COMPARATIVE ANALYSIS OF SYSTEMS FOR ASSESSING REGIONAL IMPACTS OF INNOVATIONS APPLIED TO COFFEE PRODUCTION

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The importance of education, research and extension institutions can be evaluated from the socio-economic impacts of their investments, capacity building and training of human resources, services rendered to the community and innovations resulting from their research. The knowledge and technologies generated in these institutions need to be transferred to the respective supply chains and increasingly used, to contribute in its development and environmental preservation. The dimension of their regional impacts is relevant to the strengthening of research institutions and to evaluate and update the guidelines of their programs. In Brazil there are few studies in this area and most of them are linked to the analysis of the role of universities in the growth of the regions where they are located. The evaluation of the environmental, social and economic impacts is even less significant, and emerged from the concept of sustainable development. In Brazil, progress in this area are derived primarily from studies of the Brazilian Agricultural Research Corporation (Embrapa) and from the State University of Campinas (Unicamp), who developed the systems known respectively by Ambitec and ESAC, which in this study on coffee production in Brazil, held by the Agronomic Institute (IAC), are compared mainly from their scope, complexity and cost of implementation. Both consist of the ex-post analysis of the impacts of a particular technology and are built based on criteria and indicators. Their application indicated that the ESAC system involves more complex software, and quantitative aspects more sophisticated than the Ambitec, and its use requires more intensive training of staff than Ambitec. A major difficulty of the analysis of impact assessments is to isolate the individual effects of technologies, effects resulting from their interactions with technologies developed by other R & D institutions, or even imported. The ability of the researcher to apply the questionnaires may reduce this problem. But the system ESAC presents an important advantage over the Ambitec because it considers two very important aspects for the analysis of impacts: the impacts resulting from the interactions between different technologies and the time elapsed between the development of technology and its adoption by the productive sector.

Keywords: Impacts of technologies; Sustainable development; Regional development.

INTRODUCTION

The importance of education, research and extension institutions (R, D & I), can be evaluated from the socio-economic impacts of their investments, capacity building and training of human resources, services rendered to the community and innovations resulting from their research. The knowledge and technologies generated in these institutions need to be transferred to the respective supply chains and increasingly used, to contribute in its development and environmental preservation. The dimension of the regional impacts of those technologies is relevant to the strengthening of research institutions and to evaluate and update the guidelines of their programs.

However, part of the knowledge and technologies generated in the institutions of R D & R is not available or transferred to society, or the transfer occurs through mechanisms that reduce the potential for achieving positive results for society and the institution that generated them. Some authors showed that many solutions to the technological demands of coffee production in the State of São Paulo, Brazil, were available in universities and other R D & I institutions [3].

The concern with the impact assessment of new knowledge began in the second half of the twentieth century, with increased investment in research, thematic range and importance now being given to technological innovation. Initially, evaluations of agricultural research were restricted to the economic aspect and from the 1960s have become increasingly frequent. Some studies used the approach of the production function and involved estimates of the marginal productivity of research [7-4]. Others used the cost-benefit analysis to measure the average productivity of research based on an estimate of the economic surplus resulting from the adoption of new technologies. Griliches [7] emphasized that the evaluation of the economic benefits of research activity is a complex task, because its final product, knowledge, can result in different impacts, many of them resulting in units hardly measurable. In that same decade, were performed the first evaluations of environmental and social impacts, initially used separately from assessments of economic impacts.

In 1962, Rachel Carson published a book on the effects of pesticides on the environment - "Silent Spring" - one of the most influential warnings about environmental degradation [11]. In 1969 the Environmental Impact Assessment (EIA) was formally adopted by Sweden, and in the 1970s it began to be adopted in the USA, Canada, Australia, Malaysia,

and France and later in other countries. Gradually the social aspects began to be added to the Environmental Impact Assessments. In the U.S. the Social Impact Assessment was legally incorporated in the EIA by the National Environmental Policy Act (NEPA) in 1970. This Act created a routine activity in many U.S. state governments, as well as in other countries [10]. In 1986 the World Bank included assessments of environmental and social impact in their procedures for evaluating projects.

The assessment of environmental and social impacts continued to be not significant in agricultural research until the 1990s. The need to jointly assess economic, social and environmental emerged from the concept of sustainable development. Most of the programs to evaluate impacts on agriculture are associated with assessing sustainable agricultural and non-chain specific technologies. Examples, the "National Collaborative Project on Indicators for Sustainable Agriculture" (NCPISA), in Australia, released in 1995 [17], the "European Union Concerted Action Project on Environmental Indicators for Sustainable Agriculture" (ELISA), implemented in Europe in 1999 [21], the "Committee on Sustainability Assessment" (COSA) and "Response Inducing Sustainability Evaluation" (RISE), the Swiss College of Agriculture, 2006 [8]. The base models of monitoring is the identification and classification of the indicators incorporated into.

Much of the progress made in Brazil with respect to impact assessment results of the work of the Brazilian Agricultural Research Corporation (Embrapa), whose main product is the reference method for evaluation of economic, social and environmental research [1-2] , which includes the assessment of impacts on knowledge, training, and political-institutional scenario. That is, the Ambitec is a part of the reference impact assessment of technologies.

The ESAC – name originated from the dimensions assessed by the system: economic, social, environmental and training – was developed by researchers at the University of Campinas / UNICAMP [16], and uses an approach based on advanced methods (multicriteria), from the decomposition of all parts. In Brazil, some authors analyzed the social return to investment in research on coffee plantations, for example in the period 1944-75, to evaluate the efficiency of allocation of public resources in research and technical assistance [5]. A recent example is the "Evaluation of the Circuit of Coffee Culture in the South and Southwest of the State of Minas Gerais", a program to monitor the use of technology diffusion [15]. Another example is the study of the effects of technological change promoted by the Brazilian Consortium for Coffee Research and Development – CBP & D /

Coffee [12], which showed positive impacts on the coffee economy. This analysis used temporal approach, observing changes in the production and marketing of coffee in the aggregate with the creation of CBP & D / Coffee. In 2010 this Consortium began initial individual assessments of social and environmental impacts of coffee research. To assess the impacts of shelled coffee technology, was used a multidimensional methodology, with support of the software IMPACT, to evaluate the economic, social, environmental, management and quality aspects [18, 19, 20], using indicators arranged in a tree of relevance .

Background and objectives

The technologies of the *Instituto Agronômico* / IAC (Agronomic Institute), apparently generated impacts on the Brazilian agribusiness. It is intended to quantify the impact of these technologies, using a tool that makes it possible to produce a solid understanding of the contribution of scaling (IAC) for the development of the main coffee regions of Brazil, since its founding in 1887 until 2011.

Once in Brazil advances in this area are derived primarily from studies of the *Empresa Brasileira de Pesquisa Agropecuária* / Embrapa (Brazilian Agricultural Research Corporation) and the *Universidade Estadual de Campinas* / Unicamp (State University of Campinas), who developed the systems respectively Ambitec and ESAC, we intend to compare these two methods mainly as its composition, scope, complexity and cost of implementation, comparing their advantages and disadvantages, to support the selection and application of the methodology to be used in the study regarding the impact of the Agricultural Institute in the development of Brazilian coffee regions. As there are many technologies developed by the IAC for the coffee sector, which should be analyzed, it is possible that the ESAC and Agro-Ambitec are indicated for different situations.

The models have different assumptions and are used according to its explanatory power against the phenomenon we are attempting to investigate. The choice of method to use is an accessory that would allow developments relevant to team members, institutions involved, as well as to other researchers and institutions that may be faced with the need to use similar methods in analyzes of impacts of technological innovations.

METODOLOGY

1. Characterization of the impact assessment systems Ambitec and ESAC, mainly for the following characteristics: dimensions that can be assessed, kinds of indicators and means of selection of these indicators, weighting, systems measurement of impacts, the possibility of parameterization of the system, form of presentation of results, recommended size of the sample size and complexity of the questionnaires, time and cost of the questionnaires.

2. Comparison of these two methodologies, from three experiments of the authors regarding their applications in the field, to assess the environmental and socioeconomic impacts of different technologies used in the production chain of arabica coffee (*Coffea arabica*):

• Evaluation of economic and environmental impacts of the technology of shelled coffee (CD), developed by the Agronomic Institute (IAC), through the application of ESAC (IMPACT software) in coffee farms in the State of São Paulo, Brazil, in 2006;

• Assessment of the impacts of four cultivars resistant to diseases and pests developed by IAC (Tupi IAC 1669-33, Tupi RN, Obatã IAC 1669-20 and Apoatã IAC 2258 – rootstock), through the application of the system Ambitec on coffee farms the main producing regions of Brazil, in April and May 2011, and

• Assessment of the impacts of technology "coffee forest" or "agro-ecological farming system," from the application of Ambitec in properties located in areas of rural settlement in the region of Pontal do Paranapanema, Western State of Sao Paulo, Brazil in March 2012.

3. Summary of applicability identified for each of the methodologies and recommendations concerning the possibilities of their use in the case of assessing the impact of a large set of technologies developed and diffused throughout an institutional trajectory.

Overview of Ambitec System

Ambitec System consists of the ex-post analysis of the impacts of technology, to the extent that it is being conducted after the completion of the research that prompted it. Every aspect of the assessment is covered by a specific methodology. Socioeconomic aspects are evaluated by the Evaluation System of Social Impact of Technological Innovations

Agricultural (Ambitec-Social) and environmental impact assessment system through the Environmental Impact Assessment of Agricultural Technology Innovations (Ambitec-Agro). Together they make up the system Ambitec [9]. Within the Ambitec-Agro, which assesses the environmental aspect, there is Ambitec-Agriculture, Ambitec Animal-Production and Ambitec-Agroindustry. All three are adaptations to environmental assessment of the different segments [2]. The Ambitec is complemented by the Cost Benefit Analysis in the economic dimension, and the generation of jobs in the social aspect. The Ambitec would be the part of the qualitative impact assessment [2].

This system is commonly used in the centers of Embrapa [2-9-13-14]. The Consortium Research Café (CBP & D-Coffee) has encouraged its use in the coffee sector, so the results obtained using this methodology can be compared to those obtained by other Brazilian institutions, for their respective technologies coffee, because currently the CBP & D-Coffee embraces about 50 institutions of RD & I.

Ambitec System consists of spreadsheets that consider the contribution of the various aspects of a particular technological innovation for environmental improvement, depending on the agribusiness segment under evaluation. Each of these aspects comprises a set of weighting matrices arranged in automated. The components of the indicators are rated with coefficients change as personal knowledge of the adopter / guardian of the technology. The application of the system involves an interview / survey conducted by the user of the system and applied to the adopter / responsible for the activity of agribusiness. The interview aims to obtain the coefficient of change of the component, for each of the indicators of impact, as rated by the adoptive / guardian, specifically as a result of application of technology to the activity in the current situation.

The insertion of the coefficients of change, the component directly in the arrays, and sequentially in spreadsheets, automatically results in the expression of the coefficient of the impact of technology, relativized by weighting factors due to the scale of the occurrence of the change and the weight of the component in the composition the indicator. The results are expressed graphically in the spreadsheet "AIA Technology", after the automatic weighting coefficients of change collected data by weighting factors. In the case of Social Ambitec-AIS is the spreadsheet. In summary, the system involves three steps [9]:

• Collection of general information about the technology, including scope (breadth and influence), geographical area and population of adopters (definition of the sample of adopters);

• Application of questionnaires on individual interviews with adopters and insertion of selected data on impact indicators in spreadsheets components of the platform (MS-Excel □), obtaining quantitative results and impacts of partial indexes and aggregate environmental impact of the selected technology ;

• Analysis and interpretation of indices and indication of alternative management practices or technologies to minimize negative impacts and enhance positive ones, contributing to local sustainable development.

The Ambitec-Agro consists of the following criteria (and indicators) for assessment of environmental impacts: the use of inputs and resources (inputs and resources, veterinary inputs and raw materials, energy) and environmental quality (air, soil quality, quality water, biodiversity, environmental remediation). To assess the socioeconomic impacts, in this case the Ambitec- Social, the following criteria and indicators are used: respect for the consumer (product quality, ethical production), employment (training, local employment opportunity and qualified, offer and working conditions, quality of employment), income (income generation of the establishment, diversity of sources of income, value of the property), health (personal and environmental health, occupational health and safety, food safety), management and administration (dedication, and profile of the head, condition of marketing, disposal of waste, institutional relationship).

The evaluation procedure is to ask the adopter / tech responsible for indicating the direction (increase, decrease, or remain unchanged) the coefficients of the components of change for each indicator, due to the specific application of technology to the activity and conditions management for their particular situation. The evaluator informs the adoptive / guardian the aspects and impacts indicators, and survey the unit under evaluation in order to ascertain the quality of the information. The result of the evaluation depends on the coefficients of the components change, just the subjectivity in its attainment should be reduced by rigorous standardization of the coefficients on the one hand, and his interpretation of another. This standardization is done in two steps: 1) selection and precise formulation of the components and indicators, and 2) delimitation and definition of these components, the

technological context. The automatic matrices include weighting factors relating to the importance of the component for the formation of scale and the geographic indicator of the occurrence of the change in the component.

The sum of the weighting is equal to one (1) and varies with the number of components of a given indicator constituting normalization factor as defined in test sensitivity. Since the total amount of all components equal to one (1), the importance of each may be modified to better reflect situations in which certain components must be emphasized. Therefore, in this study the weights of the original system will be reviewed, with contributions from other research institutions (which signed the Brazilian Consortium for Coffee Research and Development), and amended as necessary to adequately represent the reality sector.

The scale of the event explains the space in which the change takes place in the component of the indicator, depending on the specific situation of technology application and can be: 1) Spot: the effects of technology are restricted to the place of its occurrence or production unit in which the change is occurring, 2) Local: the effects are felt externally to the production unit, but confined within the boundaries of the property assessment, and 3) In the surroundings: the effects are felt beyond the boundaries of the property. Due to the highly localized characteristic of some components of indicators, some matrices limit the scope off the occurrence, for example, the use of fertilizers. The weighting factors for the scale of occurrence can not be modified by the user and expresses a value proportionally greater when technology affects an area or an environment that goes beyond the limit of the business unit.

The use of spreadsheets of Ambitec System is simple, flexible and user can adapt them to specific situations [9]. In the environmental dimension, the method provides measures of the contribution of agricultural technology for sustainable local development. The system allows active participation of the producers or responsible and serves for the communication and storage of information on environmental impacts. The computing platform is widely available, subject to distribution and use at low cost and allows the direct release of printed reports and easy to handle. The graphical presentation of results of environmental performance of technological innovation for each individual indicator provides a diagnostic for the producer or director, pointing to the situation in accordance with environmental standards in every aspect of the impact of technology in terms of the establishment. The graphics of the aggregated results for the different dimensions provide an overview of the

contributions, positive or negative, of technology for sustainable site development, facilitating the definition of measures to promote or control the activity within the community and provide an accurate unit measurement of impact.

As the sample size will depend on the universe of adopters, it will be defined during the study, after the identification of the scope, geographical area and population of adopters of each technology to be analyzed. The tests are applied in situ, in regions where the technologies are used.

Overview of ESAC System

The conceptual basis of the model [6-16] were developed from the application of the methodology to programs of cane sugar and citrus of the IAC, from a study funded by FAPESP and FINEP in the early 2000s. The methodology considers, with the same level of relevance, impact of four dimensions: economic, social, environmental and training and uses multicriteria evaluation methods (MADM), which allow modeling a complex problem in a shared language and multiple analyzes.

This model has been used to evaluate impacts of programs for human resources training, and development and innovation, funded by the *Fundação de Amparo à Pesquisa do Estado de São Paulo* / Fapesp (Foundation for Research Support of São Paulo State).

Vegro, Fronzaglia and Veiga Filho [20] used this method in evaluating the economic impacts of shelled coffee technology in four cities in the São Paulo state, with a sample of 15 farmers. The authors found that the volume of indicators and the depth and scope of the survey, conducted through interviews with both open and closed questions, restricts the possibility of working with large samples. The dimensions used in the studies Vegro et al. [18/01/20] were: Management, Economic, Social, Environmental and Quality (GESAQ). The environmental dimension has been described in Vegro et al. [19].

The ESAC is also based on indicators. To them hierarchically, creating questionnaires, collect, organize, tabulate and generate tables with statistical results, we use the IMPACT software, developed by the company elaborates, when incubated at the *Universidade Estadual de Campinas* / Unicamp (State University of Campinas). Each component is assigned a weight (k) as a function of the perception of experts during the validation of the questionnaire and impact components. For data collection, we use questionnaires with closed questions for

all components of impact with Lieckert scale, which are converted by software in the interval [-1, 1] allowing the comparison of measured (x) between the components of impact. It is used a measure of the frequency distribution of the responses (z) to determine a limit of its cohesion, to enable the component parts of the tree. For the analysis of economic impact, we seek to obey the limit of cohesion of the sample. Vegro, Fronzaglia and Veiga Filho [20] used $Z = 0.75$ as the level of tolerance for ambiguity. In such cases, the best measure of impact is given by the strata in which $Z \geq 0.75$, and not the aggregate result of the evaluation. As support for the critical evaluation of the impact measures are used complementary qualitative information obtained during the interviews. To deal with the interference, we use the coefficient of participation of the technology (α) which allows isolating of the causal effect of technology change in the general context for a particular component. The decomposition is performed by the impacts of the overall impacts (IG) and its cohesion Z x; impacts of technology (ICD) and the cohesion of the Z, and impacts resulting from other causes (IOC). The sum of ICD and IOC corresponds to IG, the weighted cohesions and the weights of the components of impact (k). Thus, one arrives at the final aggregated impact of the analyzed dimension [6].

The IMPACT software enables the registration of components impact on each dimension. For each component, the tool lets you create customized scales for responses (order, number of elements, description labels, according to the type of scale), and the definition of questions of the questionnaire for each component of impact, with a form for notes information for each interviewee response, useful for comparing the explanation of the impact on each respondent. The tool is designed primarily to handle large volumes of data, performing the automatic calculation of the convergence of responses and activation of components when there is convergence to the analysis of aggregate results. It also allows the simultaneous completion of several questionnaires through the Internet, either by the interviewer or the respondent previously registered, storing the data on a server.

The ESAC consider two very important aspects for the analysis of impacts: the impacts resulting from the interactions between different technologies and the time elapsed between the development of technology and its adoption by the productive sector. Moreover, the theoretical and methodological foundations of this model, involving studies such as those of de Janvry and Sadoulet (1995).

RESULTS

Applicability of the systems Ambitec and ESAC

Table 1 shows the main similarities and differences between the systems Ambitec and ESAC, from their applications to evaluate the environmental and socioeconomic impacts of different technologies used in the coffee production chain: a) adoption of the technology of shelled coffee (CD), developed by IAC, 2) cultivation of varieties of arabica coffee, resistant to pests and diseases, developed by IAC (Tupi IAC 1669-33, Tupi RN, Obatã IAC 1669-20 and Apoatã IAC 2258 – rootstock), and 3) cultivation of the coffee agroecosystem or agroforestry. The sample for each of the three assessments was defined according to the recommendations of the system used: ESAC in assessing the impacts of the CD and Ambitec for evaluation of cultivars resistant to pests and diseases and agroforestry cropping system.

Since we want to apply these methods to the study of impact assessment of the technological innovations of the IAC, developed for the coffee sector, with the objective of evaluating the impact of the IAC in the development of Brazilian coffee regions, i.e., an ex-post the application of either method should be made of the time period between the development of technology and the interview, i.e., a time after the introduction of technology to impacts can be observed. In the case of two methods, one can establish a time period preceding the end of the interview, when it desires to establish a specific period.

Regarding the assessment of impacts of innovations, both methods do not provide your treatment together, i.e., each dimension is treated independently. Their results are not combined.

In the case of ESAC, this is a concept adopted to prevent the evaluation of the weights of the dimensions however there is valuation between components. This can be adjusted and, using a single tree can be added components at each level of each branch until the last level, the more aggregate.

In a study to assess the impact of technological innovations, information about scope and influence of each technology individually, the geographical area and population of adopters can be used to evaluate the substitution of technology in this period. One of the main difficulties of this type of study is to isolate the individual effects of technologies, effects resulting from their interactions with other technologies developed by R & D institutions or

imported. The ability of the researcher to apply the questionnaires Ambitec or ESAC may reduce this problem. However, the ESAC greatly facilitates this process the researcher to precisely capture by comparison, among all respondents, which was the general context (IG) and the individual context (I), which may be reflected in the size of the bias obtained when using one or another method, and consequently the results of the analyzes.

The main features of the systems Ambitec and ESAC, which may facilitate or complicate its application in assessing the impacts of the innovations developed for coffee sector at the *Instituto Agronômico*/IAC (Agronomic Institute), depending on the objectives to be achieved in the study, are shown respectively in Tables 2 and 3.

However, there are other aspects to be considered in the selection of the method of impact assessment and one of them demands special attention: the timeline of the analysis. This is a key aspect of the study design and demarcation of the concomitant evolution of the coffee sector and of IAC greatly facilitates this chronology. It can also differentiate the methods to be employed in each major phase, and in the periods prior to the frost that occurred in 1974 the methods should focus only on interviews with key people, including researchers and industry representatives may - recognized vivid memories about those times. For all stages will be required to review documentation and description of technological trajectories in which the IAC participated intimately. The description of technological trajectories important for coffee production in the IAC did not have role, would be important to clarify the considerations of interference from other causes. The application of questionnaires to the producers can only be justified from the frost of 1974, and the comparative discussion between the systems of impact assessment is restricted more to the evaluation period. Therefore, the previous phase has a more historical approach centered more in evidence in documentary collection, with validation through interviews to capture the participants' memory of the period, which in turn can help improve the archival work.

Table 1. Similarities and differences between the systems Ambitec e ESAC.

Characteristics	Ambitec	ESAC
Sample size	• Function of the scope, geographical area and of population of adopters	• Function of the scope, geographical area and of population of adopters
Basic units of the system	• Generic indicators	• Generic indicators
Selection of indicators	• Consultation with experts	• Consultation with experts
Number of criteria	• 7	• Can be parameterized
Number of indicators	• 24	• Can be parameterized
Weighting of scale of occurrence	• Spot (1), Local (2) and Surrounding areas (5)	• There is not. Each component or responder has its wide occurrence implicit
Valuation of impacts	• Coefficient of changing the default component in the ordinal scale (+3, +1, 0, -1, -3)	• Can be parameterized with different types of scale
Interferences	• Refers only to causal change	• It changes separately and general causal
Flexibility of the Software	• Closed	• Free parameterization
Presentation of the results	• Graphics and indicators obtained automatically only for each questionnaire	• Statistics available in html page, for components, layers and dimensions
Space for comments	• It is not programmed	• Graphics are not obtained automatically
homogeneity	• It is not assessed	• Changes to each level of aggregation
Convergence of responses	• It is not assessed	• Evaluated for each indicator and disable if not achieved • Automatic analysis of convergence and sample extracts
Isolation of individual effects	• The program becomes inactive a given indicator, only if the interviewer considers that it is not relevant	• Captures the impact on the overall context (IG) and individual (I). If the perception of change in the IG does not have converging distribution (Z> 0.75), the indicator is off, without considering the impact. • It is asked which the perception of respondents about the change of the indicator in the GI, the following is requested to award a percentage (α) of this change to technology, yielding a difference of their impact (I).
Aggregate impacts of the dimensions analyzed	• Do not allow	• Do not allow

Source: Information raised in the study.

Table 2. Characteristics of systems Ambitec and ESAC that facilitate their application in assessing the impacts of the innovations developed for coffee sector at the *Instituto Agronômico* / IAC (Agronomic Institute).

Ambitec	ESAC
• Provide comparability, because it is widespread in many units and some Brazilian research abroad • Graphics generated for each respondent can be used to provide aggregated results, but after statistical treatment out of the instrument	• Can be adapted for any size and indicators • Automate the handling of responses to the indicator, layers and dimensions • Interference to differentiate the values for change in the general context of those caused by technology • Differentiates values for change in the overall indicator of those caused by technology, so it treats the answers on the perceptions of respondents in relation to general changes, separately from the responses on the contribution of technology to change • Uniformity changed at each level of aggregation • It treats the cohesion of the answers automatically for each stratum and off the indicator that convergence does not occur

Source: Information raised in the study.

Table 3. Characteristics of systems Ambitec and ESAC that could hinder their application in assessing the impacts of the innovations developed for coffee sector at the *Instituto Agronômico* / IAC (Agronomic Institute).

Ambitec	ESAC
• Spreadsheet of collecting and analyzing of data from each respondent, not offering the automatic aggregation, and data processing • To make improvements and / or inclusion of new indicators and dimensions, the instrument must be re-drafted	• Software belongs to private owners, which can generate costs for its use, training and technical assistance

Source: Information raised in the study.

CONCLUSIONS

It is first important to distinguish that we are comparing methods and tools. In relation to the instrument, the ESAC involves the processing of data as it is incorporated into the IMPACT software, more complex and sophisticated than the worksheets in Ambitec. Regarding the automation of the process of data consolidation and analysis of results, the IMPACT software saves many steps, but the database is not readily accessible to other statistical uses.

For Ambitec, the statistical treatment would be beyond the scope of the method, and its use should involve more intensive work of the team for the design, tabulation and processing of the data. However, since the data are tabulated for the Ambitec after use, it is easier to produce analyzes correlate different types of impact and layers of the sample.

Although the IMPACT software to be proprietary software, this brings flexibility in the ability to add, delete and / or adapt dimensions, indicators and scales.

Considering the properties of methods, the ESAC is wider because it involves more indicators and dimensions. Despite the treatment of interference, Ambitec not treat separately the data from the respondents' perception of the change of context, to differentiate due to the impact that technology related to other causes. But the ESAC is this distinction, including the

cohesion of analyzing responses of the strata, both for the overall change, and to that derived from the impact.

When you want to monitor the impacts of a particular technology through periodic analyzes, or if is necessary to evaluate a large number of technologies, where the use of such technologies is geographically dispersed, or when there is constraint of time and resources for staff training to apply the questionnaires and for displacement and maintenance of this team, Ambitec presents significant advantage. As for monitoring the evolution in time, there is no possibility of aggregating results from different technologies. This comparison in time is specific to a particular technology, in order to verify that their impacts are increasing or not, with the aim of analyzing the need for improved technology or analyze whether it has reached its maximum potential.

That is, the volume of indicators in ESAC and the depth and breadth of the survey, conducted through interviews with both open and closed questions, restricts the possibility of working with large samples.

In summary, the Ambitec is less flexible than the ESAC, which at first is a disadvantage to thoroughly evaluate each specific case, but it is an advantage for comparing different evaluations, because the criteria are similar. For example, to assess the impacts of the IAC in the coffee regions of Brazil, based on the evaluation of various technologies, can be more interesting to use the Ambitec because it offers greater uniformity of criteria, if other research institutions are evaluated by the same criteria, the evaluations could even be compared. However, the question of statistical treatment, the ESAC is more sophisticated, while the Ambitec only calculates the average of respondents. So, if there is a large variance between the scores obtained for each of the questionnaires, the Ambitec can generate a detour.

The methods that are being compared have a common origin – almost the same interaction Embrapa Environment and Geopi-DPCT/Unicamp – both methods are very similar, changing only the issue of flexibility in terms of their institutionalization or not. In the process of institutionalization, one runs the risk of lead to a bureaucratization of the evaluation, which should be an investigation in which particularities, context, circumstance, and the intersubjectivities are present, are rich sources of evidence, and involve the design of the method.

In the specific case of coffee technology, the Agronomic Institute, one must decide between the Ambitec the advantage of simplicity of application and advantages of the ESAC, with greater flexibility, more accurate and statistically more complex.

In the case of the IAC technology, the historical process and the large number of technologies implies the option of grouping them into technological trajectories, considering the impact of the development of technologies within each trajectory. This analysis will be used to explain the relationship between investment in coffee research programs in the IAC and its impact on increasing productivity and product sector. This implies the choice of a method and apparatus that enables the use of specific indicators for each technological trajectory in question. Some technologies have very specific technical indices, which reflect this trend and may not be present in systems of predefined indicators.

It was decided, therefore, perform two kinds of analyzes.

• First, analyze the IAC technologies individually, through Ambitec, to technologies developed since 1932, the year it was created in the IAC the "General Plan for studies of coffee."

• Second, raising the historical trajectory of coffee research at IAC, having as scenery the modernization process of Brazilian agriculture, and analyze the impacts of the different stages of this path through the ESAC. These different phases may be represented by families of technologies, innovations such as biological, mechanical, chemical and qualitative, which represent the search for productivity increases, resistance to pests and diseases, mechanization and improving the quality of the drink. In this case, the first issue of ESAC is to identify whether or not changes on these matters in the period from 1974, called the "great frost," which marked the restructuring of the Brazilian coffee production, and specifically whether these changes result from the IAC technology.

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