Document

Providing Biotechnology Statistics and Indicators to the OECD Biotechnology Statistics 2008[*]

The OECD has been collecting and publishing data on biotechnology from its Member and several non-member countries since the 2001 Biotechnology Compendium. The most recent publication is the *OECD Biotechnology Statistics 2006*,[1] which includes more internationally comparable indicators than the 2001 Compendium. The OECD is planning to produce its next collection of biotechnology statistics in 2008 and hopes to further improve international comparability. This involves increasing the number of countries that provide comparable data for specific indicators and the absolute number of comparable indicators.

The *Biotechnology Statistics 2006* report includes data for three non OECD countries: Israel, South Africa and the Shanghai province of China. For the 2008 edition, the OECD would like to include comparable data on biotechnology statistics for a larger number of non OECD countries, or, if necessary, for regions or provinces within large countries such as China, India, or Brazil.

This brief report explains the approach of the OECD to producing internationally comparable biotechnology statistics. This information should be helpful for countries that would like to provide indicators for inclusion in the 2008 edition of *Biotechnology Statistics*.

Relevant Data

The *Biotechnology Statistics* reports include three types of data:
1. Biotechnology activities of the public sector, particularly investment in biotechnology R&D.
2. Biotechnology activities of the business sector.

3. Methodology of data collection (metadata).

The information needed by the OECD for each type of data is given below in Sections 2, 3 and 4. A country only needs to provide a few internationally comparable indicators and the supporting metadata to be included in the 2008 Biotechnology Statistics.

Definition of Biotechnology used by the OECD

International comparability is strongly dependent on how biotechnology is defined. The OECD limits biotechnology indicators to modern biotechnologies. This excludes the traditional fermentation of soy, dairy and alcohol products. Conventional plant and animal breeding are also excluded, unless biotechnologies such as marker assisted selection (MAS) are used as part of the conventional breeding programme.

To maximise comparability of both the public and business sector biotechnology statistics, countries should use the OECD single definition of biotechnology and the list-based definition (see Box 1 below) of different types of biotechnology. Both definitions were developed by an OECD expert group. The first defines biotechnology as, "*the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services.*" Although the single definition defines the purpose of biotechnology, the list-based definition is essential for identifying modern biotechnology.

In the *Biotechnology Statistics 2006* report, the OECD includes data for a few countries that used a different definition of biotechnology, as long as the definition was limited to 'modern' biotechnology. This option will still be available in 2008, although we encourage countries to adopt the OECD definition.

Reference Year

The OECD prefers to have data for the most recent available year, which is 2006 or 2007 for the 2008 report. However, the report will include data for 2004 or 2005, if no data are available for 2006 or 2007.

Application Field

Where possible, the OECD provides biotechnology statistics for up to four major applications of biotechnology: in the following sectors namely health, agriculture (including food processing and marine uses

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BOX 1: OECD list-based definition of biotechnology techniques

DNA/RNA: Genomics, pharmacogenomics, gene probes, genetic engineering, DNA/RNA sequencing/synthesis/amplification, gene expression profiling, and use of antisense technology.

Proteins and other molecules: Sequencing/synthesis/engineering of proteins and peptides (including large molecule hormones); improved delivery methods for large molecule drugs; proteomics, protein isolation and purification, signaling, identification of cell receptors.

Cell and tissue culture and engineering: Cell/tissue culture, tissue engineering (including tissue scaffolds and biomedical engineering), cellular fusion, vaccine/immune stimulants, embryo manipulation.

Process biotechnology techniques: Fermentation using bioreactors, bioprocessing, bioleaching, biopulping, biobleaching, biodesulphurisation, bioremediation, biofiltration and phytoremediation.

Gene and RNA vectors: Gene therapy, viral vectors.

Bioinformatics: Construction of databases on genomes, protein sequences; modelling complex biological processes, including systems biology.

Nanobiotechnology: Applies the tools and processes of nano/microfabrication to build devices for studying biosystems and applications in drug delivery, diagnostics, etc.

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such as aquaculture), industrial, and environmental. Data by application has many advantages in terms of predicting the future direction of biotechnology, improving the comparability of output indicators,[2] and estimating social and economic impacts, which are strongly dependent on the application.

Public Sector Investment in Biotechnology R&D

Optimally, the OECD would like to publish data on total government expenditures on biotechnology R&D, plus expenditure data broken down by application field and by the recipient of the funding. The template for 'Public Biotechnology R&D' is provided as an example of

how to obtain the basic data from government ministries.[3] The following indicators for a specific year can be produced using the information collected in the template:

1. Total public expenditures on biotechnology R&D.
2. Total public expenditures on biotechnology R&D by field of application.
3. *Alternative if a breakdown by application is not available*: Share of all Government programmes for biotechnology R&D by application field.
4. Total public expenditures on biotechnology R&D by type of recipient.
5. *Alternative if a breakdown by recipient is not available*: Share of all government programmes for biotechnology R&D by recipient.

Section 4 below lists four metadata items that are required for public R&D data.

Public Biotechnology R&D Template

Please list publicly funded biotechnology R&D programmes that exist in your country in the table below. For each programme, please provide as much of the information below as possible. Please use a separate template for each programme that funds biotechnology R&D.

1. Basic information		
Name of programme		
Responsible government ministry		
Is this programme dedicated to funding biotech R&D?	Yes ☐	No ☐
Or, any other programme that also funds biotech R&D?	Yes ☐	No ☐
Duration of programme (number of years)	_____ Start year ____ End year	
Total amount of funding for biotech R&D (*exclude non biotech R&D*) over the lifetime of the programme	_____ (National currency)	

2. Distribution of programme funding for biotechnology R&D by application field

Type of biotech R&D funded:	Check all that received funding:	Estimated share of total funding of biotech R&D *(Exclude non biotech R&D from total)*
Health (human and animal)	☐	_____
Agriculture-marine-food processing	☐	_____
Industrial	☐	_____
Environmental	☐	_____
Other (please describe):	☐	_____
		100%

3. Distribution of programme funding for biotechnology R&D by sector of recipient

Recipients of biotech R&D funds:	Check all that received funding:	Estimated share of total funding of biotech R&D *(Exclude non biotech R&D from total)*
Business	☐	_____
Higher education	☐	_____
Government research organisations	☐	_____
Private non-profit	☐	_____
		100%

2. Biotechnology Activities of the Business Sector

The OECD *Biotechnology Statistics* publishes indicators on the number of biotechnology firms and R&D, employment and sales within these firms. Ideally, data on R&D, employment and sales are obtained for both biotechnology-related activities and for all activities of

biotechnology firms. For example, many firms that perform biotechnology R&D also conduct R&D in other fields, or some sales could be due to non biotechnology goods and services. However, depending on the survey design, some studies are not able to provide results that are limited to biotechnology. Consequently, the OECD publishes data on all activities of biotechnology firms plus results that are limited to biotechnology. The only requirement is that each country includes metadata that clearly defines R&D, sales and employment data

Metadata Template for Business Surveys

Variable	Result	Comments
Reference year	_____	
Definition of biotechnology	☐ OECD definition ☐ Other 'modern' ☐ Other	*If 'other modern' or* *'other', give details*
Definition of a biotechnology firm	☐ Core ☐ Bio-active ☐ Other	*If 'other', give details*
Must perform biotech R&D? Sample frame	☐ Yes ☐ No ☐ Large scale survey ☐ R&D survey ☐ Secondary sources ☐ Other	*Give details*
Number of firms surveyed	_____	
Survey response rate	_____%	
Results weighted?	☐ Yes ☐ No ☐ Not relevant	*If not relevant,* *give details*
Results extrapolated?	☐ Yes ☐ No ¨ Not relevant	*If not relevant,* *give details*
Coverage area	Describe if limited to a specific province, region, etc.	

Data Collection Template for the Biotechnology Activities of the Business Sector

Biotech firms		Country: Reference year:	Note (Please indicate whether the reference period differs; whether the indicator's comparability could be affected by your country's question wording or the population asked the question; details any reliability issues associated with the indicator, etc.	*Source* (name of survey, secondary sources, etc.)
Firms	1. Total number of biotechnology firms			

	2. Biotech firms by application field:
	   Health
	   Agro/Marine/Forestry
	   Food & beverages processing
	   Industrial
	   Environmental
	   Other: please specify
	   Other: please specify
			If not available please give approximate distribution by industrial sector	

	3. Total biotech firms by size-class:
	   <50 employees
	   50-249 employees
	   250+employees			

R&D Firms	4. Expenditures on R&D by biotech firms
	   (millions national currency)
	   Of which: Total
	              Biotech R&D			

Employment firms	5. Employment in biotech firms
	   Total employees
	   Of which: Biotech employees
	              Total R&D employees
			Please check if these data are for:
			Full-time equivalent (FTE)_____
			Headcount_____	

Sales firms	6. Total sales of biotech firms
	   (millions national currency)
	   Total sales
	   Of which: Sales of biotech goods & services			

plus the survey design or other information on how the data are obtained.

The template given below obtains the required metadata for the business sector, plus additional details are requested in the data collection template. The variables in column 1 are defined in section 4. The data collection template (available as an Excel file) defines six main indicators (if data are unavailable, the relevant cell should be left blank). Of note, wherever possible the OECD would like to have data on firm numbers disaggregated by the firm's main area of application for biotechnology. Five application areas are given, such as health (which includes both human and animal health), agriculture/marine/ forestry, food and beverage processing, industrial, and environmental. If data are not available at this level, applications can be combined. For example, the application 'industrial' could be combined with 'environmental'. The 'other' category can be used for different applications or for different ways of combining applications.

3. Methodology of Data Collection (metadata)

Due to the complexity of biotechnology, there are many different ways of defining biotechnology, a biotechnology firm, and of measuring biotechnology activities. For these reasons, *Biotechnology Statistics* includes information on the definitions used to collect biotechnology data as well as information on the methodology. Page 11 of *OECD Biotechnology Statistics 2006* summarises the necessary metadata for each country in a single table.

Business Sector

The following metadata are needed to support indicators of business sector biotechnology activities:

Year: Reference year for the biotechnology statistics.

Definition of Biotechnology: How biotechnology was defined, for instance in questionnaires sent to firms. Possible options include the OECD list based definition or other definitions of modern biotechnology.

Definition of a Biotechnology Firm: How a biotechnology firm is defined. For guidance, three defining characteristics are in common use:

Core biotechnology firm: The firm's main activity is biotechnology. Most of these firms are likely to be small, with less than 500 employees.

Most consulting reports, such as by Ernst and Young, are limited to core biotechnology firms.

Bio-active firm: Includes all firms with some activities in biotechnology. Some of these firms will be very large, with only a small share of total economic activities due to biotechnology.

R&D status of the firm: Both the definition of a core and a bio-active firm can vary depending on whether or not the firm performs biotechnology R&D. For example, R&D surveys capture all bio-active firms with some biotechnology R&D.

Definition of a Biotechnology Employee: All employees that have biotechnology-related responsibilities in R&D, production, administration, and management.

Sample Frame: Describe the basic structure of the sample frame. It is often difficult to construct a sampling frame for surveys of biotechnology firms because firms with some biotechnology activities can be difficult to identify. Three methods of constructing the frame are in common use:

Large Scale Survey: All firms are randomly sampled and asked if they have biotech activities. To save costs, these surveys are usually limited to sectors where biotechnology is thought to have applications.

R&D Survey: All respondents to the business R&D survey are asked if they have expenditures for biotechnology R&D.

Secondary Sources: A list of biotech firms is constructed from a diverse set of sources, such as biotechnology industry associations, searching patent data to identify firms that have applied for a biotechnology patent, results of previous R&D surveys, applicants to government support programmes for biotechnology R&D, etc.

Survey Response Rate: Give the percentage of the sampling frame that responded to the survey. In some cases this is not relevant, as when biotechnology data are extracted from the annual reports of firms.

Weighting and Extrapolation: Give details on weighting and extrapolation methods, if used. When the survey response rate is less than 100%, the results for non respondents can be extrapolated or imputed. When the survey is a random sample of a much larger population, the results should be weighted to reflect the full population. In both cases weighting and extrapolation techniques estimate indicators for the complete population of biotechnology firms.

Region: Give details if the survey is limited to a region or province of a country.

Public Biotechnology R&D Expenditures

The main challenge for indicators of public sector biotechnology activities is to determine if all government support or only a part of such support is adequately covered. The necessary metadata for government support of biotechnology R&D include the following:

Year: Reference year for the biotechnology statistics.

Definition of Biotechnology: How is biotechnology defined in support programmes for biotechnology R&D, etc.

Level of Government: Government R&D data can be limited to specific levels of government, such as federal expenditures only. Some information on this is necessary, particularly when different levels of government (federal, provincial/state, municipal) can fund biotechnology R&D.

Coverage: How was government R&D expenditure for biotechnology obtained? This can be based on surveying the location of the expenditures (for instance, universities and government research institutes) or on the source of the funding (different government ministries). The template on public biotechnology R&D uses the latter method.

Endnotes

[1]   The report can be downloaded for free from http://www.oecd.org/dataoecd/51/59/36760212.pdf

[2]   As an example, Biotechnology Statistics includes an output indicator for the total sales of biotechnology goods and services as a proxy measure of the economic effects of biotechnology. However, market sales data combine non-biotechnology inputs into the production of the good or service plus biotechnology inputs. The share of biotechnology inputs in the sales price is likely to vary substantially across applications, but less within applications.

[3]   An earlier version of this template was produced in 2003 and circulated to OECD experts. Based on experience with the 2003 version, the complexity of the current template was reduced in order to focus on collecting useable data.