

SOCIAL AND ENVIRONMENTAL IMPACTS AND JOB GENERATION FROM THE FARMED SHRIMP PRODUCTION CHAIN

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Abstract

This study analyzes the economic and social impacts of shrimp farming in Brazil. The objectives of the study were to present a discussion on sustainable development of the shrimp industry in Brazil and estimate impacts of the production chain on job and income generation. Results indicate that the number of direct and indirect jobs generated by the industry surpasses by far the number of jobs generated by other industries located in the same areas. Income generation was also much greater for shrimp production as compared to other industries. The discussion on sustainable development of shrimp farming in Brazil concludes that there must be a balance between production technologies that preserve environmentally protected areas and provide the sustainable exploitation of mangrove areas.

The rapid development of shrimp farming in many countries is a phenomenon of the last 25 years, with increased growth rates after 1985. It happens simultaneously with the conclusion that: (a) the fantastic increase in food supply brought by the green revolution in the sixties and early seventies in Asia has occupied most of the productive areas, (b) the spectrum of the Malthusian trap could return if no new lands were put into production and (c) the oceans were one of the last frontiers to be explored for the production of cheap protein. However, as the

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production from capture fisheries was leveling-off, the only alternative to meet the increased demand was to expand aquaculture.

Several studies produced by the International Food Policy Research Institute (IFPRI) reinforced the notion that by the year 2020 animal protein will constitute the major food shortage (IFPRI 2000). Also, demand elasticities and demand projections show a growing demand for aquaculture. But statistics confirm the leveling-off from capture fisheries as predicted by Gulland (1971). Detailed studies by FAO, cited by Araújo (2000), conclude that 69% of world stocks are under intensive exploitation. In Brazil, for instance, total captures reached a maximum of 956 thousand tons in 1985, leveling-off around 700 thousand tons in the last 15 years (FAO 2003).

Thus, not surprisingly, the aquaculture development in the last 25 years, including shrimp farming, became a reality. Shrimp farming developed early in Southwest Asia, in Taiwan, Philippines and Indonesia, spreading rapidly to Thailand, China and across the ocean to Ecuador. Brazil, as a late comer, benefited much from technological improvements that may help retain a sustainable development and avoid sanitary problems that triggered some of the early pioneers in shrimp farming. Consequently, Brazil may benefit from the positive social impacts in shrimp farming while avoiding the negative ones. In addition, contrary to the conclusions of some studies (Neiland et al. 2001), referring to Asia, job generation in Brazil has been particularly significant.

The paper is divided in five sections: the positive social impacts, the negative social impacts, direct job generation, indirect job generation and concludes with an appreciation of shrimp production chain contribution to economic development.

The Positive Social Impacts from Shrimp Aquaculture

Shrimp farming in Brazil started in the seventies but only in the nineties, with the introduction of the species Litoperaneous vannamei, reached very high growth rates. There

is no doubt that it represents an economic success for the Brazilian case. But it is also necessary to highlight the positive social impacts.

Initially, it must be emphasized that in the late seventies EMPARN, the research institute of the State of Rio Grande do Norte, was involved in an extension project called “Projeto Camarão” (GERGN, 2001). This project had the objective of transforming decadent areas with salt exploitation into shrimp farms (Araújo 2003). The salt industry presented high growth rates from the sixties through the seventies, but a necessary modernization of the industry required a high social cost: the displacement of a large part of its workers (Romão et al. 1990). When the salt industry started having problems the “Projeto Camarão” was seen as a social policy with economic feasibility. Thus, it started with a social character completely different from the Asian experience.

As the farmed shrimp production chain developed, it involved small, medium and a few large farms. From an economic viewpoint, a small farm with only a few hectares can be as efficient as a large one. That is, there exists no sizable economies of scale.

In 2002, Brazil produced around 60,000 tons in 11,000 hectares and over 90% of all farm shrimp was produced in the Northeast region, the poorest region in Brazil. Since then, the sector's generated income has induced several positive impacts in the region.

Net generated income is almost equal to total income as the alternative economic uses are almost inexistent. This compares positively with some densely inhabited areas in Asia. Contribution to net income in all shrimp areas is sizable and considering the low growth rates that Brazil achieved since the eighties this is a major contribution to improved social conditions. This is true since it is widely recognized that increased income is an essential required condition to increased social conditions (Rocha 2001).

Contribution to income distribution is more controversial because not a single study has been conducted. There are two positive aspects. Small producers represented, in 2001, 35% of total farmed area. This is a much higher percentage than any other participation of small producers in the industry or agriculture in Brazil. And, as analyzed below, job generation adds to labor participation in total income. If created jobs represent a significant addition in farming areas, there is no doubt that income at the base level is increasing and that most probably income distribution is becoming less unequal.

Another major contribution with positive social impacts is through tax payments. Small and poor municipalities in the Northeast region of Brazil do not fulfill their social purpose due to budget shortages. In fact, this is a major shortcoming in the Northeast region when compared to other regions of Brazil. An economic viable alternative as shrimp farming represents a permanent increase in tax income for the local municipalities. As a consequence it is expected that social expenditures in health and education shall increase.

Also, it is expected, as it is already happening in several areas, that large companies will invest in the improvement of social conditions. These investments are seen as a way of helping to stabilize social conditions that allow economic development to speed up (Holloway and Picciotto 1979).

Finally, shrimp farming is responsible for the generation of foreign exchange credits. In 2002 farmed shrimp was second only to sugar among the leading the agricultural export activities in the Northeast region of Brazil, bringing over US\$ 142 million. Considering the problems Brazil has with foreign debt and trade imbalance (Baer 1995), this is an important contribution. It is also very important for the internal trade balance of the Northeast (Vergolino et al. 1999). Positive social impacts result from the use of foreign exchange credits to import necessary and capital goods and generate more jobs and further economic development.

The Negative Social Impacts from Shrimp Aquaculture

Negative social impacts and problems are related mainly to negative externalities, usually comprising several environmental problems.

All land uses that decrease native vegetation may affect biodiversity (Sampaio et al. 2002). But it is common sense that agricultural and livestock areas may coexist with the preservation of part of the native areas where the most important ecosystems are represented. A similar consensus does not exist in relation to aquaculture, in particular because aquaculture is very young – only 25 years – in relation to the several thousand years of agriculture existence (Diamond 2001). It is the time for society to discuss and take a mature decision in relation to the preservation of mangrove forests, ponds and salty areas, side by side with the exploitation of other marine areas, and aquaculture.

In relation to negative environmental impacts, Brazil has benefited from technological improvements in shrimp farming in the last years. Among these benefits, the emergence of hatchery-reared post larval shrimp and improved artificial feeds can be highlighted (Neiland et al. 2001). One must notice that the first shrimp virus occurrence was in Taiwan in late eighties. Late comers, as Brazil, now have technology and knowledge to avoid most disease outbreaks that can affect production and cause negative externalities (Neiland et al. 2001).

But other problems are present. For example, it is necessary to define the maximum production per pond. Planning is necessary in demarcating shrimp production areas, limiting total production capacity taking into consideration environmental, social and economic criteria. Of course, it is necessary to agree that marine areas also have a social value besides an environmental value, as already argued. This zoning of producing areas is a necessity both to avoid salinization and pollution of these areas and to reach equilibrium with native

habitats, allowing biodiversity to be maintained in some areas of strict preservation.

In relation to pollution as a negative externality, technical improvements and knowledge have contributed to avoid major problems. Still, it is necessary to control the discharge of effluents from ponds both for a sustainable development of shrimp farming and to balance ecological effects. But again this is a matter of studying and planning. Errors committed in Asia and Ecuador shall not be repeated. Government planning, in this respect, is essential as major problems seem to be associated with small farms operating sometimes even without the necessary environmental control from legal authorities.

Direct Job Generation

Shrimp farming, as already mentioned, presents positive impacts in income generation and as a foreign exchange dividends creator. But, in other context, it was said that “neither extensive nor intensive shrimp production is labor intensive and jobs created are often for outsiders” (Neiland et al., p. 272, 2001). Is this also true in relation to Brazil? What is the contribution of shrimp farming to job generation?

Direct job generation refers to the jobs created in hatchery labs, farms and processing plants. Therefore, only the continued hired work and that work related to the production cycle was considered in the methodology used in this study. Temporary jobs generated for the construction of ponds, edifications, reservoirs, etc., related to the industry expansion were not considered. During the recent years of continuous expansion of this agribusiness, this type of hired work has been very expressive. However, according to what projects evaluation’s manuals recommend, this temporary work is not computed, due to the limited horizon of this type of hired work.

According to size, farms in this study are characterized as small (<20 ha.), medium (20 < 100 ha.) and large (>100 ha.). There are differences in technologies among the size groups being analyzed. In some farm sizes, extensive farming is predominant, while others use feeding trays and water pumps in a more intensive way. These differences are responsible for variation on the number hired personnel. However, in a more general way, a tendency for a semi-intensive type of production was observed, adopting labor intensive work and modern techniques.

The job generated according to farm size was initially calculated using the farm size distribution reported by the 2001 Census of the Brazilian Shrimp Farmers Association (Associação Brasileira de Criadores de Camarão, ABCC 2002). Production in small farms generates, on average, 1.38 direct jobs per hectare of producing shrimp ponds (Table 1). Medium size farms generate 1.31 jobs/hectare, and large farms generate 1.01 jobs/hectare, due to economies of scale, since there are no representative differences in the technologies employed by medium size farms. Taking into account all farm sizes, and expanding the sample results to the whole population reported in the 2001 Census, results show that 1.20 direct jobs are generated per hectare of producing shrimp ponds.

Direct jobs generated in shrimp farms are mostly composed of full time employees – approximately 84% of all directly hired labor – an expressive result. Thus, the seasonal type of direct hired work, used mainly for harvesting time and ponds' preparation prior to growing, is responsible to as little as 16% of the total direct hired work. Interestingly, shrimp farming retains workers in a permanent way, with good jobs and salaries (as confirmed in related answers from interviews). In small farms, seasonal work is more expressive (over 41% of all direct hired work), given the employment of temporary work in harvesting and ponds' preparation times. This result compares positively with the results for medium and large size farms,

whose farmed areas' dimensions justify the full time employment of harvesting and ponds' preparation teams. The temporary work was converted to permanent to compare with full time work considering 220 working days/year and an 8-hour work journey per day. By using these parameters, the conversion underestimates the average hired work usually found. Results might suggest however, that the seasonal workers are becoming a specialized type of work, being able to work in many farms. On other hand, given the weather conditions in the northeastern coast of Brazil, no seasonality is found in the farmed shrimp production cycle, and shrimp can be farmed 12 months a year. Therefore, combination between temporary work in this agribusiness and other activities becomes more flexible, as it is commonly seen in rural business environments (Graziano 1996 and Graziano and Del Grossi 2001).

Direct jobs generated are composed of workers with low education levels – approximately 88% of the hired work has a primary level education – while the other 12% are divided between secondary level educated workers and college degree workers. Consequently, the investment in farms' operation and expansion does not ask for a more intensive training of hired labor, which represents an additional advantage in the shrimp production chain from the viewpoint of absorbing local workers.

In hatcheries, direct jobs were calculated per million postlarvae. To obtain the conversion to jobs per hectare of farm ponds in production, the average postlarvae density used in farm ponds, 49 postlarvae/m², and the average number of production cycles, 2.5 cycles/year, were used. Table 2 presents the direct jobs generated in postlarvae hatcheries. The obtained value, 0.20 jobs per hectare of producing ponds, is considerably low. This result shows that this stage of the production chain, even representing an essential stage because it incorporates value and provides the essential input in the production cycle – the postlarvae –, has little to contribute to the total direct hired work

computation. The generated job is mostly full time and is composed of workers with secondary level education.

In processing plants, direct jobs were calculated per shrimp processed tons. Using the average of the total processed shrimp per plants, obtained by the research observations, and the average production per pond in farms per year, 0.49 jobs per hectare of production ponds were obtained. The generated jobs are predominantly full time and composed of hired people with primary level education (see Table 2).

Summing the jobs generated in farms (1.20), hatcheries (0.20), and processing plants (0.49), the result is equal to the estimated generated direct jobs in the production chain: 1.89 jobs per hectare of production ponds. This result compares, favorably, against results obtained in the job generation estimation for the irrigated fruit production industry in the Northeast region of Brazil. In a recent work, Sampaio and Sampaio (in press) estimated that 1.00 direct jobs per hectare for small producers and 0.88 direct jobs per hectare for companies were generated in the irrigated fruit production industry in the São Francisco Valley. These coefficients were considered considerably high and superior to those calculated before the irrigated fruit production industry expansion, 0.58 direct jobs per hectare (Maffei et al. 1986). By analyzing more closely, by specific products, one can observe that grapes production deserve a considerable position, generating on average 1.44 jobs per hectare, and numbers for mangoes production, another production industry with many small producers as members, generates only 0.42 jobs per hectare. Rain fed agriculture generates even less jobs: 0.55 jobs per hectare on average (Sampaio and Sampaio, in press). One can consider therefore that no specific product in the irrigated fruit production industry, by itself, generates as much direct work per hectare as the farm shrimp agribusiness.

Indirect Job Generation

The generated indirect jobs obtained by the farm shrimp production chain are calculated by the chain connections to inputs and services suppliers and by the consumption effect, that is, the generated jobs from expenditures with the income obtained in the production chain.

An input-output matrix is used to calculate the indirect jobs generated in the production chain. The matrix is properly disaggregated to incorporate the shrimp farm business. The methodology used to calculate the generated indirect jobs follows that developed in the study by Casimiro Filho (2002). The direct and indirect requirements matrix is obtained disaggregating the line and column corresponding to the farm shrimp sub-sector,

$$(I - A^*)^{-1}. \quad (1)$$

From this matrix, the increase in total employment, L_j , is obtained given the unitary increment in production of the sub-sector j ,

$$L_j = \sum l_i A_{ij}^*, \quad (2)$$

where l_i = additional job coefficient in sector i and A_{ij}^* = production in sector i necessary to correspond to an unitary increment in production of sector j .

Comparing the vector l^* with the incorporation of indirect impacts caused by the consumption expansion, in a Leontieff's closed model, one can obtain:

$$L^* = l^* (I - A^*)^{-1}. \quad (3)$$

L^* incorporates both the direct and indirect impacts, of input usage and consumption, over jobs generation, caused by the unitary increment in production on each of the economy sectors, as a consequence of production in the farm shrimp agribusiness.

Finally, taking into consideration the additional demand for inputs usage and consumption created by sub-sector X_i^* , one can obtain the indirect effect generated by the shrimp farm industry:

$$L^*X^{**} = \sum L_i^* X_i^* \quad (4)$$

The basis for the calculus is, besides the input-output matrix, the generated value per hectare of production ponds. In this study, the average productivity obtained in the 2001 Census, 4,706 kg/ha, and the average selling price of US\$ 4.80 per kg were used. The resulting value of 1.86 indirect jobs generated per hectare was then obtained.

In the irrigated fruit production, generated indirect jobs, estimated using the input-output matrix for the Northeast region of Brazil, were equal to 1.14 jobs per hectare (Sampaio and Sampaio, in press). Again, the generated jobs by the farm shrimp industry, this time the indirect, exceed the indirect jobs generated by the sub-sectors connected to the irrigated fruit production of the São Francisco Valley in the Northeast region of Brazil.

Shrimp Production Chain Contribution to Economic Development

The shrimp production chain has contributed to the net generation of income, for the generation of foreign exchange credit and considering the country as a whole to the improvement of income distribution. It has also contributed much to direct and indirect job generation, and further improving its positive social impacts. On the other hand it can generate negative social impacts on the environment. Considering all these aspects what role can the shrimp production chain have to sustainable economic development?

Sustainable economic development is defined in the Brundtland Report as the “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development 1987). It comprehends economic, social and environmental sustainability. That is, shrimp production must generate a permanent income flow, and this flow must contribute to the incorporation of low income groups through employment and income distribution and shall not compromise future preservation of biodiversity in ponds areas and coastal regions. A complete discussion of all these aspects is not possible at this moment but some preliminary conclusions are advanced.

Shrimp production is the economic activity that contributes most to income generation among all agribusiness alternatives for the coastal zone of Brazil called “Zona da Mata”. One hectare generated around US\$ 25,000 in 2002. In comparison sugar generates US\$ 850 and coconut generates only US\$ 575¹. These are the two main activities that compete against shrimp for agricultural areas. Thus, as an income generation activity, the potential contribution of shrimp production is a highlight. Shrimp production will only be sustainable if modern technology and knowledge are used to avoid viruses and diseases outbreaks, which requires a rigid planning and control of production capacity in each production area.

Shrimp production contribution to job generation, by hectare, is another high point: 1.89 direct and 1.86 indirect jobs, adding up to a total of 3.75 jobs. In comparison, sugar cane generates 0.35 direct and 0.16 indirect or a total of 0.51 jobs per

¹ In the case of sugar cane, the whole chain is considered (cane/sugar/alcohol). Unfortunately, for coconut, there exists available data only for the agricultural production; if processing into oil and other products is considered, the income and employment impacts increase.

hectare. Coconut contribution to job generation is even smaller: 0.16 direct and 0.03 indirect jobs, adding to a total of 0.19 jobs per hectare.

In addition to its contribution to economic and social sustainability, is it possible for shrimp farming to contribute to environmental sustainability? The answer is yes, it is possible to achieve environmental sustainability but only if biodiversity is preserved. First, it is required that disease outbreaks stay under control. Second, pollution shall also be maintained under control, what requires a close monitoring of effluents. Third, land use planning must define areas of strict preservation and propose the maximum exploitation rate in other areas. Nowadays, the technology and knowledge to reconcile economic uses and environmental preservation exist, but only if planning and close monitoring are adopted (Neiland et al. 2001). It is thus possible to speed up sustainable economic development with planning and adoption of the best available technologies. It all depends on the joint effort of government agencies and the private sector.

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Table 1. Direct Jobs Generated at Shrimp Farms.

Farm Size	Per hectare	Per education level (%)			Job type (%)	
		Primary	Secondary	College	Full-time	Seasonal
Small	1.38	87.66	8.23	4.11	58.62	41.38
Medium	1.31	88.82	8.80	2.38	91.36	8.64
Large	1.01	88.31	8.65	3.04	99.40	0.60
Total	1.20	88.19	8.53	3.27	83.73	16.27

Table 2. Direct Jobs Generated in Postlarvae Hatcheries and Processing Plants.

Unity	Per hectare	Per education level (%)			By type (%)	
		Primary	Secondary	College	Full time	Seasonal
Hatcheries	0.20	16.58	75.39	8.03	99.00	1.00
Processing Plants	0.49	90.10	8.24	1.66	100.00	0.00