

**SOCIAL AND ENVIRONMENTAL INDICATORS OF THE PEACH PALM (*Bactris gasipaes* Kunth)  
RESEARCH IN SÃO PAULO STATE – BRAZIL<sup>1</sup>**

**INDICADORES SOCIOAMBIENTAIS DA PESQUISA COM A PUPUNHEIRA  
NO ESTADO DE SÃO PAULO – BRASIL**

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**ABSTRACT** – The main objective was to study the impact of the introduction in São Paulo State of the Amazonian palm, peach palm (*Bactris gasipaes* Kunth) as a heart-of-palm producer, to evaluate its influence on the local dynamics, by means of social-environmental indicators, under three distinct geographic conditions in São Paulo State. First, the North Coastal region, second, the Ribeira river Valley region, both within the Atlantic forest limits, where exists the possibility of the native 'juçara palm' to be threatened by extinction by the predatory exploitation of heart-of-palms. The third region is the São Paulo State plateau where the peach palm has been cultivated in several areas, as an economical alternative. As far as the research on the peach palm crop is concerned, when analyzing its technical parameters associated to higher soil erosion control, reduced soil compaction, rational use of chemical fertilizers and organic matter, higher awareness of the irrigation requirements in lower rainfall regions it is evident that there was meaningful aggregation of knowledge by farmers on the crop, which became an important sustainable agricultural innovation. In general, there was a positive environmental impact both in the North Coastal and the Ribeira river Valley region since the early implantation of the peach palm crop, whereas in the Plateau region no effect was observed. In all regions there was an improvement of the labour force skills, as well as an improvement of the basic living conditions of the small farmers. Despite the significant differences among the regions, concerning the edaphoclimatic point of view, requiring that distinct technological packages be adopted, and the social one, the peach palm crop represents for São Paulo State, an agricultural alternative environmentally sustainable, showing promising economic perspectives and significant social importance.

**Keywords:** *Bactris gasipaes*; impact evaluation; research; investment; South America.

**RESUMO** – O principal objetivo deste trabalho foi estudar os impactos socioambientais da pesquisa com a pupunheira (*Bactris gasipaes* Kunth) para produção de palmito, com o intuito de se avaliar sua influência na dinâmica local em três condições geográficas distintas do Estado de São Paulo, de 1990 a 2006. A primeira corresponde ao Litoral Norte Paulista, a segunda ao Vale do Ribeira, ambas situadas dentro dos limites da Mata Atlântica, em que ocorre a possibilidade de extinção do palmitreiro juçara (*Euterpe edulis* Mart.), espécie nativa, pela colheita predatória de palmito.

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A terceira região corresponde às áreas do planalto paulista em que a pupunheira vem sendo cultivada como alternativa econômica. Com respeito à pesquisa com a pupunheira, analisando os parâmetros técnicos do cultivo, relativos ao alto controle da erosão do solo, redução da compactação do solo, uso racional de fertilizantes químicos e orgânicos, maior conscientização da necessidade de irrigação em regiões de baixa precipitação pluviométrica, fica evidente que houve significativa agregação de conhecimento pelos agricultores, sobre o cultivo dessa espécie, que se tornou uma importante e sustentável inovação agrícola. De maneira geral, houve impacto ambiental positivo no Litoral e no Vale do Ribeira a partir do cultivo da pupunheira e praticamente nulo no Planalto. Em todos os casos verifica-se que houve incremento na qualidade da mão-de-obra, representando uma opção rentável, com melhoria nas condições do trabalhador. Apesar das significativas diferenças entre essas regiões, tanto do ponto de vista edafoclimático com a necessidade de adoção de pacotes tecnológicos distintos, como do ponto de vista social, essa nova cultura caracteriza-se como alternativa agrícola para o Estado de São Paulo, sustentável ambientalmente, com boas perspectivas econômicas e significativa importância social. Dessa forma, é importante que sejam geradas novas tecnologias, visando a elevação da produtividade agrícola, a minimização dos danos ambientais e a promoção da inclusão social de todos os setores envolvidos.

Palavras-chave: *Bactris gasipaes*; avaliação de impacto; pesquisa; investimento; América do Sul.

## 1 INTRODUCTION

Brazilian agriculture has been adapted progressively to the consumer demand, as well as to the changes in the eating habits both in Brazil and abroad. One of the main current and future challenges refers to the possibility that new technological frontiers can be properly incorporated into producers, taking into account the environmental and social laws. In this sense, the scientific advances, especially from the research institutes, have played an important role in some paradigm shifts. New crop options as well as new technologies have been continuously developed, upgrading the agribusiness to face the new challenges, increasing the internal and external competitiveness, contributing effectively to the Brazilian economic development.

A crucial point for agriculture is to establish consistent parameters of sustainability, which do not affect the environment. In addition to meeting economic aspects, such as increased productivity or cost reduction, new agricultural technologies that have been developed and made available to the producers, have taken into account social and environmental impacts in the regions where they are adopted.

The peach palm crop for heart-of-palm production represents an important referential. During the past century, an increasing predatory extractivism of the juçara palm (*Euterpe edulis* Mart.) native to the Atlantic Forest has been observed, which contributed significantly to accelerate the process of the species extinction throughout its habitat (Reis and Guerra, 1999). Concomitantly there have been continuous research efforts aiming to restrain the devastation of the environment through the development of new economically feasible alternatives, adding income to the farmers without harming the forests still remaining.

According to Germeck (1978), by 1940, peach palm seeds were introduced by Instituto Agrônomo – IAC. Studies concerning to the commercial production of the species for heart-of-palm production began last century in the mid – 70, with the researches by Emilio Bruno Germeck, at IAC. Thereafter, there were significant advances of the researches on the peach palm, led by the researcher Marilene Bovi at IAC, propitiating better perspectives for the peach palm crop, as a heart-of-palm producer, replacing the juçara palm predatory exploitation.

In this context, *a priori* researches were performed by IAC and Instituto de Tecnologia de Alimentos – ITAL, in the early 80s of last century, on the Amazonian species peach palm, and the possibility of its cultivation for heart-of-palm production under the subtropical conditions of São Paulo state. Germplasm was introduced giving rise to the first research results about the acclimatization of the species to the subtropical conditions. Researches were also performed on the peach palm heart-of-palm quality, and the favorable results in both scopes drew the attention of farmers to the possibility of growing the peach palm for heart-of-palm production. Some of the preliminary relevant results can be found in Ferreira et al (1982), Bovi et al (1988), Bovi (1993), Bovi and Cantarella (1996), Clement and Bovi (1999).

It was found that over the years there has been increasing investment in research leading to advances in technology, which affected positively the implementation of the peach palm crop in the state of São Paulo, as well as the spread of its heart-of-palm consumption. According to Anefalos et al. (2009), it was found along every quinquennium significant advances in the peach palm crop research, concerning breeding, phytotechny, as well as heart-of-palm postharvest, all of them with the active participation of Instituto Agrônômico – IAC.

Significant results were achieved by the establishment of germplasm collections as well as by the evaluation of experiments carried out at the former IAC Experimental Stations, currently named Pólos da Alta Paulista, Leste Paulista, Centro Norte, Vale do Ribeira, Vale do Paraíba (Ubatuba UPD), Centro Sul – and also at private farms in partnership with farmers. The results allowed advances that have been intensively reported to producers, generating several techno-scientific publications (Castro, 2008). In this process, relevant partnerships with other research institutions and with universities, accounted for the boost of the heart-of-palm productive chain in the state of São Paulo.

Although there is still no structured market, the almost forty years of research on this perennial species allowed advances in the heart-of-palm processing, with new forms of presentation, such as *in natura* and minimally processed, due to some peculiarities of the species, mainly the fact that the heart-of-palm does not darken when exposed to the air.

With the joint effort of well-targeted public policies and engagement of farmers, since the 90s, there was in Brazil an upward migration from the extractivism of the juçara palm and the açai palm (*Euterpe oleracea* Mart.), to a rational exploitation of a perennial crop, mainly the peach palm crop. In São Paulo state this trend was more evident, once from 2000 to 2005, about 98% of the total production of heart-of-palm came from perennial crops, rather than extractivism (Anefalos et al., 2007b).

The increased cultivated heart-of-palm production is closely related to the introduction of the peach palm crop in São Paulo state in the 70s, as an alternative to the juçara palm predatory extractivism, as well as to the continued efforts of researchers over the years to provide increases in the productivity and in the final product quality. In addition to the efforts to develop technologies for the peach palm crop in the areas where there is the possibility of the juçara palm predatory extinction, the research efforts also enabled the peach palm cultivation for heart-of-palm production in São Paulo state nontraditional regions as in São Paulo state plateau regions where the peach palm has been cultivated as a new economic alternative.

The main objective of this work was to study the social and environmental impacts of the research on the peach palm crop for heart-of-palm production, aiming to evaluate its influence on the local dynamics, from 1990 to 2006, in three different geographical conditions of the state of São Paulo – Northern Coastal, Ribeira river Valley and São Paulo state plateau.

## 2 MATERIAL AND METHODS

The study was carried out under conditions of three distinct geographic in São Paulo State, Brazil, where the peach palm has been grown for heart-of-palm production (Figure 1). First, the Northern Coastal region, second, the Ribeira river Valley region,

both within the limits of the Atlantic forest, where there is the possibility of the native juçara palm to be threatened by extinction, by the predatory exploitation of heart-of-palms. The third region is the São Paulo State plateau where the peach palm has been grown in some areas as an economical alternative.

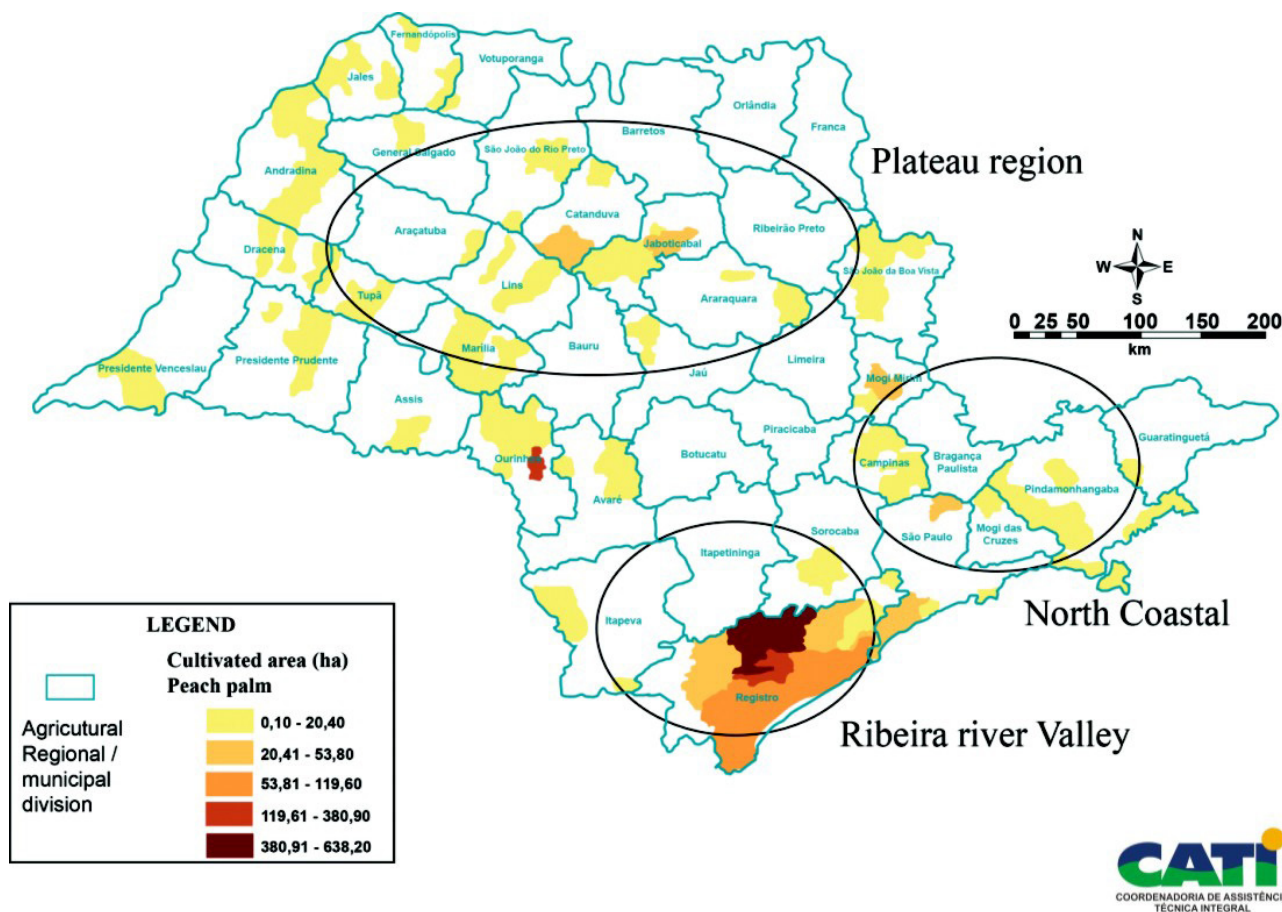


Figure 1. Area of peach palms for heart-of-palm production in São Paulo State, Brazil, 2007/2008.

Figura 1. Área de Pupunha para produção de palmito no Estado de São Paulo, 2007/2008 (Levantamento censitário de unidades de produção agrícola do Estado de São Paulo – LUPA 2007/2008, 2008).

For the primary data collection, personal interviews with the main actors directly involved in the introduction and cultivation of the peach palm in São Paulo State, were carried out in 2008, based on previously designed questionnaires, in order to evaluate the impact of this technology innovation. The reference period corresponded to the interval from 1990 to 2006 and the actors were selected among researchers and extensionists from the institutions

associate with Instituto Agrônomo – IAC, as well as peach palm growers, cooperatives and rural associations, mainly from Ribeira river Valley and São Paulo State plateau regions, amounting to 22 interviews, 50% with researchers and extensionists and 50% with farmers and rural associations. The evaluation performed by IAC researchers was focused on assessing the global impact of the innovation.



Questionnaires and evaluations of social and environmental impacts were carried out by the systems AMBITEC-AGRO (Avaliação de Impacto Ambiental da Inovação Tecnológica Agropecuária) (Furtado, 2003; Paulino, 2003, Irias et al., 2004) and AMBITEC SOCIAL (Avaliação de Impacto Social da Inovação Tecnológica Agropecuária) (Rodrigues et al., 2005), of the AMBITEC method, developed by EMBRAPA.

The following points were taken into account to assess the environmental impact of the innovation, and points were assigned for each question: first, the technological efficiency, concerning the use of agrochemicals, energy and the natural resources water and soil; second, the environmental conservation, concerning changes in atmosphere, in soil and water quality and in biodiversity; third, the environmental recovery, taking into account the soils, and the permanent preservation areas and legal reserves.

The assessment of the social aspects of the innovation included the following points: employment, concerning the changes in supply and in employees conditions, quality of employment, taking into account the labor laws, and employees benefits, income, based on the changes on the income generation, the diversification of the income sources and the property value; changes in the environmental and personal health, occupational safety and food security; management and administration, taking into account the changes in the profile of the person in charge of the property, changes in the marketing conditions, and in the waste recycling, and also changes in the inter institutional relationships.

AMBITEC-AGRO system, allows a general indicator of environmental impact to be assessed to evaluate each specific technology. The general indicator was divided into 19 sub-indicators, according to the following aspects: the technology scope, and efficiency, and the environmental preservation and recovery.

The aim is to identify the changes brought about by the inappropriate use of agrochemicals, energy and natural resources, as well as the changes in atmosphere, in the soil and water quality and the changes in biodiversity.

The social impacts were assessed by the AMBITEC-Social system, which makes it possible to calculate a general indicator of social impact that was divided into 14 sub-indicators, according to the following aspects: employment, income, health management and administration.

In general, the calculation of the impact coefficient of each indicator  $i$  ( $CIA_i$ ) by the AMBITEC system, according to Ávila et al. (2008), can be expressed by Equation (1). The changes are assessed by 5 coefficients: (+3), (+1), (0), (-1), (-3), representing large increase, moderate increase, no effect, moderate decrease, and large decrease of the component evaluated, respectively:

$$CIA_i = \sum_{j=1}^m A_{ji} E_{ji} P_{ji} \quad (1)$$

in which:

$A_{ji}$ : alteration coefficient of component  $j$  of indicator  $i$ ;  
 $E_{ji}$ : ponderation factor for spacial occurrence scale of component  $j$  of indicator  $i$ , and  
 $P_{ji}$ : ponderation factor of the importance of component  $j$  in indicator  $i$  composition.

The impact index of the agriculture technological innovation ( $IIA_i$ ) for each region is assessed by Equation (2), ranging from -15 (highly negative) to +15 (highly positive):

$$IIA_i = \sum_{i=1}^m CIA_i P_i \quad (2)$$

in which:

$P_i$ : ponderation factor of indicator  $i$  importance in the composition of  $IIA$  in technology  $t$ .

Table 1 presents the ponderation factor to calculate the impact coefficient of each indicator  $i$  ( $CIA_i$ ) for each indicator related to environmental and social impact.

Table 1. Ponderation factor for each indicator related to environment and social impacts.

Tabela 1. Peso para cada indicador relacionado aos impactos ambiental e social.

Ambiental impact indicator	Ponderation factor	Social impact indicator	Ponderation factor
Use of agrochemicals	0.125	Capacitation	0.1
Use of energy	0.125	Local qualified employment opportunity	0.1
Use of natural resources	0.125	Employment offer and labor conditions	0.05
Atmosphere	0.125	Employment quality	0.1
Soil quality	0.125	Income generation	0.05
Water quality	0.125	Diversity of income sources	0.05
Biodiversity	0.125	Property value	0.05
Environmental recovery	0.125	Human and environmental Health	0.05
		Safety and Health at work	0.05
		Food safety	0.05
		Profile and dedication of person in charge	0.1
		Marketing condition	0.1
		Waste recycling	0.1
		Inter-institutional relationship	0.05

A new index – global impact of peach palm crop research ( $IIA_g$ ) – was proposed to analyze the research impact, considering the three studied regions together. It takes into account the perceptions of the IAC researches, directly involved from the beginning in the peach palm crop research coordination. It was calculated according to Equation (3):

$$IIA_g = \sum_{r=1}^4 (IIA_r P_r + IIA_{IAC} P_{IAC}) \quad (3)$$

$IIA_r$ : impact index of the agricultural technological innovation for each region (North Coastal, Plateau and Ribeira river Valley);

$P_r$ : ponderation factor of  $IIA_r$ , for each region; in this case the value is considered 0.25 for each one, and

$P_{IAC}$ : ponderation factor of  $IIA_{IAC}$ , for the IAC researchers, directly involved, from the beginning in the peach palm crop research in the three regions; in this case the value is 0.25;

### 3 RESULTS AND DISCUSSION

The technological advances in the peach palm crop researches, allowed the insertion of this new crop as a sustainable agricultural alternative for the state of São Paulo, as reported by Anefalos et al. (2007b). The adoption of technological packages developed since the 70s, allowed a higher quality control for the production system of other heart-of-palm producers palms, not only for the peach palm heart-of-palm, allowing the peach palm productive chain to increase its possibilities to take advantage of new market niches, with significant value added, according to Figure 2.

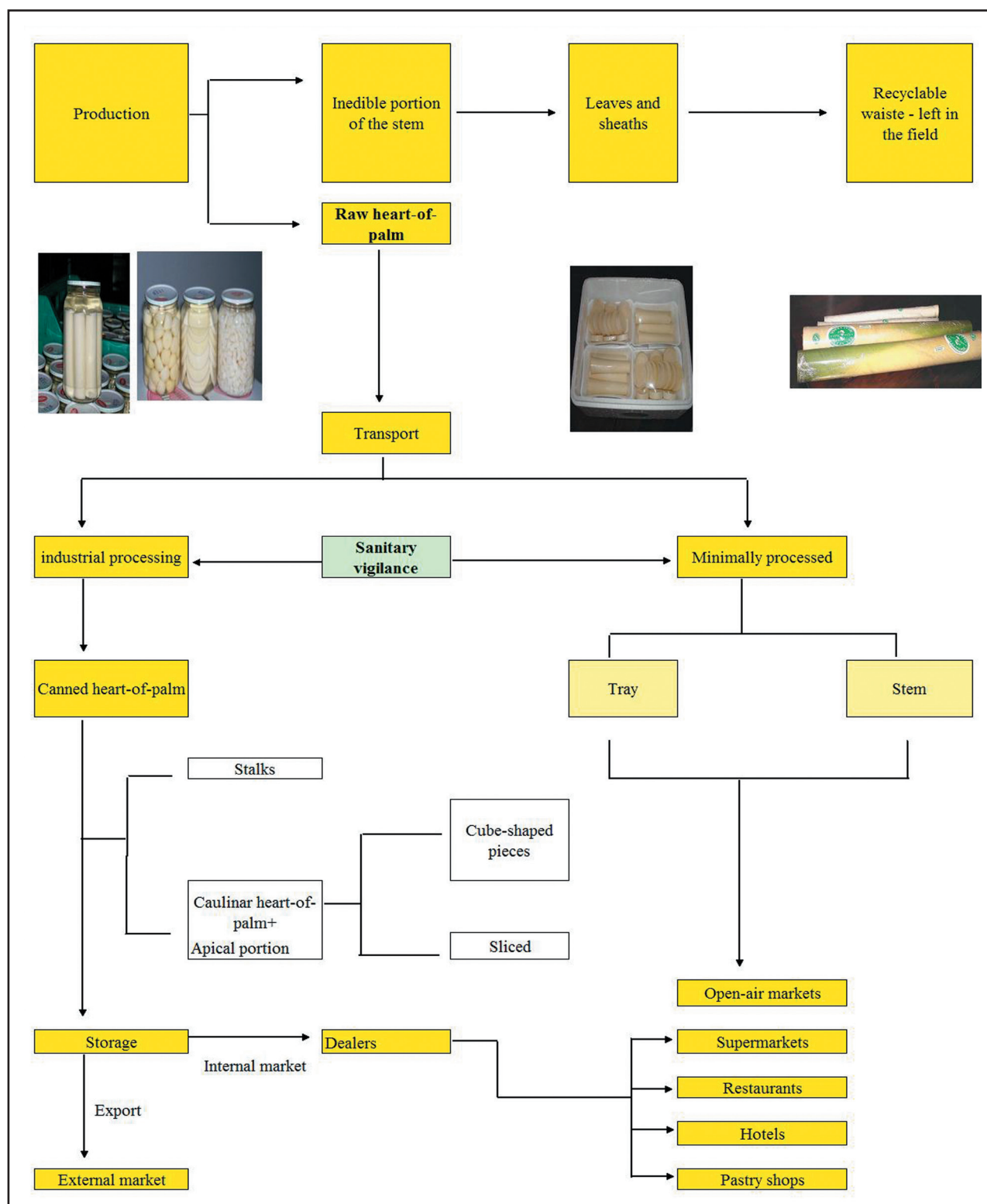


Figure 2. Flowchart of the peach palm productive chain.

Figura 2. Fluxograma da cadeia produtiva de pupunha.

According to the interviewers, before the start of the peach palm cultivation for heart-of-palms production, the heart-of-palms processed in the factors were harvested in a predatory way from the juçara palm or they were processed by the collectors themselves within the forest risking the product to develop the dangerous. From the 60s however, the socio-economic situation of the region underwent an aggravation, with the increasing monitoring of the heart-of-palm withdrawal of the forest, culminating with the closing of local factories and their displacement to other Brazilian regions. The environmental and social impacts of the researches on the peach palm crop for heart-of-palm production in the state of São Paulo have shown differences among the three growing regions studied. In Ribeira river Valley, the peach palm crop has been from the beginning a new option to the traditional crops, such as banana, natural pastures as well as the 'juçara palm' (*Euterpe edulis* Mart.), native to Atlantic forest (Anefalos et al., 2007a). Peach palm besides being a new option to the predatory exploitation of juçara palm has turned out to be an economically feasible alternative to other economic species grown in Ribeira river Valley. At first, the peach palm was considered as a secondary crop. The situation has changed and nowadays, according to Anefalos et al (2010), it represents an interesting alternative to the traditional regional crops, tea and banana. It is also worth mentioning that the peach palm can be grown under agroforest systems with other perennial crops such as banana, coffee and cacao.

Despite the suitable climate conditions, similar to those of Ribeira river Valley, the coastal northern region of the state has shown a smaller and more restrictive expansion of the peach palm crop,

once there is an increasing emphasis on the tourism activity, with high real estate value of the agricultural properties, with a tendency for some farms to be used in tourism projects.

On the other hand, the plateau regions differ from the others concerning the climatic conditions, mainly by the low rainfall in winter, so irrigation is required for heart-of-palm production, in order to achieve high yields and high quality products, Observed at first by Ramos et al (2001; 2002; 2003). In fact, farmers who have adopted this technological level have stood out in productivity and product quality from the others.

Table 2 shows the use of pesticides and fertilizers both in the North Coastal and Ribeira river Valley region, as well as in the Plateau, with the generation of a negative impact on the environment. Except the North Costal region, higher use of energy and natural resources (water and/or soil) was observed in both the other regions. On the other hand, the peach palm cultivation brought about a positive impact on the environment conservation and recovery, both in terms of soil quality improvement and in terms of better use of the areas damaged by the inappropriate practices previously used. As far as fertilizers are concerned, the use of NPK is required, and the farmers use the information recommended by the researches, improving the fertilization practices. Prior to the research on peach palm soil fertilization and liming for the crop were not rationally performed, often producing imbalances affecting deeply the physiology of the species. The soil of Ribeira river Valley region is generally poor in mineral nutrients and crops require proper fertilization, otherwise economic productivity will not be achieved.



Table 2. Indicators of environmental impact of the peach palm crop in North Coastal, Ribeira river Valley and the Plateau regions of São Paulo state, Brazil.

Tabela 2. Indicadores de impacto ambiental da cultura da pupunheira nas regiões Northeastern Coast, Ribeira river Valley e São Paulo state plateau, do Estado de São Paulo, Brasil.

Indicator	Regions		
	North Coastal	Ribeira river Valley	Plateau
Use of agrochemicals	-2.25	-6.00	-3.60
Use of energy	0.00	-2.75	-4.20
Use of natural resources	0.00	-6.00	-6.40
Atmosphere	-1.60	0.00	0.00
Soil quality	10.00	12.50	6.00
Water quality	0.25	0.00	0.00
Biodiversity	1.55	-1.00	3.28
Environmental recovery	0.60	24.00	3.84
Environment impact index	1.07	2.59	-0.14

According to the interviewers, the researches on the peach palm, allowed the adoptions of proper agricultural practices that contributed to the soil quality improvement, for instance regarding the soil conservation practices. In fact, according to Bovi (1998), the peach palm as a perennial crop improves the soil physical properties, preventing soil erosion by means of its superficial fasciculate root system.

In general, there has been a positive environmental impact both in the North Coastal and the Ribeira river Valley region since the early implantation of the peach palm crop in the region,

whereas in the plateau region no effect was observed. In spite of the environment benefits, the local edaphoclimatic conditions led to a more intensive use of agrochemicals, as well as energy and water. This apparent paradox should be the object of further scientific investigation.

Concerning the social aspect, a positive impact was observed in all regions according to Table 3, which highlights the effective influence of the peach palm crop on the income generation for both local and surrounding communities, mainly in Ribeira river Valley region, where family agriculture predominates, in small rural properties.

Table 3. Indicators of social impact of the peach palm crop in North Coastal, Ribeira river Valley and in Plateau regions of São Paulo state, Brazil.

Tabela 3. Indicadores de impacto ambiental da cultura da pupunheira nas regiões litoral norte, Vale do Ribeira e planalto paulista, São Paulo, Brasil.

Indicator	Regions		
	North Coastal	Ribeira river Valley	Plateau
Capacitation	3.75	8.25	5.20
Local qualified employment opportunity	2.66	2.30	0.56
Employment offer and labor conditions	8.18	1.65	4.34
Employment quality	4.88	0.00	2.25
Income generation	10.00	15.00	5.00
Diversity of income sources	4.88	5.75	3.55

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continuation – Table 3  
 continuação – Tabela 3

Indicator	Regions		
	North Coastal	Ribeira river Valley	Plateau
Property value	3.38	1.25	1.85
Human and environmental Health	0.00	-1.20	0.00
Safety and Health at work	0.00	0.00	0.00
Food safety	3.60	12.60	5.76
Profile and dedication of person in charge	0.00	4.50	3.90
Marketing condition	5.05	5.30	3.37
Waste recycling	3.50	3.00	3.60
Inter-institutional relationship	3.50	11.50	4.70
Social impact index	3.66	4.66	3.15

In general the harvest is performed by skilled labor of the processing industry, according to the research recommendation. Due to the crop precocity first harvest can start two years after planting. The heart-of-palm price varies according to its quality and the type of the product, what is less advantageous to less technified farmers. Aiming to evaluate the environmental and social impacts of the research in all three regions, a new indicator of overall impact ( $IIA_g$ ), was calculated based on the regional indicators and on the opinion of the IAC researches involved concomitantly in all three regions. Global indexes for each impact assessed were calculated to assist in validating the social and environmental indexes, with and without including the IAC researchers' assessments, according to Figure 3.

With respect to the environmental indicators it was found that the indexes were higher mainly when using the weighted average, indicating a higher positive perception of the impacts by the other partners, mainly concerning the environment recovery. When analyzing the social impacts, most indicators were slightly higher, considering the view of the IAC researches,

with emphasis on the income generation. In general it is noted that there was no discrepancy between weighted and unweighted indicators for both impacts evaluated, reflecting in higher convergence on the researches benefits among all the partners. This type of evaluation can be useful to add higher consistency to the impacts, in contrast with the coordinator and partners' perception.

In all regions there was an improvement in the labor force skills, as well as an improvement in basic living conditions of the small farmers. Once the heart-of-palm, if not processed properly, can turn out to be very dangerous to human health, there was in all regions a positive impact on food safety, as far as the peach palm heart-of-palm is concerned. On the other hand, the search for information on the peach palm crop technicalities by farmers and extensionists at Instituto Agronômico, arising from the high performance of the peach palm as a heart-of-palm producer, has stimulated the researchers to carry out new regional experiments to improve the knowledge on the species, as well as to develop new technologies, both at the crop and the industry level.

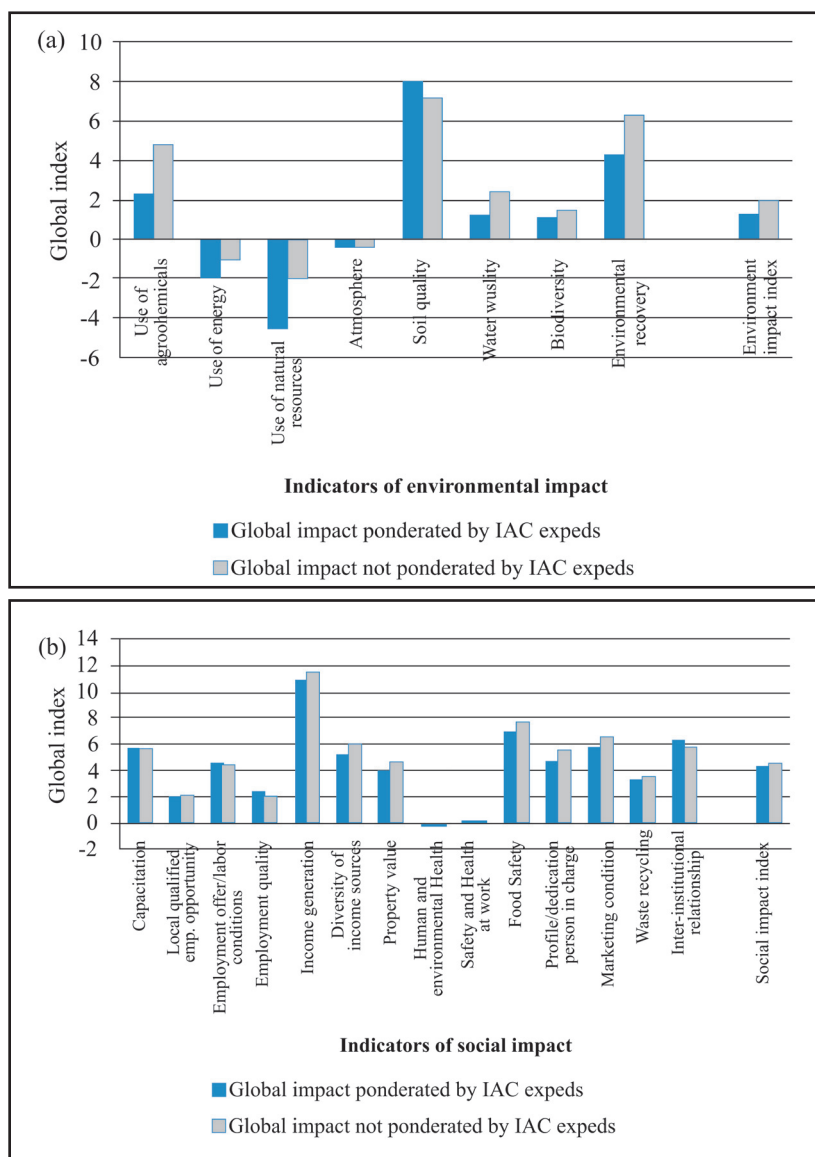


Figure 3. Global indexes of researches on the peach palm crop related to: (a) environmental impacts (b) social impacts.

Figura 3. Indicadores globais da pesquisa com pupunha relativos a: (a) impactos ambientais e (b) impactos sociais.

#### 4 CONCLUSIONS

One of the challenges of the agricultural research has been to make available technological solutions for the sector. Therefore the role of scientists is fundamental to determine the future direction of researches, often anticipating demands, providing new alternatives to face serious bottlenecks. When studying exotic perennial species long-term studies are required and despite the researchers efforts to speed up the process, it is difficult to achieve short-term results.

Concerning the peach palm crop for heart-of-palm production, introduced in the early 80ies new paradigms were established, leading to the opening of new agricultural labor, not only in regions under more suitable climate for the crop, but also with the expansion of new frontiers in marginal areas. Throughout the crop implantation, the development and adoption of proper technologies for the implementation of the peach palm crop consisted in the differential to consolidate the success of this agricultural alternative.

When analyzing the technical parameters of the crop, associated to higher soil erosion control, reduced soil compaction, rational use of chemical fertilizers and organic matter, higher awareness of the irrigation requirements in lower rainfall regions it is evident that there was meaningful aggregation of knowledge by farmers on the crop, which became an important sustainable agricultural innovation.

Although there have been differences among the North Coastal, the Ribeira river Valley and the plateau regions, the peach palm cultivation may be considered as an agricultural alternative in some regions of São Paulo State, environmentally sustainable, with good economic prospects and significant social importance.

From the socio-environmental indicators studied, it was concluded that, in North Coastal and Ribeira river Valley regions, within the Atlantic forest, where the native 'juçara palm' has already been threatened by extinction, as well as in some regions of the Plateau, where the peach palm is being grown, there was significant influence of the scientific research on the local dynamic. These results will propitiate therefore the expansion of the technology support to dissemination and development of an important option to the heart-of-palm production system.

## 5 ACKNOWLEDGEMENTS

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