Methodological Annex – Chapter 10

ST&I and the agricultural sector in São Paulo State

A.1. Values of IPCA (IBGE) for 1995- 2007

Consumer price index (IPCA) - annual average	
1995	122.317
1996	141.590
1997	151.397
1998	156.236
1999	163.830
2000	175.370
2001	187.362
2002	203.194
2003	233.093
2004	248.473
2005	265.547
2006	276.656
2007	286.728

A.2. Calculating expenditure on S&T and R&D in agriculture

The procedure for calculating expenditure on S&T and R&D in agriculture was as follows:

a) The sum of public investment in agricultural S&T included the expenditure of Embrapa and state agricultural research organizations (SAROs), CNPq and CAPES grants, and transfers by MCT (data obtained directly from the sources during 2009). São Paulo also included expenditure in the agrarian science area by FAPESP and the schools of agrarian science at public universities in the state;

b) The data sources were as shown in the following chart:

Institution	Data source
Embrapa	Budget execution, National Treasury
SAROs, APTA	Budget execution, State Treasury
MCT (via CNPq & FINEP)	Budget execution, National Treasury
Universities in SP	Budget execution, State or National Treasury
CNPq	Grants
CAPES	Grants
FAPESP	Grants, scholarships, research program funding

c) Private investment was estimated using the proportion between public and business expenditure in S&T for the same period, as shown below in Detailed Table M10.1;

d) Agricultural R&D expenditure was estimated based on the ratio of S&T to R&D investment in Brazil (total investment, not just agricultural), available at <http://www.mct.gov.br/index.php/content/view/29144.html>. Last visited Nov. 18, 2009;

e) For investment in S&T and R&D in proportion to agribusiness GDP, the latter was calculated by CEPEA/ESALQ/USP.

Detailed Table 10.1
Business expenditure and total expenditure on S&T by sector – Brazil, 2001-2005

Sector	S&T expenditure				
	2001	2002	2003	2004	2005
Total (in millions of current R$)	17,262	19,277	21,393	24,040	27,277
Public S&T expenditure (in millions of current R$)	9,553	9,995	11,098	12,588	13,597
Business S&T expenditure (in millions of current R$)	7,709	9,281	10,295	11,451	13,679
Business S&T expenditure in proportion to total	0.4	0.5	0.5	0.5	0.5

Source: <http://www.mct.gov.br/index.php/content/view/29140.html>.

A.3. Data on MCT agreements in the agricultural area

The values for agreements between the Ministry of Science & Technology (MCT) via CNPq or FINEP and institutions and researchers in the agricultural area were collected from Portal da Transparência,[1] a web portal run by CGU, the Office of the Comptroller-General, which is directly subordinated to the President of Brazil.

A search was conducted using the option Consultas por Convênios por Órgão Concedente ("Search agreements by grantor") and then selecting MCT, followed by each state and the municipalities within each state that had agreements with MCT, by institution. The following information was displayed for each agreement:
- Agreement number
- Purpose of the agreement
- Governing body (description, code)
- Grantor (description, code)
- Grantee (description, code)
- Total amount
- Amount released
- Publication
- Start date
- End date
- Matching amount
- Date of latest release
- Amount of latest release

Municipalities were selected according to the following criteria:
- Over 500,000 inhabitants (except Maceió and São Luís)
- Offices of Embrapa or SAROs
- Campuses of universities with well-established expertise in the agricultural area
- All municipalities in São Paulo State

Search results were found for the following municipalities:
- Sergipe (SE): Aracaju
- Rio Grande do Sul (RS): Bajé, Bento Gonçalves, Passo Fundo, Pelotas, Porto Alegre, Santa Maria
- Pará (PA): Belém
- Minas Gerais (MG): Belo Horizonte, Juiz de Fora, Lavras, Sete Lagoas, Viçosa
- Roraima (RR): Boa Vista
- Federal District (DF): Brasília, Gama, Planaltina
- Paraíba (PB): Campina Grande, João Pessoa
- São Paulo (SP): Campinas, Jaguariúna, São Carlos, São Paulo, Piracicaba, Ribeirão Preto, São José dos Campos, Araraquara, Assis, Bauru,

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1. <http://www.portaltransparencia.gov.br/index.asp#>.

Botucatu, Bragança Paulista, Cachoeira Paulista, Ilha Solteira, Iperó, Jaboticabal, Lorena, Marília, São Sebastião da Grama.

- Mato Grosso do Sul (MS): Campo Grande, Dourados
- Paraná (PR): Colombo, Londrina, Curitiba
- Mato Grosso (MT): Corumbá, Cuiabá
- Bahia (BA): Cruz das Almas, Salvador
- Santa Catarina (SC): Florianópolis, Concórdia
- Ceará (CE): Fortaleza, Sobral
- Goiás (GO): Goiânia, Santo Antônio de Goiás
- Amapá (AP): Macapá
- Amazonas (AM): Manaus
- Rio Grande do Norte (RN): Natal
- Rio de Janeiro (RJ): Niterói, Rio de Janeiro, Seropédica
- Tocantins (TO): Palmas
- Pernambuco (PE): Petrolina, Recife
- Rondônia (RO): Porto Velho
- Acre (AC): Rio Branco
- Piauí (PI): Teresina
- Espírito Santo (ES): Vitória

Agreements for each municipality were analyzed one by one in search of:

- Agreements with funding from the Agribusiness Sectoral Fund (CT-AGRO)
- Agreements relating to the agricultural sector
- Agreements with agricultural research institutions

The number of agreements found in this manner totaled 1,265, with start dates between January 1996 and June 2008, and for a total value of R$ 295.6 million. Because data on annual disbursements are not available, these were estimated by dividing the aggregate amount released by the number of years for which the agreement was in force.

A.4. Primary survey of agricultural research budgets in higher education

Expenditure on agricultural research by HEIs was estimated for public universities with postgraduate programs. The following HEIs in São Paulo State were selected:

- University of São Paulo (USP) – School of Agriculture (Escola Superior de Agricultura Luiz de Queiroz, ESALQ)
- State University of Campinas (Unicamp) – School of Agricultural Engineering (FEAGRI)
- Universidade Estadual Paulista Júlio de Mesquita Filho (Unesp) – Department of Veterinary Medicine, Araçatuba
- Unesp – School of Veterinary Medicine & Animal Science (FMVZ), Botucatu
- Unesp – School of Agronomic Sciences (FCA), Botucatu
- Unesp – Ilha Solteira School of Engineering (FEIS), Ilha Solteira
- Unesp – School of Agrarian & Veterinary Sciences (FCAV), Jaboticabal
- USP – School of Veterinary Medicine & Animal Science (FMVZ)
- USP – School of Animal Science & Food Engineering (FZEA)
- Federal University of São Carlos (UFScar) – Center for Agrarian Sciences
- University of Taubaté (UNITAU)

The following information was requested:[2]

- Total university budget
- Total budget of the school or unit whose core activity related to agrarian sciences
- Number of academic staff employed at the school or unit whose core activity related to agrarian sciences
- Percentage of the school or unit's budget reserved for payment of serving academic staff
- Estimate of agricultural research expenditure in 1996-2006, detailing:
  - Salaries paid to academics dedicated to research
  - School or unit running costs
  - School or unit's capital expenditure

In the case of FEAGRI (Unicamp) and FZEA and FMVZ (USP), the information was furnished by the respective schools. In the case of Unesp and UFSCar, the information came from the respective rectoral offices.

No information was collected on the academic staff's work regime, i.e. whether they were full-time or part-time. It is therefore impossible to assure compatibility between this estimate of research expenditure by HEIs and the 82.7% factor estimated in Chapter 3 for the proportion of HEIs' budgets spent on R&D.

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2. Only Unitau failed to respond adequately to the survey.

A.5. Courses selected for calculating CAPES grants in São Paulo

Institution	Postgraduate Program
ESALQ	Agronomy (statistics & experimentation)
ESALQ	Agronomy (environmental physics)
ESALQ	Agronomy (plant pathology)
ESALQ	Agronomy (genetics & breeding)
ESALQ	Agronomy (agricultural microbiology)
ESALQ	Agronomy (soils & plant nutrition)
ESALQ	Animal science & pasture
ESALQ	Food science & technology
ESALQ	Ecology of agroecosystems
ESALQ	Irrigation & drainage
ESALQ	Farm machinery
ESALQ	Forest resources
IAC	Tropical & subtropical agriculture
Unesp/Botucatu	Agronomy (horticulture)
Unesp/Botucatu	Animal science
Unesp/Jaboticabal	Agronomy (soil sciences)
Unesp/Jaboticabal	Agronomy (energy in agriculture)
Unesp/Jaboticabal	Agronomy (agrarian entomology)
Unesp/Jaboticabal	Agronomy (agricultural entomology)
Unesp/Jaboticabal	Agronomy (genetics & breeding)
Unesp/ Jaboticabal	Agronomy (irrigation & drainage)
Unesp/ Jaboticabal	Agronomy (production & techniques)
Unesp/ Jaboticabal	Agronomy (plant production)
Unesp/ Jaboticabal	Aquaculture
Unesp/ Jaboticabal	Veterinary surgery
Unesp/ Jaboticabal	Animal genetics & breeding
Unesp/ Jaboticabal	Veterinary medicine
Unesp/ Jaboticabal	Veterinary medicine (medicine)
Unesp/ Jaboticabal	Veterinary medicine (pathology)
Unesp/ Jaboticabal	Agricultural microbiology
Unesp/ Jaboticabal	Animal science
Unesp/Araçatuba	Animal science
Unesp/Botucatu	Agronomy (agriculture)
Unesp/Botucatu	Agronomy (energy in agriculture)
Unesp/Botucatu	Agronomy (horticulture)
Unesp/Botucatu	Agronomy (irrigation & drainage)
Unesp/Botucatu	Agronomy (plant protection)
Unesp/Botucatu	Veterinary medicine
Unesp/Botucatu	Animal science
Unesp/Ilha Solteira	Agronomy
Unesp/Ilha Solteira	Animal science

Institution	Postgraduate Program
Unesp/Jaboticabal	Agronomy (agriculture)
Unicamp	Agricultural engineering
USP	Veterinary clinical practice
USP	Animal nutrition
USP	Animal reproduction
USP	Animal science

Source: Ministry of Education (MEC).

Note: No information was collected on grants for the following courses at ESALQ: applied ecology (ESALQ/Cena), applied economics, entomology, plant science.

A.6. Fisher index and Törnqvist index

Volumes of agricultural products and production factors were aggregated using index numbers. Agricultural productivity was calculated as the quotient of a production index (based on the volume and price of each good produced) and a production factor use index. Choosing the most suitable formula to represent the values concerned leads to the "index number problem". The various formulas available have traditionally been compared using the logical tests set out in the classic book by Fisher (1922), in accordance with the approach known as axiomatic.

According to these criteria, the formulas of Laspeyres and Paasche (among the most widely used) do not satisfy the tests of causal decomposition (the product of the quantity index and the price index calculated by these formulas differs from the value index), time reversal (the product of the quantity index for year 0 compared with year t and the index for year t compared with year 0 is different from unity) and circularity (which requires that an index number should be independent of the choice of a third point in time, so that it can be decomposed by the product of two similar indices, where the base for one is the current period for the other). The Fisher formula fails only the circularity test, but this can be circumvented by chaining, as described below.[3]

More recently, besides the need for constant updating of weighting factors (discrete approximation to the Divisia integral), stress has been laid on the study of the relations between functional specifications admitted by economic analysis and index number formulas according to the economic approach. Diewert (1976) defined a flexible functional form for a cost function as one which could provide a second-order differential approximation to an arbitrary (linearly homogeneous) function with first and second derivatives, and termed "superlative"

an index number formula that is exact (i.e. consistent) for a flexible functional form. He showed that the Törnqvist index (also known as the Törnqvist-Theil translog index) is exact for a homogeneous translog aggregator function (and hence superlative), and that the Fisher formula is exact for a homogeneous second-order quadratic aggregator function (and hence superlative).

The formula for the Törnqvist quantity index is:

$$TQ_{0,1} = \prod_{i=1}^{n} \left(\frac{q_1^i}{q_0^i} \right)^{\frac{w_0^i + w_1^i}{2}}$$

The Fisher formula (or Fisher ideal index) for quantity indices between two time periods (0 and 1) is the geometric mean of the Laspeyres and Paasche indices:

$$FQ_{0,1} = \sqrt{LQ_{0,1} \cdot PQ_{0,1}} \quad , \text{ were,}$$

$$LQ_{0,1} = \frac{\sum_{i=1}^{n} p_0^i \cdot q_1^i}{\sum_{i=1}^{n} p_0^i \cdot q_0^i} = \sum_{i=1}^{n} \frac{q_1^i}{q_0^i} \cdot w_0^i \quad , \text{ and}$$

$$PQ_{0,1} = \frac{\sum_{i=1}^{n} p_1^i \cdot q_1^i}{\sum_{i=1}^{n} p_1^i \cdot q_0^i} = \frac{1}{\sum_{i=1}^{n} \frac{q_0^i}{q_1^i} \cdot w_1^i} \quad .$$

The capital letters identify the index (T=Törnqvist; F=Fisher; L=Laspeyres; P=Paasche); Q refers to quantity; pi1 is the price of item i in period 1; p_0^i is the price of item i in period 0; q_1^i a is the quantity of item i in period 1; q_0^i is the quantity of item i in period 0; $w_0^i = \frac{p_0^i \cdot q_0^i}{\sum_{i=1}^{n} p_0^i \cdot q_0^i}$ is the share of item i in the budget for period 0; and $w_1^i = \frac{p_1^i \cdot q_1^i}{\sum_{i=1}^{n} p_1^i \cdot q_1^i}$ is the share of item i in the budget for period 1.

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3. For a complete description of the tests, see Silva & Carmo (1986).

Superlative formulas are also characterized by providing second-order approximations (Diewert, 1976), which limit the range of variations measured, making the question of choosing between them less relevant. Because the Fisher and Törnqvist formulas belong to the class of superlative index numbers, their results are virtually identical from an empirical standpoint.[4] Nevertheless, considering the axiomatic and economic approaches to index number theory, according to Diewert (1993), the Fisher index is probably the best functional form for bilateral comparisons.

Indices calculated for longer periods, where the occurrence of changes to the economic structure have to be taken into account, may entail a significant bias if a fixed base is used. This problem can be mitigated by constructing chained series and periodically updating both the calculation base and the weighting sys-tem (Silva & Carmo, 1986). The Fisher chain formula is as follows:

$$FQ_{0,n} = FQ_{0,1} \cdot FQ_{1,2} \cdot \ldots \cdot FQ_{n-1,n}$$

where FQ is the Fisher quantity index and subscripts 0 to n represent the period analyzed.

A.7. USPTO and INPI patent search strategy

Patent applications and grants were searched in two steps. The first consisted of a set of keywords used to search abstracts. The queries entered into each database are presented in the chart below (Detailed Chart M10.1). All the results were then read through with great care in order to remove patents not related to agriculture or agribusiness.

Detailed Chart 10.1
Queries used in first stage of patent search

Database & field	Query
INPI – inventor & applicant	Summary: 'AGROECOLOGIA or AGROENERGIA or AGROINDUSTRIA or AGROINFORMATICA or AGROMETEREOLOGIA or AGRONOMIA or AGRONEGOCIO or AGRICOLA or AGRICULTURA or AGROPECUARIA or AGRIMENSURA or COLHEITA or CULTIVO or PLANTAÇÃO or FERTILIZANTES or SEMEADURA' Application filed: '01/01/1996' a '31/12/2006'
USPTO – applicant	(((acn/br$) and APD/1/1/1996->12/31/2006) and (abst/("agribusiness" or agric$ or harvest$ or "cultivation" or "planting" or "sowing" or fertiliz$ or "plant breeding" or "molecular genetics" or ((inbred or cultivar) and plant)) or aclm/("agribusiness" or agric$ or harvest$ or "cultivation" or "planting" or "sowing" or fertiliz$ or "plant breeding" or "molecular genetics" or ((inbred or cultivar) and plant))))
USPTO – inventor	((icn/"br$") and ICL/(a01$) and APD/1/1/1996->12/31/2006) and (abst/("agribusiness" or agric$ or harvest$ or "cultivation" or "planting" or "sowing" or fertiliz$ or "plant breeding" or "molecular genetics" or ((inbred or cultivar) and plant)) or aclm/("agribusiness" or agric$ or harvest$ or "cultivation" or "planting" or "sowing" or fertiliz$ or "plant breeding" or "molecular genetics" or ((inbred or cultivar) and plant))))

The second step was to select firms and some institutions that operate in the agricultural sector, and to locate all patent applications filed by them and patents granted to them. Applicants with more than three INPI applications or grants and at least one USPTO application or grant were selected. A thorough manual analysis was again performed to exclude records not related to agriculture or agribusiness.

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4. See Silva & Carmo (1986) for an empirical example using data for São Paulo State.

A.8. Decision codes for applications, patents and certificates of addition

Decision code		Simplified description
10.1	Abandonment ratified	Dismissed
11.1	Application dismissed because examination was not requested within the time specified in the Industrial Property Law (LPI, art. 33). Applicant has sixty days to request withdrawal of abandonment using Form 1.02, paying the appropriate fees on pain of definitive dismissal.	Dismissed
11.1.1	Dismissal under art. 33 of LPI. Application definitively dismissed because withdrawal of abandonment (or examination) was not requested.	Dismissed
11.14	Publication annulled.	Dismissed
11.2	Patent application definitively dismissed for lack of response to a requirement from INPI	Dismissed
11.4	Dismissal under art. 38 §2 of LPI	Dismissed
11.5	Dismissal under art. 34 of LPI	Dismissed
15.7	Petition unknown in compliance with art. 218 or 219 of LPI.	Dismissed
23.6	Dismissal	Dismissed
3.5	Publication of withdrawn application and closure of administrative proceeding. File containing descriptive report, claims, designs and application abstract can be obtained from INPI's Documentation Center (CEDIN).	Dismissed
3.6	Publication of application definitively dismissed under art. 216 §2 and art. 17 §2 of LPI owing to failure to file power of attorney or to filing of later application. Closure of administrative proceeding. File containing descriptive report, claims, designs and application abstract can be obtained from INPI's Documentation Center (CEDIN).	Dismissed
6.1	Requirement under art. 36 of LPI, suspending patent application until the requirement is met or contested. If the requirement is not clearly specified in the decision published by RPI [INPI's official gazette], the applicant may request a copy using Form 1.05. Failure by Applicant to take action within ninety days triggers definitive dismissal of the application.	Dismissed
8.6	Dismissal under art. 86 of LPI, for failure to pay an annuity at all or on time, or for failure to comply with a requirement to supplement payment of an annuity. Applicant has three months to appeal the dismissal and request reinstatement of the examination proceeding, using Form 1.02 and paying the reinstatement fee as well as either paying the portion of the annuity still due, filing a receipt for past-due payment of the annuity or paying the supplementary amount, whichever is applicable.	Dismissed
9.2	Application dismissed for non-compliance with the legal requirements, as evidenced by a technical opinion. A copy of the technical opinion can be requested using Form 1.05. Applicant has sixty days to appeal. In the case of dismissal of an application for a certificate of addition for not having the same inventive concept, Applicant may, within the time period allowed for appeal, request its conversion into an application for an invention patent or utility model in accordance with art. 76 §4 of LPI.	Dismissed
1.3	Notification – PCT national phase	Deposit[5]
1.3.1	Rectification of errors in PCT national phase notification.	Deposit
12.6	Other appeals – Notification of appeal to INPI's president against a decision by the Patent Department (DIRPA) to have the matter re-examined. Any interested party has sixty days to present counter-arguments. A copy of the appeal can be requested using Form 1.05.	Deposit
15.11	Change in classification – Application reclassified as appropriate.	Deposit
19.1	Notification of decision – Notification of a court decision regarding a patent.	Deposit
25.1	Transfer allowed – Notification of permission for requested transfer. Interested parties have sixty days to appeal.	Deposit
25.7	Change of head office allowed – Notification of permission for requested change of address. Interested parties have sixty days to appeal.	Deposit

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5. Deposit is defined as the act whereby INPI allows a patent application, allocating a specific number following an initial review of its formal aspects, or allows an appeal, addendum etc.

Decision code		Simplified description
3.1	Publication of application for patent or certificate of addition.	Deposit
3.2.	Early publication.	Deposit
3.8.	Rectification – Rectification of errors in patent application publication that do not prevent its identification. Does not alter patent application publication date or deadlines deriving therefrom.	Deposit
16.1	Grant of patent or certificate of addition.	Patent
23.9	Issuance of patent.	Patent
24.4	Restoration – Notification of patent restoration.	Patent

Source: INPI (data furnished in 2008).

A.9. Scientific article search strategy

The strategy used to search *Web of Science* was as follows:

Database selected: SCI-Expanded

Period (publication year): 1996-2006

Query: (cu=("brazil" or "brasil" or br* or "basil") and ps=("Sao paolo" or "sao paulo" or "são paulo" or sp or "sao pablo" or "são paolo") and ts=(agrobusiness or agric* or harvest* or "cultivation" or "planting" or "sowing" or fertilis* or "plant breeding" or "plant genetics" or "molecular genetics" or ((inbred or cultivar) and plant)))