

Defining biotechnology – carefully

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Henry Miller's opinion piece, *Biotech's defining moments* [1], in the February issue of *Trends in Biotechnology*, raises the important problem of how to define biotechnology and some of the problems that definitional issues have created, in his opinion, for regulation. He then turns to the report *OECD Biotechnology Statistics 2006* (<http://www.oecd.org/dataoecd/51/59/36760212.pdf>), which he cites as an 'egregious and recent example of definitional dysfunction' that partly uses a broad definition of biotechnology that would 'yield worthless results'. He concludes that 'the data in the OECD report are garbage'.

Being responsible for the report, we are bemused by Miller's scathing review. The irony is that we share his concerns over the need to carefully define biotechnology – which is precisely what the report does.

Miller's main criticism is that the data are derived from different and worthless definitions of biotechnology in questionnaire surveys of firms. He notes, correctly, that the OECD's single definition of biotechnology can cover everything from modern biotechnology to fermented foods. He also seems dissatisfied with the OECD's list-based definition that asks firms if they are active in seven main categories of modern biotechnology. For instance, the list-based definition includes 'DNA/RNA' as a major category and gives examples of relevant technologies, such as genomics, pharmacogenomics, genetic engineering, and DNA and RNA sequencing. A third definitional failing, according to Miller, is that some surveys use other definitions of biotechnology.

We agree with Miller that the single definition, when used alone, is of minimal value, which is exactly why the results in the report are *not* based on the single definition, as noted in the methodology chapter. The OECD recommends that national statistics offices provide survey respondents with both the single and the list-based definition of biotechnology [OECD (2005) *A Framework for Biotechnology Statistics*; <http://www.oecd.org/dataoecd/5/48/34935605.pdf>]. The list-based definition is essential because it is the only way of limiting results to respondent firms that are active in modern biotechnology.

The OECD report provides data for up to 26 countries on biotechnology employment, sales and R&D expenditures in firms. The results for 15 countries are based on firms that meet the requirements of the OECD list-based definition, while the results for an additional seven countries should

similarly be limited to firms active in modern biotechnology, giving largely comparable results for up to 22 countries. Four countries did not limit their definition to modern biotechnology (although they exclude fermented food and other traditional products). This is clearly noted in the methodology section and in the tables and figures.

Definitional problems, however, do not end at how biotechnology is defined. There are also serious issues over how to define a biotechnology firm and biotechnology R&D, employment and revenues. Many collections of biotechnology statistics are limited to data on core or dedicated biotechnology firms and assume that all revenues, employment and R&D within these firms are related to biotechnology. Survey research has consistently shown that this is not the case. Furthermore, failing to include the significant biotechnology activities of large diversified firms can result in substantial underestimates of biotechnology activities. These issues are fully discussed with examples in the methodology section of the OECD report.

An important feature of the OECD report is that it provides extensive information on factors that affect the quality and comparability of national biotechnology statistics. As an example, Table 1 is a modified extract for 21 countries of a table in the report that summarizes methodological issues. It provides details on how biotechnology is defined, how a biotechnology firm is defined, the sample frame, the survey non-response rate and whether or not the survey results were extrapolated to account for sampling methods or non-respondents. The bar charts of the report also use distinct patterns to identify major differences that affect comparability. For example, the chart for sales of biotechnology products clearly differentiates between data for total sales of core biotechnology firms, which includes sales of products that are not produced using biotechnology and excludes sales of biotechnology products by large diversified firms, versus more accurate sales data for biotechnology-based products only from *all* firms active in biotechnology.

The OECD is continuing to work with member countries to standardize how biotechnology firms, sales, employment, R&D and other statistics are defined. A future *Biotechnology Statistics* report should require far fewer footnotes to identify differences in methodologies or definitions. Until then, we will continue to document fully issues that can influence comparability and interpretation. Of course, this does require the reader to review the methodological chapter and the footnotes to the tables and charts carefully.

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Table 1. Methodological information on biotechnology statistics surveys^a

	Year	Biotechnology definition	Biotech firm definition ^b	All firms innovate?	Sample frame ^c	Response rate	Extrapolation
Australia	2003–2004	OECD	R&D	Yes	R&D	86%	Partial ^d
Belgium	2003	OECD	All	I.n.a.	Secondary	31%	No
Canada	2003	OECD	All	Yes	Secondary	80%	Yes
China (Shanghai)	2003	Modern	All	I.n.a.	Secondary	39%	No
Denmark	2003	None given	R&D	Yes	R&D	63%	Yes
Finland	2003	Modern	Core	I.n.a.	Secondary	71%	Partial ^d
France	2003	OECD	R&D	Yes	R&D	72%	Yes
Germany	2004	OECD	All	No	Secondary	65%	Yes
Iceland	2003	OECD	R&D	Yes	R&D	100%	N.r.
Israel	2002	OECD	All	No	Secondary	96%	Yes
Italy	2004	OECD	R&D	Yes	R&D	50%	No
Japan	2003	Mixed ^f	All	No	Secondary	76%	No
Korea	2004	Modern ^g	All	I.n.a.	Sector	100%	N.r.
New Zealand	2005	OECD	All	No	Secondary	93%	No
Norway	2003	OECD	R&D	Yes	R&D	95%	Yes
Poland	2004	OECD	I.n.a.	Yes	I.n.a.	34%	No
South Africa ^e	2002–2003	Mixed	All	No	Secondary	72%	No
Spain	2004	OECD	R&D	Yes	R&D	86%	Yes
Sweden	2003	Modern	Core	Yes	Secondary	I.n.a.	I.n.a.
Switzerland	2004	OECD	R&D	Yes	R&D	81%	Yes
United States	2003	OECD	R&D	Yes	R&D	81%	Partial ^d

^aAbbreviations: N.r., not relevant; i.n.a., information not available.

^bR&D, firms that perform biotechnology R&D; all, includes all identified firms with biotechnology activities; core, limited to dedicated biotechnology firms.

^cR&D, national R&D survey; secondary, combination of different sources to identify biotechnology firms; sector, all firms active in specific sectors.

^dImputed or extrapolated results limited to selected firms or indicators, or to missing survey questions for respondents only.

^eLarge firms in traditional biotechnology (fermented food products) were excluded, but some traditional and second generation biotechnology firms are included in the sample.

^fWherever possible, the results are limited to 'modern' biotechnology, but this could still include some second-generation or traditional biotechnology activity.

^gCould include some second generation biotechnology.

Reference

- 1 Miller, H.I. (2007) Biotech's defining moments. *Trends Biotechnol.* 25, 56–59

AGORA initiative provides free agriculture journals to developing countries

The Health Internetnetwork Access to Research Initiative (HINARI) of the WHO has launched a new community scheme with the UN Food and Agriculture Organization.

As part of this enterprise, Elsevier has given hundreds of journals to Access to Global Online Research in Agriculture (AGORA). More than 100 institutions are now registered for the scheme, which aims to provide developing countries with free access to vital research that will ultimately help increase crop yields and encourage agricultural self-sufficiency.

According to the Africa University in Zimbabwe, AGORA has been welcomed by both students and staff. "It has brought a wealth of information to our fingertips", says Vimbai Hungwe. "The information made available goes a long way in helping the learning, teaching and research activities within the University. Given the economic hardships we are going through, it couldn't have come at a better time."

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