Coffee Pulping Technology Impact over Economic Dimension*

T. FRONZAGLIA[1], C.L.R. VEGRO[2], A.A. VEIGA FILHO[3]

Embrapa Sede – Secretaria de Gestão e Estratégia, Brasília, DF
1Annalist at the Management and Strategy Secretary of EMBRAPA.
E-mail: Thomaz.Fronzaglia@embrapa.br
[2]Researcher at the Institute of Agricultural Economics - IEA/APTA.
E-mail: Celvegro@iea.sp.gov.br
[3]Researcher at the São Paulo State Agribusiness Technology Agency – APTA.
E-mail: Alceu@aptaregional.sp.gov.br
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SUMMARY

This study is on economic impact assessment of coffee pulper technology in the São Paulo State, Brazil, from the 1990s to 2006. This innovation is an alternative procedure for post-harvest preparation of no-washed Brazilian coffees, with relevant advantages on product quality to the point of substituting the Colombian and Central American washed coffees in the blends of largest global roasters. We used indicators on transaction cost, productivity and risk, and structural changes, disposed in a relevance tree of indicators, employing *IMPACTOS* software developed by *Elabora* at the *Universidade Estadual de Campinas*. Surveys were applied *in loco*, also with deep interviews for complementary information. We used Lieckert's scale, which was converted in the interval ranging from –1 to 1, for aggregating values from the bottom to the top of the impact hierarchy structure. Values were weighted and pondered according to impact component weight given and answers cohesion. The sample was regionally stratified. The economic impacts of the technology were positive, with satisfactory data consistence. Transaction costs were lowered, investments were fostered and risks diminished.

INTRODUCTION

We intended to evaluate the economic impacts of the cherry coffee pulping technology concerning a broad range of indicators to discriminate selected impacts for different regions and agents. Creation of new technologies designed for the increase of input productivity in agriculture and, consequently, for the agricultural sector competitiveness, is a permanent guideline of the R&D policy. In the coffee production, a technology that promotes decreasing harvest and post-harvest costs and the search for quality enhancement for better drink lead the recent history of the Brazilian coffee production to be divided in two periods: before and after the emergence of the preparation of peeled cherry coffee (PC). The impacts derived from this technology for coffee preparation, had reconfigured the coffee supply pattern in the different producing belts, removing from the exclusion, the previously considered disqualified areas for the production of high quality coffees. The PC is obtained by the means of an intermediate process between the two most traditional existing modes of coffee preparation: i) natural (dry process) and; ii) the pulped ones (humid process). In the PC preparation, the grains harvested felt into the ground are washed for separating the over ripen coffee (by floatation), rocks and

pieces of soil. After that, the green, the cherry coffee and the raisins, are submitted to the pulper: a spinning framework for removing the outer skin and pulp portions from the coffee cherries and raisins. It also separates the whole green grains from the cherry and raisin coffee beans[1]. The absence of defects green and black beans) in the peeled cherry coffee lots (substantially improves the flavor of the drink. As disadvantage we can mention the fresh water needed for the PC preparation. The cumulative technological improvement of the equipment (new generations) is gradually reducing the water need for preparation. Beyond the intrinsic advantage of attainment a high quality product, obtaining a premium price comparing to the best natural coffees, the PC preparation allows the cost reduction of yard drying (up to 40% of the volume being dried during the harvesting season) and storage cost reduction (once rinds and part of the mucilage had been removed). Also, the PC can dispense the refinement as a consequence of its beans' high homogeneity. Selected electronically, the PC grains show fewer losses up to 6% of the prepared volume, comparing to the selection percentage of the lots naturally prepared. The impact assessment of adoption the coffee pulping equipment is interesting for many agents in the coffee business. From farmers, roasters to consumers, and the governmental credit policy that financed these investments, benefit from the impact information, also the equipment manufacturers can make strategic use in their business, because the impact assessment supplies elements for product improvement, market planning and sales force training. The absence of consensus on the possibility and interest of coffee producers to invest in equipments capable to improve the product quality, lead **(**Carvalho, 2000) to survey 10 farmers that had adopted the preparation of PC throughout 2 years, concluding that: a) for all the situations the production cost had increased; b) only justifies the investment in PC preparation if the market pays off; c) quality of product is more related to cost and profitability; and d) coffee producers need training to apply quality concepts and to better sell their product in the market. The inquire **(**Oliveira et al., 2005) on the economic viability of the investment on coffee pulper in Pirajú, SP, Brazil concluded that profits only reached advantageous level in the case of premium price paid for the product surpassed 50% of the regional natural coffee market price. When analyzing the determinant factors of the PC adoption (Monte and Teixeira, 2006), in the Venda Nova do Imigrante, ES, Brazil, region, the variables: yield, associative organizations, equity capital and education level, had been the most important in the decision on the adoption of the technology by coffee producers. Regarding the education level of the coffee producer, the authors concluded that the probability to find pulper machinery among those with a bachelor degree was the double comparing to the ones with the lowest education level, denoting the prevalence of capital and education for the adoption of this technology.

METHOD

The choice of the State of São Paulo for impact assessment of the adoption of pulper technology for coffee cherry and raisin peeling is strategic because in this state the coffee production presents great diversity of social and economic profiles, from small family farm to the larger entrepreneurial ones, and from micro climates less favorable to extremely vacationed location for the production of high quality coffee. Differentiated profiles allow that, in the field survey, the diversity of situations was disclosed, revealing the discriminating power of the method and the impacts intensity of the innovation at each stratum. The survey of the economic dimension was part of a complete study that dealt with other four dimensions of impact: social, environmental, managerial and quality of grains and beans. In a

[1] After separation of the rinds each coffee bean still has a parchment at the surface of it, what is dried by sun exposition and mechanical driers. The difference between the washed traditional coffee from the peeled-cherry-coffee is that the first has clean parchment while the second has mucilage residues on it.

multidimensional structure, each dimension has no relation with the other, and in the specific case of this article we deal only with the economic one. Therefore, the amount of indicators and the survey with deep interviews including closed and opened questions restricted the possibility of working with large samples, given the deep character of the study. The sample was constituted by 13 PC adopting producers. The regions chosen were: Piraju, São Manuel, Franca and Espírito Santo do Pinhal. We used the software *IMPACTOS* developed by the company *Elabora* in partnership with *UNICAMP*, for the economic dimension subdivision, weighing, elaboration of questionnaires, interviews and data reporting. The ultimate components for operating the measurement of impact, as well as their orientation (O) of scales are related below (Table 1).

Table 1. Impact components for economic dimension.

Component	Description*	O
Contractual Level	Change for transactions with written contracts.	+
Bargain Power	Capacity of appropriation of profits from buyers and with better terms of transactions.	+
Forward Processing	Adoption of an added value strategy by the means of processing, roasting and packing.	+
Geographical Asset Specificity	Dependence of the geographical location and its physical characteristics, primarily the climate conditions for taking advantage of the peeled coffee technology (PC).	-
Physical Asset Specificity	Relative amount of permanent capital (of specific use and low liquidity) in total assets.	-
Human Asset Specificity	Investment necessary for training, contracting, rewarding and to keep specialized workers in the PC facility and management.	-
Reputation	Signaling reliance to the market: long term contracting with buyers, trademarks recognition by consumers, lower cost or less bonds for loans in the market.	+
Process Vulnerability	Interruptions in the functioning and variation of the effectiveness of the equipment, damages, easiness to repair, technique assistance, electricity power breakdowns	-
Breed diversity	Number of varieties chosen in terms of harvesting period distribution for facilities optimization.	+
Economic Risk	Variations on the expected return of the enterprise, regarding gross revenue, costs and margins.	-
Fertilizer	Variation of the productivity of the fertilizer used and its marginal contribution in total product.	+
Labor	Variation of the labor productivity and its marginal contribution in total product.	+
Investment	Variation of facilities and machinery capital invested.	+
Concentration	Number and market share of buyers.	-
Security	Change in the security level of the income expected from the farm.	+
Stability	Change in the stability of the income expected from the farm.	+
Distribution	Change in the time distribution of the income along the year.	+
Amount	Change in the sum of income from the farm.	+
Income Source Diversity	Changes in the income sources portfolio.	+
Investment in facilities	Improvements in the farm facilities with new resource allocation.	+
Natural Resources Conservation	Change in the conservation of natural resources practices.	+
Legal Compliance	Changes of conformity with the legislation in the agricultural property.	+
Collective Pulper Facility	Adoption of collective processing facilities (for PC) under collective management.	+
Minimum Size Requirement	Minimum size necessary to take advantages of scale economy.	+

**After the adoption of PC (peeled cherry coffee).*

Source: components, its description, questions and impact direction orientation were submitted for key personnel representing different actors from the coffee industry.

The criteria tree was previously weighted (k) for each indicator regarding the contribution of lower components to the upper in the multi-criteria tree. For impact intensity measurement, we used questionnaires with Lieckert's scale converted into the interval (from - 1 to 1) for the purpose of aggregation, in which negative results means negative impact. The aggregation process balance the results from the bottom to the top of the criteria tree, regarding the convergence of the answers in each indicator (analyzing the frequency distributions the software calculates a measure of cohesion among interviewees). For analyzing the economic impact, we defined a limit for answers cohesion (z) in each stratum or sample, Z=0.75 as a minimum tolerance level for ambiguity, in which the best measure is given by the stratum in which $Z \geq 0.75$ and not by the aggregated result of the assessment. We asked for complementary qualitative information during the interviews, as support for the impact assessment explanation, regarding its intensity and stratification, and the interpretation and confirmation of each answer. A coefficient (α) for technology impact attribution for each component was answered in the survey, what allows isolating its contribution from the intervenient or exogenous contributions in the context of change, therefore consists the interviewee technology impact's attribution perception. Thus, we have the general context impact (IG) and its data cohesion ($Z(x)$); technology attribution for the impact (IPC) and its data cohesion ($Z(\alpha)$); and impacts from other causes (IOC). Hence, ICD + IOC = IG. Regarding cohesions (z) and weighs (k) for each component we got the resulting aggregated impact of the economic dimension (Furtado et al., 2003).

RESULTS

The impact over economic dimension, after the introduction of the coffee cherry pulper technology was analyzed focusing three main components: "Transaction costs", "Productivity and risk" and "Structural change". The results from the aggregation of these three macro-components presented IG = 0.13 (IPC = 0.07 and IOC = 0.06), showing that besides of an economic positive change at the general context, in which the technology was adopted, there is positive economic impact strictly related to the adoption of the technology. The $Z(\alpha)$ was above the tolerance limit being satisfactory ($Z\alpha = 0.79$), resulting from good convergence of answers among many interviewees. There were high "Adherence of the General Impact Structure" designed for this assessment as Z = 0.96, although with less "Adherence of the Technology"[2] impact structure and the "Components Activation" (Table 2). Partial analysis of components reveals that "Transaction Costs", IG = 0.11 (IPC = 0.08 and IOC = 0.03), were reduced after PC adoption. This component is formed by subcomponents: "Market Dependence"; "Contractual Level"; "Geographical Asset Specificity"; "Physical Asset Specificity"; "Human Asset Specificity" and "Reputation". For this group of components we observed three patterns: positive impact for the subcomponents "Market Dependence" and "Reputation"; null impact for "Contractual Level" and "Geographical Asset Specificity", and negative for "Physical Assets" and "Human Assets" Specificities. "Reputation", IPC = 0.62 and $Z\alpha = 0.75$, confirms that when a coffee producer became specialty coffee producer there is an improvement of his image at the market, primarily allowing more recognized insertion at the quality contests. Indirectly, there is an important effect over the regional reputation, which earns merit not only nationally but internationally[3]. With the process of roasted coffee trademarks segmentation, with the increased high quality and gourmet coffee supply, the roasters increased the procurement steadily for peeled cherry coffee, allowing an easier direct sell by coffee farmers. The interviewees said that it is been common to receive visiting from

[2] The "Technology Adherence" refers to the portion of components that had IPC with any kind of impact, in relation to the components that had none. It represents how much the components tree has the power for revealing the technology impact attribution in the general context.

[3] This was the case of regions as Piraju, SP; Zona da Mata, MG and Cornélio Procópio, PR.

buyers in the property searching for PC, or yet buyers requiring the future productions' reservation. It is according to the economic assumption that certainty about the product uniformity, higher frequency of transactions, and higher reputation develops routines of transaction cost reduction.

Table 2. Economic impact for peeled-cherry-coffee technology impact assessment in São Paulo, 2006.

Impact Components	k	IG	IPC	IOC	Zx	Zα
ECONOMIC IMPACT		**.13**	**.07**	**.06**	0.71	0.79
Transaction Costs	.15	**.11**	**.08**	**.03**	-	-
Market Dependence	.30	.33	.21	.12	-	-
Bargain Power	.50	.67	.42	.25	0.75	0.75
Forward Processing	.50	.00	.00	.00	0.75	0.75
Contractual Level	.10	.00	.00	.00	0.75	0.75
Geographical Asset Specificity	.10	.00	.00	.00	0.75	1.00
Physical Asset Specificity	.10	-.48	-.37	-.10	1.00	1.00
Human Asset Specificity	.10	-.28	-.21	-.07	0.25	0.75
Reputation	.10	.62	.62	.00	1.00	0.75
Productivity Variation and Risk	.70	**.13**	**.06**	**.06**	-	-
Risk	.40	.03	-.06	.06	-	-
Production Risk	.50	.20	.00	.20	-	-
Process Vulnerability	.60	-.11	-.05	-.05	0.25	0.75
Breed Diversity	.40	.67	.08	.58	0.75	0.75
Economic Risk	.50	-.15	-.11	-.04	0.25	0.75
Partial Input Productivity	.60	.19	.14	.05	-	-
Fertilizers	.33	.00	.00	.00	0.75	1.00
Labor	.33	.08	.05	.03	0.50	0.75
Investment	.33	.50	.38	.12	1.00	0.75
Structural Changes	.15	**.20**	**.10**	**.09**	-	-
Market Structure	.80	.25	.13	.12	-	-
Appropriation	.70	.26	.17	.10	-	-
Income generation	.60	.28	.17	.11	-	-
Security	.20	.17	.05	.12	0.75	1.00
Stability	.15	.17	.00	.17	1.00	0.75
Distribution	.15	.12	.07	.04	0.25	0.75
Amount	.50	.40	.30	.10	1.00	0.75
Property Value	.60	.32	.21	.11	-	-
Investment in Facilities	.50	.55	.41	.14	1.00	0.75
Nat. Resource Conserv.	.30	.14	.00	.14	1.00	0.75
Law Compliance	.20	.00	.00	.00	0.75	0.75
Income Sources Diversity	.10	.00	.00	.00	0.75	0.75
Concentration	.10	-.04	-.02	-.01	0.25	0.75
Collective Pulper Facility	.20	.33	.08	.25	0.75	0.75
Minimum Size Required	.20	.00	.00	.00	0.75	0.75
Impact Structure Adherence	0.96					
Technology Adherence	0.41					
Components Activation	0.56					
Source: research results applying software *IMPACTOS*.						

The investment in specific facilities and machinery for the preparation of CP was as expected, although, with negative contribution for the subcomponent "Physical Asset Specificity", IPC = -0.37. Depending on the producer size, the investment in machinery can reach very high money amount. Also, the "Human Asset Specificity", IPC = -0.21 was negative, due to the need for the introduction of training routines of the operations personnel with a significant increase on their wages. This specificity was higher as higher the investment and producer professionalization, revealed in Franca and Pinhal regions, therefore, there were increase in human capital in these regions, where was supposed the lesser interest or benefits for this technology regarding climate local conditions. It refutes the fundamental premise on region exclusion for technology promotion with governmental credit policy, as occurred in the FEAP/BANAGRO program in São Paulo State. The second component family "Productivity Variation and Risk", received the higher weigh in the impact tree, because it has the major importance among its peer components of the economic impact (k = 0.70). It accounted for < IG = 0.13 and IPC = 0.06, it means, the productivity gains, specially, from the input productivity increase of "Investment", IPC=0.38, which more than compensate negative results from "Economic Risk", IPC = -0.11 and from "Process Vulnerability", IPC = -0.05. The "Partial Input Productivity", IPC = 0.14, is in fact, a consequence of the pulper introduction at the coffee preparation facility. Actually, by segregating different coffee ripeness types (over ripped; green; cherry and/or raisin peeled), it optimizes operations at the yard and at the dryer. The increase in "Economic Risk" is due to the conjunction of the higher investment level and the higher cost for a product that besides receiving a premium price, follow the same volatile referential of natural coffee prices in the market and exhibits a relative concentration of buyers. Therefore, while the green coffee can find innumerous market channels, the PC is a differentiated product and the market volatility can incur losses to the producer. The exiguous marketing period of PC concurred with the end of harvest season sales, what coincides with the period of lower prices, influencing sales revenue. Situations when the producer can not wait for better terms of transaction, due to the need for generating cash flow, there were occasions that, when not finding a buyer for the PC, they were obligated to sell it as natural coffee if it starts downgrading. In the group of components "Structural Changes", its aggregation resulted IPC = 0.10. The component "Market Structure" had a positive contribution, IPC = 0.13 due to the entrance of new gourmet coffee buyers. In the general analysis, the subcomponent with the higher impact was "Investment in Facilities", IPC = 0.41, followed by the increase of "Amount" of income generated, IPC = 0.30. Certainly, the rebuild of the preparation facility for setting the pulper machinery, contributed for the increase in productivity in this step of production process. Regarding the "Amount", it was said that the regional prices were generally higher for all grades, due to the PC reputation, what increased the total revenue. In reality, the whole item "Income Generation at the Property" (composed by "Security", "Stability", "Distribution" and "Amount") was positively evaluated, IPC = 0.17. As direct result of the relevant impact derived from "Investment in Facilities", occurred positive impact in the "Property Value", IPC = 0.21.

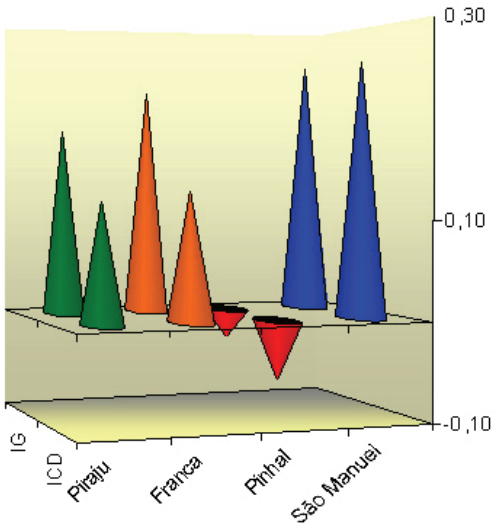

Figure 1. Economic impact of peeled cherry coffee technology, by region, in SP, 2006. Source: Research data and use of software *IMPACTOS*.

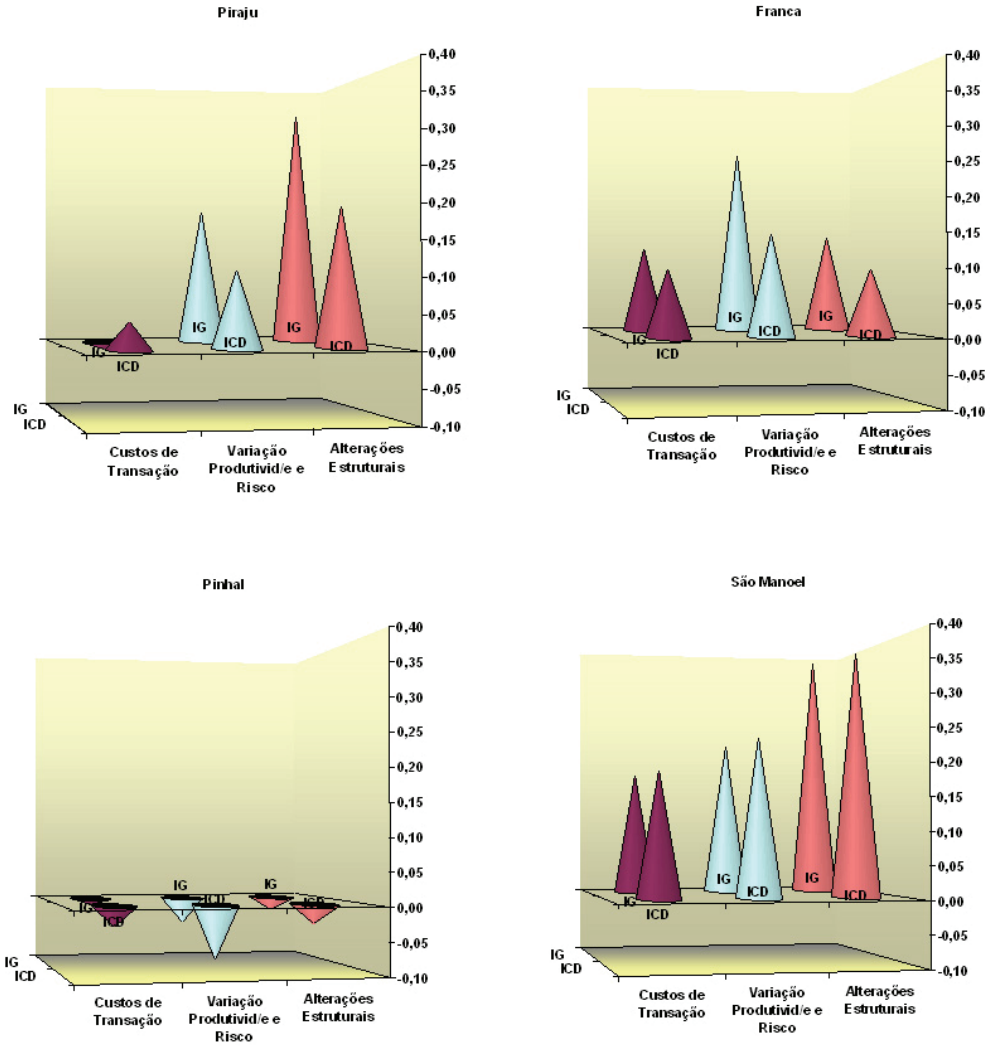

Figure 2. Macro-components for coffee pulping economic impact, selected regions of São Paulo, 2006. Source: Research results applying software *IMPACTOS*.

Concerning the regional analysis, we observed that the higher impact occurred the São Manuel region, IPC = 0.23 (Figure 1). In his region, there were coffee producers that were implementing added value strategies by the means of laughing trademarks of roasted and milled for gourmet espresso drink. Additionally, contrary to other regions, in São Manuel, the coffee producers also perceived a diminishing on the "Economic Risk", IPC = 0.67. This can explain the dismantlement of the coffee producers' local cooperative, what caused the disorganization of the marketing operations, although preserving the larger CP producers, because they weren't exclusively dependent on the cooperative for marketing their produce. The economic impact at Franca and Piraju regions was positive, IPC = 0.13 and 0.12 respectively, above the total aggregate, IPC = 0.07, that includes all four surveyed regions. Contrary to the expected, in Pinhal, the place where the innovation was early turned viable, in the beginning of 1990 years, the impact of the economic dimension was negative, IPC = -0.06. Possibly, coffee producers from Pinhal, who adopted PC, demand training and a more structured network of technology users for benefiting from the machinery (Figure 2). The regional analysis of the impact components "Transaction Cost", "Variation of Productivity and Risk" and "Structural Changes", reveals other relevant discrepancies among regions. The decrease of "Transaction Cost" was more important at regions of Franca and São Manuel. In Franca, the already recognized excellence of the naturally prepared coffee contributes to the PC quality in that location, promptly, considered by buyers as unique, increasing "Reputation".

In São Manuel, as already mentioned, the larger coffee producers who adopted PC went out of the local cooperative, because the spot market transaction costs became lower. In Pinhal, the absent of buyers that routinely demand the PC can answer for the negative evaluation of "Transaction Cost". In fact, there was PC being sold at natural coffee prices what occurred very often among these coffee producers. In this sense, the local cooperative could have a better price policy for better coffee once it already has a gourmet coffee trademark. In the subcomponent "Variation of Productivity and Risk", Piraju, Franca and São Manuel regions showed relevant and positive impacts. In the "Risk" component, the coffee producers from Piraju and São Manuel reported positive impacts, while in Franca, the impact was negative, essentially due to the "Economic Risk", IPC = -0.61. Apparently, the coffee producers that prepared CP in Franca expected difficulties to sell their product, or yet, to experience lower prices periods, enough to turn difficult to pay the mortgage of the sunken investment. In general, they are larger entrepreneurial farmers regarding other regions surveyed. This characteristic exposes them much more to the economic risk. In Pinhal, the assessment of "Productive Risk" and "Economic Risk" exhibited negative results for the IPC = -0.08 and -0.25, respectively. These results correspond to coffee producers' perception about their inability to internalize economic advantages from the technology adoption. Apparently, coffee farmers from Pinhal, inclusive the specialized in gourmet coffee production, perceived better profit opportunities in eucalyptus, comparing to the investment in the modernization of post-harvest facilities for peeled cherry coffee.

When considering "Structural Changes", for Piraju, Franca and São Manuel, it exhibits positive variations for the IPC, while in Pinhal the opposite occurs. The subcomponent "Income Generation" was positive due to "Amount", in the regions were the coffee was poorly graded, particularly, Piraju and São Manuel, ICD = 0.23 and 0.41, respectively. In Franca, as expected due to the superior natural coffee quality, the impact over the "Income Generation" was lower, ICD = 0.18. In Pinhal, contrary to other regions, the impact over the income was null for all subcomponents. The "Property Value" was benefited by the technology adoption, in Piraju, ICD = 0.24, Franca, ICD = 0.24, and São Manuel, ICD = 0.28. It happened because the "Investments' in Facilities" weigh k = 0.50 and ICD = 0.41. In Pinhal, "Property Value" was modestly positive, ICD = 0.02. Therefore, among these Pinhal's

producers, not even the possibility for mortgaging and rewarding the investment sunk at the peeled-cherry-coffee preparation facility was perceived for increasing property value.

CONCLUSIONS

Main factors as size of the farm, climate conditions and credit policy have important role in the adoption of this technology, also in its economic impacts. The study pointed positive changes in the general context for the components and agents surveyed. What strongly contributed for these changes was the peeled-cherry-coffee technology adoption. Among 24 impact components, only 5 exhibited negative impact. It increased bargain power, reduced transaction costs, increased investments in facilities but also economic risk. We refute the premise on region exclusion for technology diffusion with public credit policy, revealing qualified employment and investment in human capital impacts. It also reaffirms the role of co-operatives for small producers.

REFERENCES

Carvalho G.A. (2000) Qualidade como fator de competitividade para a cafeicultura. In: Anais do I Simpósio de Pesquisa dos Cafés do Brasil – resumos expandidos. Poços de Caldas/MG, set., pp. 354-356.

Furtado A.T. et al. (2003) Políticas Públicas para a Inovação Tecnológica na Agricultura de São Paulo: métodos para avaliação de impactos de Pesquisa**.** Relatório Final de Atividades. Programa de Políticas Públicas. Campinas, FAPESP, 233p.

Monte E.Z. and Teixeira E.C. (2006) Determinantes da adoção da tecnologia de despolpamento na cafeicultura. Revista de Economia e Sociologia Rural. SOBER, vol. 44, n. 02 abr./jun., pp. 201-127.

Oliveira M.D.M. et al. (2005) "Análise de Retorno dos Investimentos em Equipamentos para Produção de Café Cereja Descascado: estudo de caso" In: Anais do XLIII Congresso da Sociedade Brasileira de Economia e Sociologia Rural. Ribeirão Preto/SP.