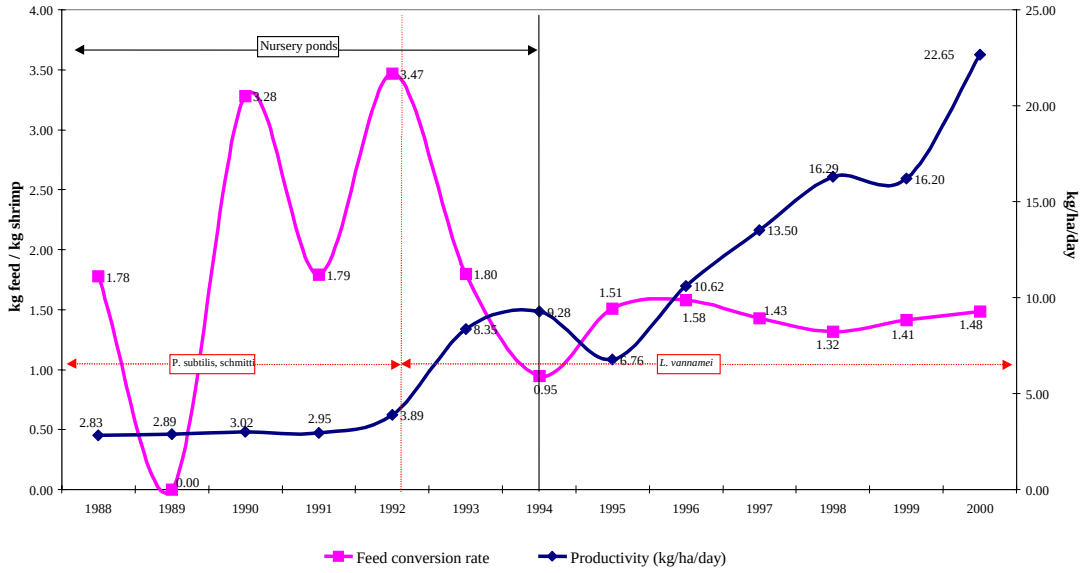

Figure 7. Feed conversion rate and productivity (Source: Camanor database, 1988-2000).

It is remarkable that even with such a high productivity increase from 1996 to 2000 the feed conversion rate remained relatively stable. This means that the production of natural feed could be increased parallel to the productivity increase suggesting that feed conversion rates could be used as a sustainability indicator because of the use of fishmeal. A better indicator than the feed conversion rate would be the protein conversion rate or even the conversion rate of wild fish to a marketable product such as shrimp.

Processing and Marketing

Processing

Camanor did not have its own processing plant initially, so harvesting and marketing of the company's products had to comply with the schedules of the processing plants. These plants were badly organized, had low standards of hygiene, and were not competent in negotiating prices, terms of payment, etc. Consequently, Camanor sold most of their product directly to resellers without passing through a processing plant. The main reason for building an on-farm processing plant in 1997 was the idea of producing a fresh product from the operation with its own Brazilian SIF-number. Management felt that the value added from processing offered the company a better financial return on its investment.

Marketing

In the first years of production, some of the shrimp were sold locally and some to a processing plant that exported their products. These exports continued only for a short period of time. Most of the shrimp were ultimately sold within Brazil.

From 1994–98, about 90 percent of Camanor's production was sold to two big shrimp resellers in Brazil. Although having only two clients made the sales process very easy and efficient, the risk of having an insolvent partner was very high. In 1998, 18.2 percent of the firm's total assets were in the form of debt

from one insolvent customer. This debtor was responsible for 99 percent of all outstanding payments owed to the company. Such dependency on a single buyer sapped the company's financial strength. To reduce this high risk, Camanor started to diversify by producing its own end products. This product is sold to a range of resellers and supermarket chains all over the country. Camanor's product was introduced in 1998 but never gained significant market share in the national market. Various reasons could explain this failure—the logistical problems of supplying fresh products to market, high processing costs, increasing demand for shrimp in general (and therefore no need for a differentiated product), the increasing competitiveness of exports, and so forth.

As mentioned earlier, Brazilian shrimp products entered the international market in 1999, reflected in the sales data from Camanor. In 1999, about 10 percent of Camanor's production was exported (through co processing), mainly to Europe and the United States. During the first month of 2000, shrimp exports constituted more than 70 percent of all production.

By July 2000, Camanor received permission to export from their own certified processing plant. Initially, at least, Camanor will focus on a few international shrimp buyers. Camanor managers assume that the stability of these international companies is better and the chance of insolvency is lower. Even so, the company wants to diversify the buyers to which it sells as quickly as possible. In general, these marketing changes require the commercial manager to have additional skills, including expertise on export legislation, international negotiations, language skills, and the formulation of long-term contracts.

Camanor's Progression to the Present

Lessons to Learn

It is important to realize that ensuring the survival of Camanor was the biggest challenge in the first years of its existence. The fight against financial collapse was always present. Other shrimp farmers can learn some crucial lessons from Camanor's experiences by analyzing their own development stage within the context of normal business development. Focusing on organizational growth would allow companies to manage their own company ahead of the curve, trying to anticipate the development challenges that are likely to occur next. With this kind of forward-thinking management, critical resources can be mobilized ahead of time, anticipating future necessities and helping to reduce the risk of failure and incorrect decisions.

Where Is Camanor on the Development Spectrum?

Along the continuum in the column "Opportunities for and Threats to Sustainability" in Table , Camanor can be situated between the stages "Expansion" and "Professionalization and Consolidation." The old part of Camanor (the part that existed before expansion from 120 ha in 2000) is today in the consolidation phase. In this stage, it is important to manage by objectives, to optimize the process, and to train employees. Rules need to be established, employees should be given greater responsibility and motivated to gain skill and competence in the work they do.

Because it is constructing new farms, however, Camanor is still in the expansion phase. It is projected that the production area will more than triple in the next two years, from 190 ha (2000) to 650 ha (2002). In this expansion phase Camanor has to address the challenges of site evaluation and impact assessments, elaborating the design and organizing the construction, ensuring the availability and timing of the most important resource inputs, finding qualified labor, and others. The current and future aspects of the expansion will be described in the last section, Perspectives for the Future.

Key Management Factors in Camanor's History

Figure 8 identifies the key factors in the first 18 years of Camanor's existence. The columns specify the main elements that are required for the operation to work. Administration and employment matters are management factors that influence the whole operation. The figure also shows the importance of different

abilities over the years and indicates clearly how some factors became more important over time while others lost importance.

Because Figure 8 shows internal factors at Camanor, it does not portray the external circumstances, including other producers, increasing supply, and increasing processing capacity in the sector.

Phase 1: Start-up venture 1982-1989

Supply	Production	Processing	Sales
- Almost no resources (PL and feed) on the market ★ Capacity for improvisation, experimentation and invention	- Bad design (pumping, cannels, etc.) - Insufficient know-how ★ Capacity for improvisation and tests, know-how acquisition (feeding, harvesting, etc.)	- Not yet on the farm; external processing used	- Contact consumers; get to know their needs - Market evaluation. - Delivery difficulties because of unstable production ★ Develop good market contacts

Administration and Employment
Organize financing, get permits, develop political contacts, etc.
Find trustworthy employees, minimize theft and improve identification of employees.

Phase 2: Expansion 1990-1999

Supply	Production	Processing	Sales
- Improved supply of PL (species, quantity, quality, timing and price) ★ Improve transport, storage and delivery conditions	- Unstable production ★ Improve fertilization, feeding systems, stocking of PL, harvest systems and control of production parameters	- After 1997: Farm fresh shrimp processing plant - Insufficient know-how ★ Acquire processing know-how	- Increase fresh shrimp sales ★ Find flexible, reliable and trusted buyers, differentiate products and markets

Administration and Employment
Develop additional organizational and financial skills.
Aquire know-how, train employees in technical matters.

Phase 3: Expansion and Consolidation 2000-?

Supply	Production	Processing	Sales
- Continuity of input suppliers (PL and feed) ★ Evaluation and optimization of suppliers	- Stable production but risk for disease ★ Control and reduce costs, guarantee the transfer of know-how and find and implement new technologies	- Start on-farm freezing ★ Quality control, product diversification, efficiency (labor costs/kg processed, material/kg processed, etc.)	- Enter international market ★ Strategies, marketing expertise, (brands, contracts and payment), communications and negotiations

Administration and Employment
Elaborate and implement objective controls, system strategies, planning (financial, personnel, products, markets etc.). Implement manuals, training and proceedings for employees that are effective regardless of their prior knowledge. Attract qualified staff with expertise, build teams, define responsibilities and motivate through incentives.

Figure 8. Overview of Camanor's first 18 years.

- Understanding production management and technology.

During the first few years of Camanor's shrimp production, management's key challenges were to understand production and to set up systems to monitor the impact and effectiveness of the production systems being used. Because shrimp farming was a new technology and a new industry in Brazil, there was very little information available to producers. One of the problems in the early years was the lack of sufficient track records that would allow all decisions to be based on data rather than on instinct.

- Managing financial resources.

Another critical issue during the initial years of operation was the management of financial resources. Since the economy was very unstable (e.g., artificially high official exchange rates, finance for either fixed or working capital loans was difficult to obtain), many important production changes and adaptations could not be undertaken. For example in 1989 necessary adaptations of shrimp pond design, intake canals, and so forth could not be undertaken because of the lack of financial resources. During the first phase of the company's development, reducing overall risk at Camanor was linked to keeping debts as low as possible. Increasing the number of customers helped to reduce the risk of selling to insolvent buyers, but strict cash management was also very important.

At this time, planning and managing financial resources to allow expansion of the farm are the main challenges for management. In order to avoid incurring high debt, Camanor management intends to finance at least 70 percent of the ongoing investment out of the company's cash flow (Werner Jost, personal communication, 2000). This strategy has been adopted primarily because of high interest rates. Managing liquidity of the operation is now a key issue for management, in order to support rapid expansion.

- Obtaining input supplies.

Post-larvae and feed are the two most critical production inputs. Around 40 percent of the working capital costs of a shrimp farm in Brazil go to PL and feed. In addition, the quality of these inputs has a direct impact on production. The quality of PL directly affects the survival rate and feed conversion ratio. The quality of the feed together with the feeding strategy determines the growing rate and ultimately the productivity of a production cycle. In 1990 there was no reliable, high-quality shrimp feed available on the national market, and there was a shortage of PL. The management of Camanor was driven by these external factors, deciding to construct its own hatchery to improve the viability of the farm operation. This vertical integration of a key input allowed Camanor to reduce the risk of unstable supply and was an important factor in optimizing the costs of production.

- Getting more from the product through value-added processing.

On-farm processing benefited the company in two ways. It gave the company more flexibility and freedom from dependence on other processing plants, as well as the opportunity of adding value to its product. This forward integration allowed the company to diversify risk and generate better financial returns through processing. However, there are also risks involved with owning and running a processing plant. The main risks are insuring that the plant operates to capacity, which costs are under control and that product is of sufficient quality so that buyers do not reject it.

- From apprenticeship to leadership.

Developing a business in a poor, underdeveloped community is a big challenge, requiring continuous contact and communication with the local people. This helps the company develop reliable supplies of labor as well as influencing the acceptance of the company by local residents over time.

The first challenge was to find reliable and trustworthy employees. That the owner was not Brazilian and had limited experience with the Brazilian labor market undoubtedly complicated this situation. After hiring people, the next challenge was to train them and to develop teamwork. Basic education was also a

major challenge. Once the size of the operation was determined, management responsibilities were defined and assigned so that the company could be managed according to a specific set of objectives. Strategic planning, good communication, effective implementation, and strict systems of management control become more important over time

- Good siting and construction of production facilities is invaluable.

After its experiences with setting up the first production facility, Camanor has taken a different route during the second phase of expanding the operation. Now the company knows that good site evaluation and planning of the design and construction are very important for the ultimate viability of the enterprise. Camanor's experience shows that it is better to invest more time and money before construction and initial operations than to try to fix things later. Once the expansion plans were completed, then construction was quick and economical. By pursuing this strategy, management believes that Camanor can take advantage of the good market situation in Brazil both for production and export. Furthermore, it is possible to address tight cash flow with this strategy.

The Value of Better Management Practices

The financial difficulties of Camanor over a long period of time forced the company to seek continually the most effective and economical way to run the operation. Even after the difficult early years, management did not pursue a short-term profit-seeking strategy but rather a responsible way of running the operation over the long haul, motivated by the values of the owner.

The following data show some of the tradeoffs that result from changes in operational management. Some data are based on past experience and some are theoretical calculations for the future based on the best available data.

Longer Production Cycles vs. Feeding Costs

To calculate the theoretical usefulness of longer production cycles (to produce shrimp with higher average weight) a simulation model was created, using actual Camanor data from early 2000. Four simulations based on different production periods, survival rates, and final average weight was calculated. The assumptions for the simulation are shown in Table 4.

Table 4. Assumptions used for simulations

	Simulation			
	1	**2**	**3**	**4**
Average harvest weight (g/shrimp)	9	11	13	15
Production cycle (days)	70	85	105	130
Survival rate (percent)	80	80	75	75
Average FCR (kg feed/kg shrimp)	1.3 (for all simulations)			
Total production area	120 (for all simulations)			
Number of production cycles/year	4.06	3.48	2.92	2.43
Average production cycles/year	3.11 (for all simulations)			
Production/ha/cycle	1,440 kg	1,760 kg	1,950 kg	2,250 kg
Average production/ha/cycle	1,860 kg			
Average production/month	57.8 MT			

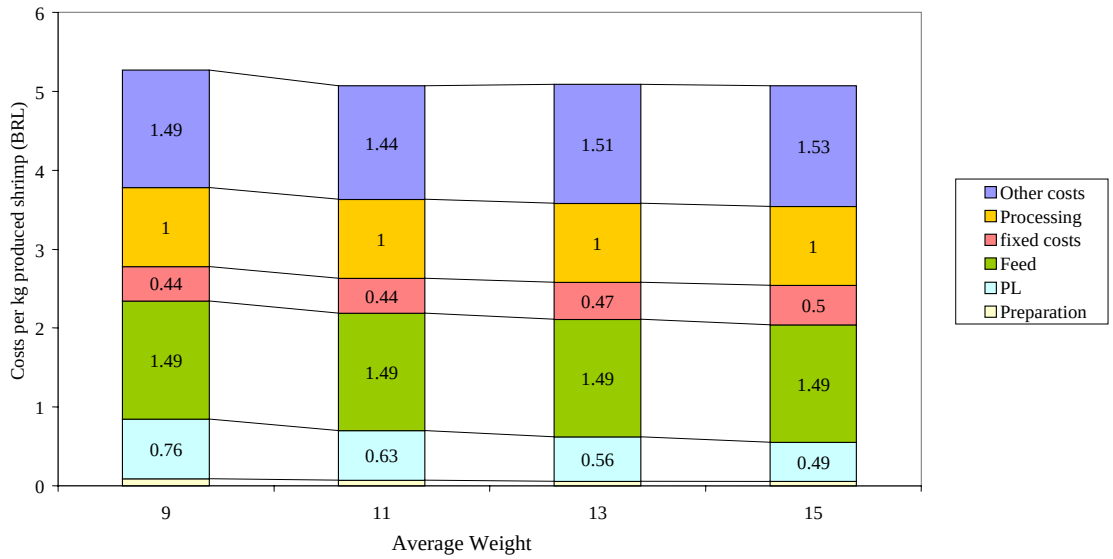

Figure 8. Distribution of production costs per kg shrimp (Source: Camanor database).

Figure 8 shows the distribution of production costs per kg shrimp under four simulations. Feed costs stay constant per kg of shrimp because of a constant FCR. Other costs, including labor and fixed costs that can not be allocated to a defined cost center, are calculated as a factor per ha and day (BRL/ha/day). That means that a longer production cycle pays more of the fixed costs of the farm.

The costs per kg for producing 9-gram shrimp in 70 days are higher than producing bigger shrimp, because of fixed costs that are incurred independent of the period of the cycle (e.g. harvesting, fertilizing, preparation of the pond). There is no significant difference between the costs/kg of producing 11-gram and 15-gram shrimp.

Producing 15-gram shrimp in 130-day production cycles would create just 2.43 production cycles per year. The average production in kg/ha/day, the average costs per day, and the profit index under the assumption of constant prices are shown in Figure 9.

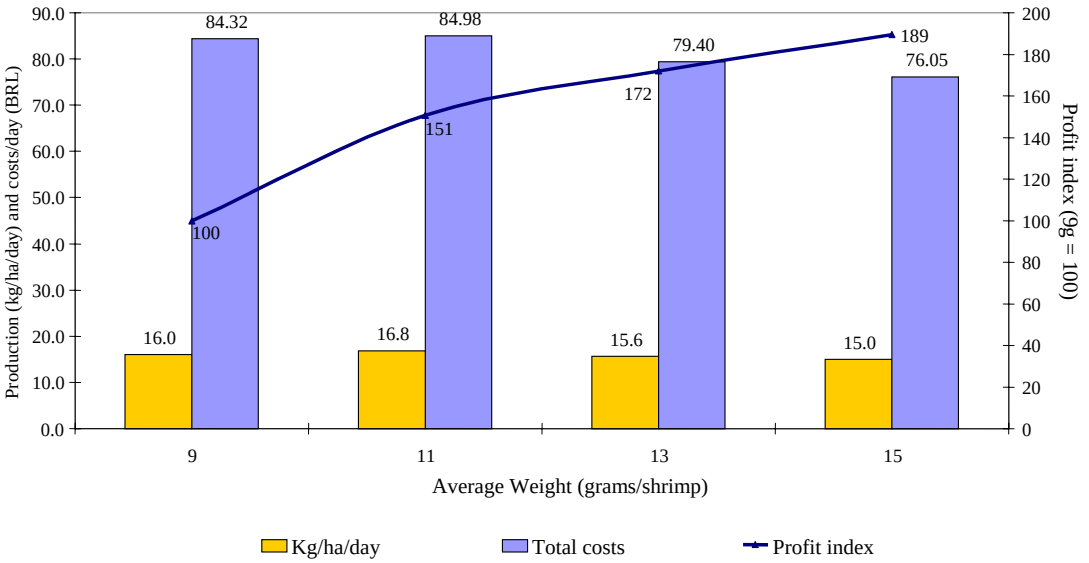

Figure 9. Average production, costs and profit index (per day) (Source: Camanor data).

The results of the four simulations show that production (kg/ha/day) is lower when producing 15-gram shrimps than with smaller ones. However, because of the lower costs and better prices for big shrimp, profits are almost 90% higher with the bigger shrimp.

Under these assumptions, it would be more worthwhile to invest in longer cycles and produce bigger shrimp. The larger shrimp lead to only 2.5 cycles per year (instead of 4 cycles for animals of 9 grams average weight), so there is less water discharge because of there is less frequent harvesting.

Use of Feeding Trays vs. Free Application of Feed

Camanor first used feeding trays in 1995. Today it uses as an average of 30 feeding trays/ha. Analyzing the data for the feed conversion rate (FCR) and the feeding costs before and after the implementation of the feeding trays (see Figure 10) no significant difference can be attributed to the use of the feeding trays.

Figure 10 shows the FCR and the average feeding costs per kg of shrimp produced for the years 1994 to 1998. The data are from 197 production cycles with harvests between January 1994 and December 1998. During this period the stocking density was increased from 6.3 to 22.3 PL/m^2. This means that the availability of natural feed produced in the pond decreased relative to the total number of shrimp.

Experience from other farms suggests, however, that the FCR could be reduced from 1.7 to 1.4 kg feed/kg shrimp with the introduction of feeding trays.

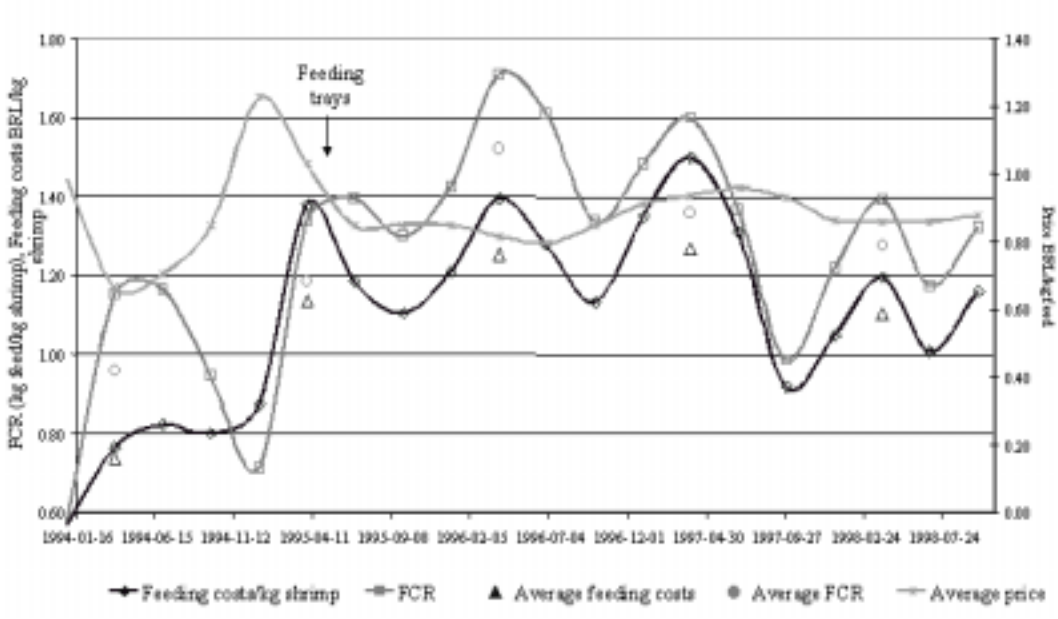

Figure 10. Feeding costs over time (Source: Camanor data, 1995-1998).

By 2000, the average FCR with a stocking density of 25 PL/m^2 was about 1.25 to 1.3. Feeding trays seem to offer a number of advantages—they allow better control over the feeding process, stabilize the FCR, and distribute the feed in the pond more evenly. In addition to improved control, feeding trays help to reduce the amount of uneaten feed, which reduces overall costs and effluents. Table 5 presents the costs and savings that arise from the use of feeding trays.

Table 5. Estimated costs of system with and without feeding trays

	With feeding trays	Without feeding trays	Savings from feeding trays/ha/year
Employees/ha	0.15	0.08	BRL (420.00)[5]
Investment (30 trays/ha)	35.00 BRL	-	BRL (35.00)
Average FCR	1.25	1.35	BRL 750.00[6]
Total			BRL 295.00

If we calculate the actual feed cost/kg and compare the two feeding systems, Camanor saves 364 kg feed/ha/year. Thus, an FCR of 1.25 kg with the trays compared to the previous FCR of 1.35 saves the company an average of BRL 295/ha/year. This calculation does not even consider the ecological advantages, which are best measured over a longer term.

Use of Aeration vs. Water Exchange

Closing the system is one of Camanor's main production challenges. Investing in an aeration system for one production unit (120 ha) would cost about BRL 3,500 per ha. The operational costs of using aeration to reduce the water exchange are shown in Table 6.

Table 6. Operational energy costs of aeration and water exchange.

	Existing system with water exchange	System with aeration and no water exchange
Fill-in pumping costs/ha/cycle[7]	BRL 52.30	BRL52.30
Pumping costs for water exchange/ha/day[8]	BRL 0.88	—
Aeration costs/ha/cycle[9]	—	BRL 318.00
Total energy Costs/ha/cycle[10]	BRL 131.50	BRL 370.30

The difference in cost of BRL 238.80/ha/cycle corresponds to an increase in shrimp production of only about 24 kg/ha/cycle. Thus, instead of producing 2,000 kg/ha/cycle productions, Camanor would need to average 2,024 kg/ha/cycle to have the same return. This calculation suggests that the difference in cost is not significant in relation to revenue.

Aeration and reducing water exchange have many ecological and “risk-reduction” advantages. The operators can control effluents and manage the shrimp operation more carefully in other ways, as well as work more independently of other producers in the area. This last factor becomes more important with the rapid expansion in the shrimp sector.

Camanor's management challenges over many years are illustrated by the learning curve in Figure 11. Experience and technical know-how accumulated over the years led to the company’s current overall strategy, as well as changes in management style and focus.

[5]Calculations are based on the average gross month salary of Camanor employees in 2000.
[6]Calculations assume three production cycles/year, production of 2,000 kg/ha/cycle, and feed price of 1.25 BRL/kg.
[7]Data from Camanor: with 150-HP pumps, 1 kwh=R$0.1, and pumps working 4.76 hours/day to fill each ha of pond area.
[8]There is almost no water exchange in the first 40 days of the production cycle.
[9]Aeration is calculated at 3 HP/ha, with aeration provided 24 hours/day after the first 30 days of the production cycle.
[10]Assuming an average production cycle of 90 days.

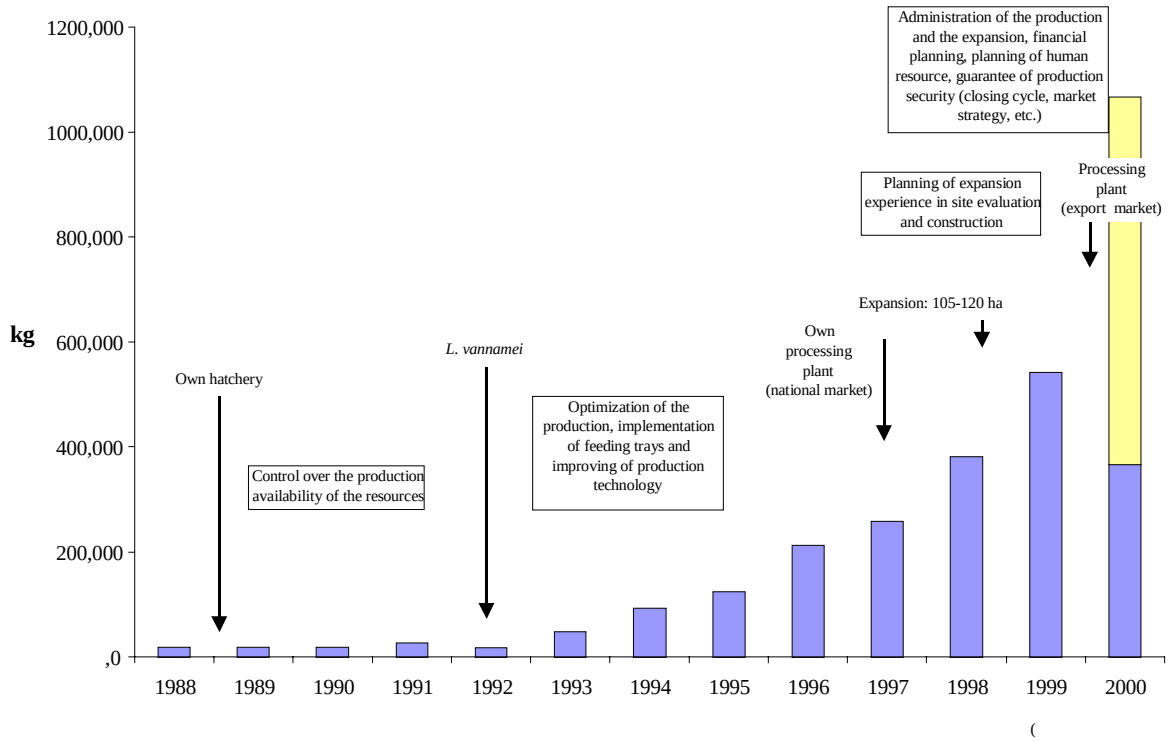

Figure 11. Challenges in Camanor's management, 1988-2000. Production data for July-December 2000 are estimated.

Perspectives for the Future

In Table 7 we summarize some of the main points relating to opportunities and threats to sustainability (as discussed in Table 2) that could affect the future development of Camanor. We have based our calculations on a model that allows us to estimate the profit-and-loss-statement and other financial details of the company based on previous production and cost structures.

The actual financial situation of Camanor in 2000 is used as the basis for the simulations in Table 7. The simulations provide estimates of the future financial situation of Camanor using different assumptions. The assumptions used are commonly cited in the literature as important factors in sustainable management. The hypotheses for the simulations are shown in Table7. Projections for the standard scenario (base case) are shown first, followed by various other scenarios. Projected results from other scenarios are expressed in terms of their differences from the standard scenario.

Table 7. Simulations of seven different scenarios.

Nr.	Scenario	Assumptions From Scenario 2 onward, only differences from the standard (base) case.	Differences from Standard Scenario (Basis: Standard 2000=100; differences expressed in points of index)		
			Economic[a)]	Ecological	Social
	Standard (= base case)	• **Product prices**: until 2002, decrease of 22% to 30% (depending on which product) • **Growth of area** (in ponds) until 2005: around 400% • **Constant yields/ha** from production • **Increase of direct product exports till 2002**. This requires a strong expansion of on-farm processing capacity (+ 800%; construction of additional processing plants). • **Changes in input costs:** Employees: + 100% Land: + 133% Investment in construction: +20% Post-larvae: constant Interest rates (real): constant	= Starting scenario		
(2)	**Site evaluation, design and construction.**	• A good **site evaluation** and an optimal **design** and **construction** of a shrimp farm leads to slower growth. The maximal pond areas will be reached later. • The **investment** costs will increase by 50% and the land prices by 20%. • **Production** will rise by 2-5% per ha because of better conditions over time.	• Sales 2005: +16 • Cash flow 2005: +20 • Return on Sales (ROS)[b)] 2005: equal • Investments in long-term assets (Inv-LTA)[b)]: + 26 • Long-term debt (LTD)[b)]: R$+968k • Value of company (VC)[b)]: -13	• Better consideration of ecological circumstances is possible: Intake and outlet structure drainage canals (filters) embankments to prevent erosion	• Better consideration of needs of local communities Local communities can be better integrated in farm operations Jobs are created but with delay
/	**Labor Costs**	• For social reasons the company provides additional programs for the employees (education, food program, etc.), which leads to higher costs of labor (average +20% in comparison with scenario “Standard”).	• Sales 2005: equal • Cash flow 2005: -1 • ROS[b)] 2005: equal • Inv-LTA[b)]: equal • LTD[b)]: +197k R$ • VC[b)]: -3	•Additional education about environmental issues could increase concern about nature	• Stimulation of self-confidence, literacy, better job prospects; in general, stimulates development

Nr.	Scenario	Assumptions From Scenario 2 onward, only differences from the standard (base) case.	Differences from Standard Scenario (Basis: Standard 2000=100; differences expressed in points of index)		
			Economic[a)]	Ecological	Social
	Value Added Processing	• Introduction of a **value-added program** with more new products from 2001 to 2005 (using between 10% and 40% of the processed shrimps) • **Product price**: ca. +50% • About four times more **work** is needed for this category of product. • No additional **investments** are needed because in this scenario labor is not substituted with capital.	• Sales 2005: +82 • Cash flow 2005: +112 • ROS [b)] 2005: +8 • Inv-LTA [b)]: equal • LTD [b)]: equal • VC [b)]: +25	•No change	• More jobs created, more options for local community Creating new income possibilities in and around the shrimp sector (supplier for material and services: packing, maintenance, etc.)
	Sustainable Operation	• Consideration of all assumptions from scenario (1) to (4) **Product price** on the export market: 2005: +5%, 2006: +10% (with a third-party-certified label) (Fishmeal and White Spot are not taken into account because these are two external factors that cannot be entirely controlled by sustainable management.)	• Sales 2005: +115 • Cash flow 2005: +121 • ROS [b)] 2005: +3 • Inv-LTA [b)]: +31 • LTD [b)]: +1'254k R$ • VC [b)]: +9	Positive aspects from the simulations 1–4: – concern about nature – environmental education	• Positive aspects from the simulations 1–4: – concern about needs of local community – stimulates education – creates income possibilities
	Fishmeal	• In the years 2001–2003 a global shortage of **fishmeal** will double the **price** per kg of shrimp feed. (This is an external change that cannot be influenced by management, but managers who care about sustainability will seek solutions that substitute other sources of protein.)	• Sales 2005: equal • Cash flow 2005: -145 • ROS [b)] 2005: -39 • Inv-LTA [b)]: equal • LTD [b)]: equal • VC [b)]: -50	• Increasing value of missing fishmeal is better reflected Alternatives for fishmeal will be sought	• Less competition between shrimp feed and sources of food for people
	White Spot	• The White Spot virus comes to Brazil in 2001 (decrease of production from 25% in 2001 to 70% in 2003). The standard prevention activities (based on experience from Ecuador) are implemented: – affected ponds harvested earlier; later, longer cycles due to increased preparation time are required – stocking density decreased (-60%, -70%) – decrease in labor costs – reduction of investment – prevention measures	• Sales 2005: -243 • Cash flow 2005: -338 • ROS [b)] 2005: -77 • Inv-LTA [b)]: -20 • LTD [b)]: equal • VC [b)]: -59	• Disease may affect the whole ecosystem Danger for use chemicals and nature-damaging material Control of disease leads to a better concern about interactions in the nature	• Partial loss of direct and indirect working places Partial loss of livelihood for local community dependent on local fishery, etc.

Nr.	**Scenario**	**Assumptions** **From Scenario 2 onward, only differences from the standard (base) case.**	**Differences from Standard Scenario** **(Basis: Standard 2000=100; differences expressed in points of index)**		
			Economic[a)]	**Ecological**	**Social**
		(This scenario tries to show the flexibility and capacity of a company to deal with crises)			

a) Abbreviations in the table:
ROS: = Return on sales (Index Standard 2005 = 100)
Inv-LTA: = Investments in long term assets (Index Standard 2005 = 100)
LTD: = Long-term debt
VC: = Value of company (Index Standard 2005 = 100)

If the index-term data contains 2005, the indicated number is for that year only. Otherwise, the number belongs to the whole period from 2000 to 2005.

Simulations of Better Management Practices

Figure12 shows the cash flow to 2005 for each of the seven different scenarios. The simulations are based on the assumptions explained in Table7. The standard scenario in 2000 was used as the index base (=100). The sustainable operation (combination of Scenarios 2, 3, and 4) shows, over the long term, the highest net earnings, resulting from increasing productivity as well as on-farm processing and value added to products.

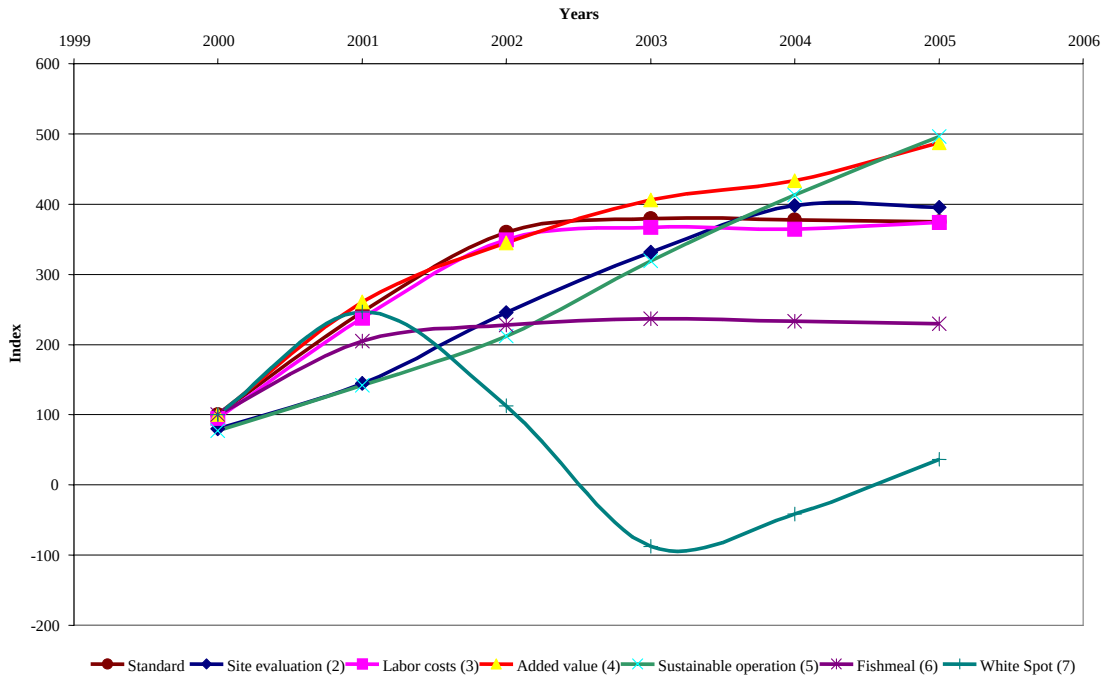

Figure 12. Cash flow (Standard scenario indexed, 2000=100)

Figure 13 shows the projected growth of interest bearing debt to 2005. It is clear that the capital requirements in the scenarios “site evaluation” and “sustainable operation” are higher in the first years than in other scenarios, due to their higher cost of investment and slower increase of area in production. However, the higher capital requirements are only a temporary phenomenon. After three years of operation the debt reaches the same level as in the other scenarios. The sustainable development scenario leads to a slower expansion rate and, in the short term, to an increase in capital needs. These factors are compensated over the long term with higher productivity and better sales, which in turn leads to a slightly higher company value (see also Figure14).

The company value resulting from the different scenarios reflects the impacts of the assumptions in Table7 (see Figure14). A more sustainable approach to development of the farm—compared to the standard scenario—may well have a positive effect on Camanor’s future value. This will occur over the long term, however. The scenarios presented, for example, are based on 11 years of planning and additional valuation data from after this initial period of planning and operation. The most critical factors to threaten reductions in company value are a rapid increase in the cost of production resources (e.g. in the fishmeal scenario) and a huge decrease in sales (e.g., in the White Spot scenario).

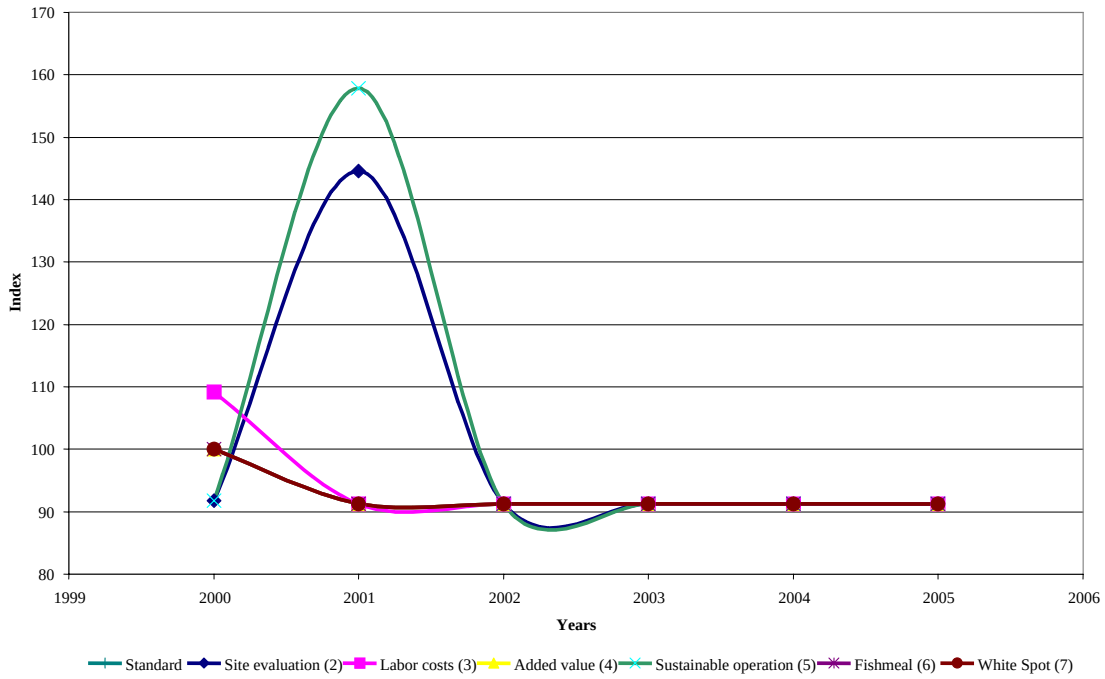

Figure 13. Interest bearing debt (Standard scenario indexed, 2000=100).

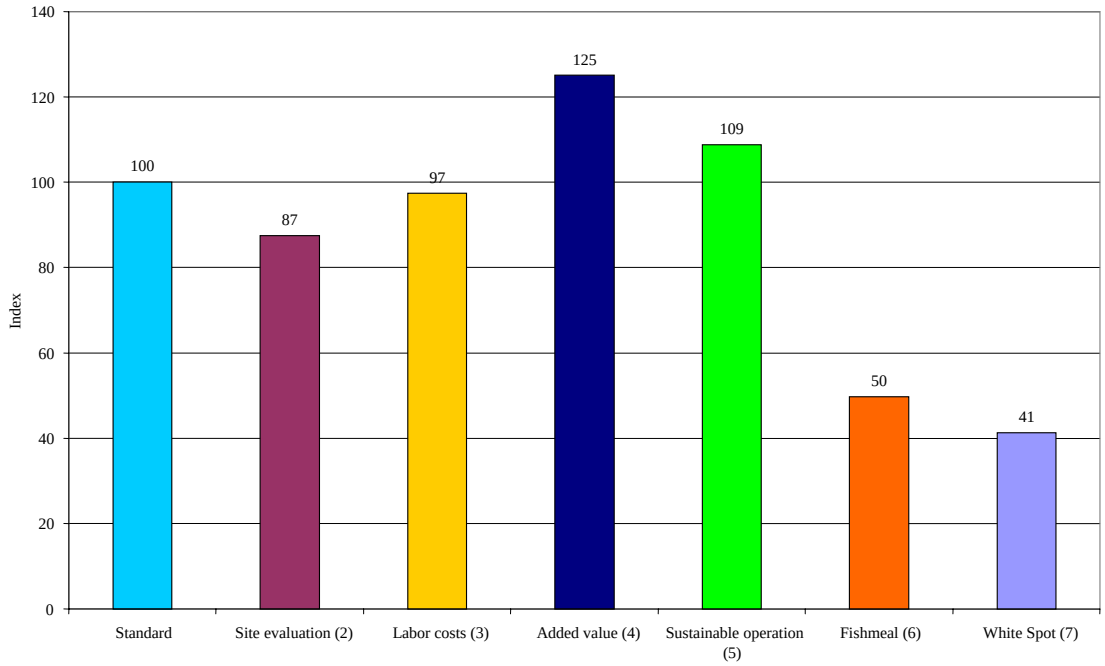

Figure 14. Company value (Standard scenario indexed, 2000=100).

Conclusions for Sustainably Managed Growth at Camanor

The assumptions underlying our quantitative model do not include such "soft factors" as the company's image, motivation of employees and identification with the company, political and social respect, and others. These factors, while probably quite important for the bottom line, are very difficult to quantify. Consequently, our calculations did not address these factors. The only factor that came close to this was ecolabeling, which is listed here as a value-added activity. We do not mean to imply that social and environmental factors are not as important as the financial factors included, but their effects are more difficult to estimate.

Even without applying values to these soft factors, our model did give the highest economic values to the "sustainable operation" methods. Modern management theories (such as Total Quality Management or Balanced Scorecard) have concluded that including long-term perspectives from social and ecological interactions, economic results can generally be improved. Thus, the financial results calculated for the sustainable way model could be even better if soft factors were accounted for.

Sustainable managed growth cannot be defined only by numerical results, however. The most important thing is the operation as a whole. An operation cannot just expand in areas without examining the resources that will be necessary. Camanor, with its own hatchery providing the capacity to increase production has a tremendous advantage. The rate of growth has to be planned carefully, taking into account financial considerations. Growth that is too rapid can generate cash flow problems or even insolvency that, in turn, force a farm to make compromises and cutbacks in the rest of its operations. For example, when Camanor experienced financial problems because of too much debt, the company decided to build ponds twice as big as initially planned, even though smaller ponds are easier to manage, harvest, and maintain. The financial situation required higher immediate production and financial return. Such situations could have been avoided with better planning.

Finding laborers will not be difficult, but finding qualified employees with specialized experience will be much more difficult. Highly qualified employees will take it upon themselves to initiate the process of reorganizing management. Another style of leadership will thus become necessary. Responsibilities have to be delegated (and competencies transferred), but decisions also must be controlled through checks and balances and even incentives. Sustainable managed growth depends on the organizational structure and having employees with the capacity to learn new skills and to identify and address new situations effectively (see Table 2).

An operation cannot work isolated from local conditions. Camanor is integrated into a local system and is influenced by national and international markets and economic developments. At the local level, other shrimp farms have a strong impact on the environment and social circumstances of production. Effluent and water pollution, destruction of mangroves, and exploitation of employees are just a few elements that could become issues at the local level. These circumstances have a strong impact on the image of Camanor, on its expansion possibilities and development. The management of Camanor has to be concerned about these factors. Transferring skills, sharing experience, and giving technical assistance to other (external) farmers are some of the ways Camanor intends to work at the local level to help other producers avoid making conditions difficult for everyone. This is both possible and financially attractive for two reasons. First, semi-intensive shrimp farming is strongly connected to the environment (e.g. obtaining water, reducing effluent, introducing species, and other issues affect farmers). Second, having other shrimp farms with good infrastructure in the area may provide purchasers for Camanor's PL or shrimp for Camanor to process, as long as demand increases.

The following activities show how a shrimp farm could support sustainable growth on the local level:

- Create a training center to educate technicians who work in the area
- Control the quality of PL used on the farm or sold to others
- Process and market the shrimp production of others
- Educate employees, provide literacy and training programs
- Invest in social services such as health programs

These kinds of activities help a farm to improve its public relations, gain local acceptance and credibility, and finally, create economic advantages by using its capacity more fully and eventually selling services to others.

At the national level, a single farm does not have tremendous potential to affect the industry, except to lead by example. A single farm is affected by national policies, politics, and market developments. To increase sustainable development across the national shrimp sector, it is very important to collaborate and to commit work and resources to an industry wide organization such as ABCC. The industry organization itself can generate considerable credibility by cooperating with environmental and social NGOs and community organizations.

On the international level, there is no way to directly exert influence. However, a company can collaborate with research initiatives such as this one, take part in international forums or technical consultations on shrimp aquaculture, and become active members of international organizations such as the Global Aquaculture Alliance. The most influential thing a single company can do, however, is to provide a positive example of a creative and innovative shrimp operation for others to learn from in their own efforts to become more sustainable.

Bibliography

A list of sited and related literature is given below:

ABCC. 2000. *Situação Atual dos Projetos de Pesquisas Aprovados Pela Assembléia Geral da ABCC em 20/03/2000.*

Flamholtz, E.G. and Y. Randle. 2000. *Growing Pains: Transitioning from Entrepreneurship to a Professionally Managed Firm.* Jossey-Bass San Francisco, USA.

Ministério da Agricultura e do abastecimento secretária executiva, Departamento de Pesca e Aquicultura. 1999. *Programa Nacional de Apoio ao Desenvolvimento do Cultivo de Camarão Marinho* (versão preliminar). Agosto.

Pümpin, C. and J. Prange. 1991. *Management der Unternehmensentwicklung – Phasengerechte Führung und der Umgang mit Krisen*. Campus Verlag. Frankfurt/New York.

Rocha, I. P. 2000. *Agronegócio do Camarão Cultivado, Revista da ABCC.* Ano2 N°1, April.

Rosenberry, B. 1999. World shrimp farming. *Shrimp News International. Number 12*.

Wainberg, A.A. and M.R. Camara. 1998. Brazilian Shrimp Farming. It's growing, but is it sustainable? *World Aquaculture*, March.

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