Public Value Mapping in a Developing Country Context

A Methodology to Promote Socially Beneficial Public Biotechnology Research and Uptake in India

Outline of a Case study

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1. Public Value Mapping in a Developing Country Context

This document outlines the necessary components of a "public value mapping" analysis of government supported biotechnology research in India. The objective is to outline how a public value mapping approach can contribute to analyses of the social benefits of public-sector research in developing country contexts.

1.1. Public Value Mapping: Analyzing Social Outcomes of Public Research

Public Value Mapping (PVM) is a new research evaluation approach that focuses on the public value of academic or public sector sponsored research (Bozeman, Gaughan and Bozeman 2001). This method goes beyond research evaluation that focuses only on outputs of research, by also focusing on the *impacts* of outputs. Moreover, in considering the impacts of publicly supported research, a driving motivation is to understand social impacts and outcomes, in addition to the more studied scientific or economic impacts of publicly supported research.

This is important because, first, a concern with outcomes and, in particular, social outcomes is sorely needed, to evaluate whether publicly supported research is meeting the societal needs it seeks to meet. Second, a concern with societal impacts of public research necessarily transcends mere *program* evaluation. Instead, the concern is with "the ability of sets of programs, agencies and even sets of agencies to achieve broader social impacts missions" (Gaughan and Bozeman 2001:7). Such a focus on linkages allows for a more holistic understanding of the social impacts of public research than a mere program-by-program evaluation would.

Third, in considering social impacts, it is possible not only to analyze nature and magnitude of impacts but also their distribution, an under-researched but crucial issue for research evaluation studies. In our present era of transformative technological change, there is urgent need for research evaluation approaches which can analyze the distributive impacts of the development and deployment of new technologies in diverse contexts.

1.2. Public Value Mapping in a Developing Country Context

This document argues for the need to apply a PVM approach to a developing country context. It does so through outlining how a PVM framework can usefully illuminate the challenges to meeting societal needs from public sector research. As an example, it focuses on publicly supported biotechnology research in the Indian agricultural sector.

The rationales for a PVM analysis of biotechnology research in India are:

First, to draw on the advantages of the PVM approach in analyzing the social impacts of publicly supported research in this critical new area, viz. research and development of biotechnological innovations in agricultural sectors of developing countries.

Second, such an analysis can illuminate the utility, strengths and limitations of a PVM approach, through applying it to a particular case. This can assist in evolution and further development of this new framework of analysis.

Third, whether and how the challenges of using public value mapping as a research evaluation methodology are similar or distinct in developing countries can be considered. Since PVM focuses on the public value of government-supported research, it is particularly important to test its utility in developing country contexts, since research and development spending is dominated by the public sector in these countries.

1.3. Public Value Mapping: the Case of Biotechnology Research in India

1.3.1. Why Agricultural Biotechnology?

Modern biotechnology constitutes a new set of techniques for use in agriculture which require substantial up-front research and development investments. Furthermore, there are widely made claims by supporters and producers of biotechnology that its use in agriculture is especially critical for developing countries, in order to meet societal needs relating to food security. This is contested by critics of the technology, who claim that scarce public funding should not be allocated to this controversial area and that lower-tech agricultural innovations should be the priority and focus of public research. Mapping the public value, i.e. the societal impact and outcomes, of public research and development (R&D) investments in biotechnological innovations for use in agriculture is thus urgent.

1.3.2. Why India?

India offers a representative case of a developing country agricultural context, both ecological (it is a tropical agricultural country and a center of crop genetic diversity and biodiversity) as well as social (with small holdings, subsistence farming, labor-intensive agriculture and productivity challenges, as well as state support for agriculture, and food security and access concerns). It also has a substantial scientific and agricultural research infrastructure *and* public sector interest in biotechnology research for use in agriculture. These factors make it a useful and potentially broadly illustrative developing country focus for a PVM analysis of the social outcomes of publicly supported biotechnology research.

Although there are not many concrete outputs of research investments in the biotechnology area in India yet (whose societal impacts can be evaluated), the PVM approach goes beyond evaluating concrete products as outcomes, and includes more “intangible” outcomes such as increased distribution of knowledge generation capacity. Given a basic agricultural research infrastructure already long-established in India, these intangible outcomes and their distribution can themselves be the focus of a PVM analysis.

In undertaking such an analysis, a number of steps are required. Sections 2 and 3 of this outline describe key components of the PVM framework that would require elaboration in undertaking an analysis of social value of agricultural biotechnology research in India. Section 2 discusses the public values that publicly supported biotechnology research in India is driven by, as well as discusses indicators for measuring such values. Section 3 discusses the biotechnological research domain within which publicly supported research in India occurs. A key aim of the PVM approach is to identify the *causal logic*, if any, between stated public values and actual public-sector funding priorities and activities, to evaluate whether and how societal outcomes can or will match stated public values. Section 4 discusses this causal logic. Section 5 summarizes the merits and benefits from undertaking such a PVM analysis.

2. Identifying and Analyzing Public value of Research

A first step in a PVM analysis is identifying the goals and values driving publicly funded research. Public values, as understood within a PVM framework, are those in which:

> “the entire society has a stake, including such factors as environmental quality and sustainability, health care and longevity, provision of basic needs such as housing, food, heating and cooling etc. Since many of these issues depend on distributional questions and not just on the ability to produce technologies and commodities, PVM is concerned not only with positive social outcomes but with equity of social outcomes, and

related access to the benefits produced by research" (Bozeman 2001, 8).

Since public values are central to the PVM research evaluation approach, applying the approach to a case necessarily "begins with the mission and seeks to work back to determine the relationship of government actions to the mission" (Bozeman 2001, 18).

As stated in its "Biotechnology – A Vision (Ten Year Perspective)" the public value of biotechnology research in India, as envisioned by the Department of Biotechnology, is:

> "Attaining new heights in biotechnology research, shaping biotechnology into a premier precision tool of the future for creation of wealth and ensuring social justice – especially for the welfare of the poor" (DBT Undated, 1).

As seen from the above, the public value of publicly supported biotechnology research, according to the Department of Biotechnology's Vision Statement, derives from:

- attaining *new heights in biotechnology research*;
- shaping biotechnology into *a precision tool for creation of wealth*;
- using biotechnology research to *ensure social justice and welfare of the poor*.

This vision of public value is elaborated in the Department of Biotechnology's Mission Statement, which states its Mission (in a Ten-Year Perspective) as:

- Realizing biotechnology as one of the greatest intellectual enterprises of humankind, to provide the impetus that fulfills this potential of understanding life processes and utilizing them to the advantage of humanity;
- To launch a well-directed effort with significant investment, for harnessing biotechnological tools for generation of products, processes and technologies to enhance the efficiency, productivity and cost-effectiveness of agriculture, nutritional security, molecular medicine, environmentally safe technologies for pollution abatement, biodiversity conservation and bio-industrial development;
- Scientific and technological empowerment of India's incomparable human resource;
- Creation of a strong infrastructure both for research and commercialization, ensuring a steady flow of bio-products, bioprocesses and new biotechnologies.

As seen from the above, one set of public values with direct bearing on biotechnology research in agriculture is the DBT desire to "launch a well-directed effort with significant investment, for harnessing biotechnological tools for generation of products, processes and technologies to enhance the efficiency, productivity and cost-effectiveness of agriculture…". Two others of relevance as targets for a PVM analysis are "scientific and technological empowerment of India's…human resource" and "creation of a strong infrastructure for research and commercialization".

The question for a PVM analysis then is: are these public values likely to be attained through the DBT's current funding priorities and practices? While this question is key to a PVM analysis, a logically prior question also is: are these "public values" at all, in the sense of being widely shared or of benefit to society as a whole? Case analyses of particular areas of publicly supported research, such as biotechnology, can illuminate the challenges inherent in identifying public values, as the discussion in the next sections on identifying hierarchies between values, and isolating value indicators, also suggests.

2.1. Sorting Values and Their Relationships

In identifying public values, one element of the PVM framework is to postulate hierarchies amongst publicly articulated values. This entails identifying whether some values are prime versus instrumental (i.e. values which are ends in themselves, versus those which are the means to a larger end). Identifying hierarchies between values can assist in analyzing which public values are closer to being realized, and hence whether public value is being maximized.

It can also assist in identifying points or levers of intervention, as in cases where the instrumental value, or the means to a larger end, can be a target of intervention.

From the DBT's mission statement, it is possible to begin to identify some potential hierarchies amongst stated values. Thus, a "well directed effort with significant investment" can be seen as an instrumental value (or a means) to another instrumental value, that of enhancing the "efficiency, productivity and cost-effectiveness of agriculture". This, in turn, is another means to the prime value (or end) of enhancing the welfare of the poor.

In distinguishing between prime and instrumental values, however, another key challenge for the evolving PVM framework (which case analyses such as the one proposed here can illustrate and help to address) are the nature of the links between instrumental and prime values. Such links may be tenuous or may require empirical verification. Thus, for example, it remains a subject of empirical inquiry whether or not enhancing the efficiency, productivity and cost-effectiveness of agriculture can aid in enhancing the welfare of the poor. At any rate, such an analysis of links between values can illuminate the additional institutional and regulatory interventions that might be required to achieve the prime value.

2.2. Metrics for Public Values

Another key step in a PVM analysis is developing measurable indicators for public values, once such values have been identified. A key challenge for the PVM framework, again, is identifying and including in the analysis both absolute and distributive values and their concurrent indicators. Achieving distributive values are a key motivation for a PVM approach, as discussed earlier, hence being able to identify measurable indicators to assess distributional impact of publicly supported research is a central aim of the PVM approach.

In the case of publicly supported biotechnology research in India, some illustrative indicators (which can be quantitative or qualitative) for key values could include:

<u>Value: A "well-directed (biotechnology research) effort with significant investment"</u>

Indicators could include: (a) existence of a clearly laid out investment strategy, with clear organizational mandates; (b) whether commitment of funds to biotechnology research are increasing as a percentage of overall public sector support for agricultural research.

<u>Value: Enhancing the "efficiency, productivity and cost-effectiveness of agriculture":</u>

In this case, indicators could be linked to particular research products, such as, for example, transgenic pest-resistant cotton. Indicators could include (a) increased cotton production; (b) reduced pesticide use on cotton; and/or (c) reduced input costs.

<u>Value: "Creation of a strong infrastructure for research and commercialization":</u>

This is akin to increased capacity for research and knowledge production in the area of biotechnology and increased ability to produce sustained knowledge and innovations or know-how. Some indicators here could include (a) effective linkages between research institutes; (b) linkages between research, safety assessments and commercialization.

It is clear from these illustrative examples that identifying appropriate indicators for public values is both a key element of and a central challenge in applying the PVM approach. This challenge is distinct for different issue-areas, hence requiring diverse applications of the evolving PVM approach to different cases, to aid in its conceptual evolution.

Thus, for example, in the case of breast cancer (where the PVM methodology has been applied most extensively to date) certain indicators for public values find broad agreement. Thus, mortality rates and screening rates are widely acknowledged as both good and easily measurable indicators for public values such as reducing breast cancer mortality or reducing disparities in incidence of breast cancer. Such measurable and well-matched indicators are not necessarily as easily identifiable in the biotechnology case, with its more diffuse, qualitative and also contested public values. Yet, assessing whether public value is being maximized is nonetheless urgent in such contested domains.

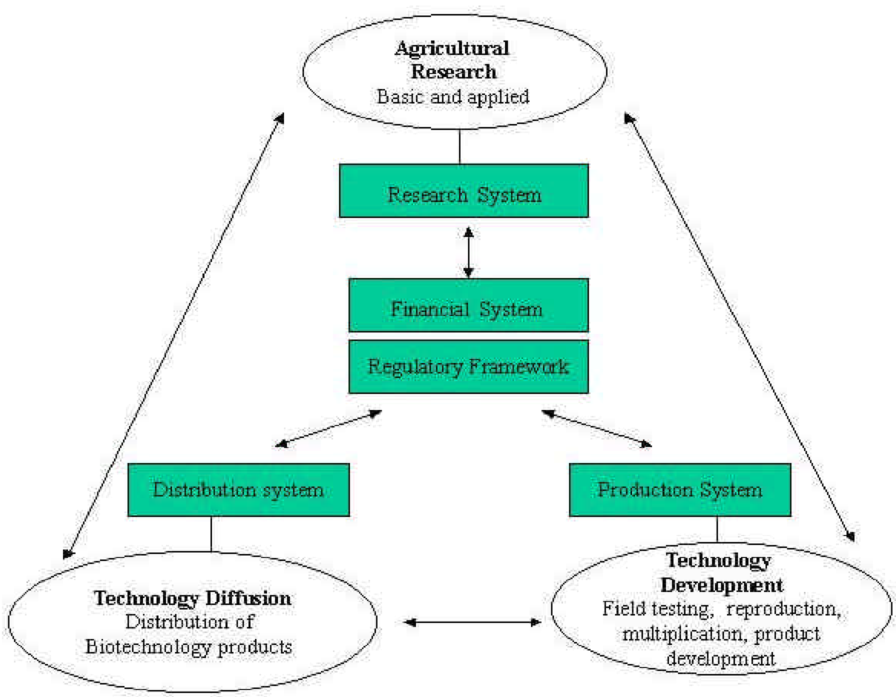
3. Mapping the Biotechnology Research and Social Outcomes Domain

The PVM approach also requires analysis of the larger context within which public sector research is undertaken, since this context shapes the social impact of the research. Analysis of what can be termed the 'research and social outcomes domain' can be divided into the macro-, meso- and micro-levels. For a PVM analysis of biotechnology research in India, therefore, it would be necessary to map this broad research and outcomes domain.

3.1. The Macro-Environment Level

Figure I below provides a useful overview of the linkages that would need to be studied as part of a PVM analysis, in order to identify those which are missing or inadequate. The figure is taken from an OECD study of biotechnology research needs and challenges in developing countries (Brenner 1997) and remains a relevant illustration of the key components of a research and outcomes domain.

As clear from the diagram, a biotechnology research and social outcomes domain consists not only of public funding agencies and researchers, but also of technology developers and end users. This is captured in the three components of the diagram: agricultural research, technology development, and technology diffusion. Furthermore, as illustrated through the arrows



in the diagram, each of these influence the other, instead of being related in a linear manner. A PVM analysis would elaborate on and describe each of these component parts of a biotechnology research and social outcomes domain for India.

Figure 1: The Biotechnology Research and Social Outcomes Domain

Source: Brenner, Carliene, Biotechnology Policy for Developing Country Agriculture, OECD Development Center, Policy Brief No. 14, 1997. Figure 1, pp. 12.

3.2. The Institutional Level

Moving from the macro-level to the institutional level, the Department of Biotechnology

Table 1: Illustrative Examples of Public Sector Priorities in Biotechnology Knowledge Generation in India

Biotechnology Research to Meet Priority Needs: A Department of Biotechnology Perspective			
Abiotic Stress Tolerance		**Delayed Ripening**	**Pest Resistance**
Cold Tolerance Gene: A gene tolerant to extreme cold temperature from a plant species of the Spiti Valley of Himachal Pradesh has been identified, isolated, sequenced and cloned. The long-term objective [is] development of transgenic plants harboring cold induced genes under the control of cold induced promoter.	**Salt Tolerance Gene:** A Betaine Aldehyde Dehydrogenase (BADH) gene has been isolated from mangrove species Avicennia marina [and] successfully integrated into tobacco system through Agrobacterium mediated transformation. Analysis of transagenic tobacco plants confirmed functional integration of this gene …Two more genes [for] salinity tolerance (Superoxide dismutase and Catylyse) have been isolated, fully sequenced and characterized.	**Delay ripening of banana:** Post harvest losses in banana limit their export to distance markets due to poor shelf life. [Biotechnology can help] in delaying the ripening process and increasing shelf life. Transgenic delay ripening tomato is a commercial reality abroad. [Similarly], three fruit ripening genes have been cloned at National Botanical Research Institute (NBRI), Lucknow [and] the antisense construct has been expressed in Agrobacterium.	**Chickpea Improvement Program** Chickpea is the third most important seed legume and in India… it ranks first amongst pulses in production and accounts [for] about 75 percent of world production. This crop is beset [by] chickpea blight and chickpea wilt. The major abiotic stress [limiting] production are drought and salinity. NCPGR propose[s] to develop improved chickpea varieties tolerant to abiotic stresses and resistant to wilt and blight.

Source: As reported in the News Update section of the Department of Biotechnology (DBT) Newsletters, February and November 2000 Available online at: http://dbtindia.nic.in/prog_nn_0.html

(DBT) within the Ministry of Science and Technology is at the center of the Indian biotechnology research domain. The DBT is the main source of public sector funding for biotechnology research in India. Table 1 provides illustrative examples of the kind of publicly supported biotechnology research currently underway in India. The main focus of a PVM analysis would be to analyze the linkages between the kind of research being supported and desired social outcomes (including the challenges facing the process of translating appropriate research into desired outcomes).

3.3. The Meso- Level

The meso-level refers to the organizational networks level, i.e. the links between the funding agencies, such as the DBT, and researchers. According to the depiction in Figure 1, this consists of links between the “research system” and “agricultural research”. The PVM approach terms this set of linkages the research ecology. Mapping this research ecology in detail, i.e. mapping linkages between the sources of research funding, researchers and research programs can reveal both the opportunities and the bottlenecks in public support for biotechnological research, so that it may fulfill stated social objectives. Mapping this research ecology can also illuminate the decision-making process within a funding agency, linkages between researchers and funders, and between research programs. This, in turn, can be useful in illustrating how priorities are being set in the kind of research that is supported.

Another element of meso-level linkages are government-led collaborations, such as, for example, the long-established Indo-Swiss Collaboration in Biotechnology. As described by the Department of Biotechnology:

> "The new phase of the Indo-Swiss collaboration in biotechnology was initiated in April 1998....In the area of agriculture, biotic, abiotic stress and soil improvement bioremediation, biopesticides and biofertilisers were identified... All these areas are focused around crop productivity and protection of wheat and pulses. ...Based on 22 Indian and 82 International experts peer reviewing and recommendations of JAC meetings, 18 joint project involving 42 Indian and 27 Swiss research groups have been so far supported [DBT 2000]

A PVM analysis would focus on who the "experts" are, the kinds of projects being supporting, and the societal needs being met. It would also, more broadly, seek to identify generalizable lessons from such collaborations, so as to avoid their becoming isolated efforts without linkages to other initiatives or to larger policy goals.

4. Causal Logic: Links between Research and Social Value

Following identification of public values and their measurable indicators, and a mapping of the research and social outcomes domain, the next step in a PVM analysis is to identify the causal logic, if any, between stated public values and the research activities supported (given the institutional context within which they are occurring). Such an analysis of causal linkages will address the following: what assumptions link stated public goals and the activities funded? Do such assumptions hold? Why or why not? Such a PVM analysis should illuminate whether the hurdles to meeting social objectives lie in the links between funders and researchers and/or between research (once done) and the larger context within which is to be converted to publicly valued outcomes.

Thus, it can illuminate whether a mismatch between values and outcomes arises from hurdles within the research system (such as the "wrong" kind of research being done, misguided funding priorities, insufficient funds, misallocation of funds, lack of research capacity, bureaucratic hurdles to disbursement of funds, nepotism, corruption, lack of merit, duplication of research etc.) Or rather, it may reveal the bottlenecks and hurdles to converting (well-conducted and appropriate) research to socially desired outputs.

5. The need for a PVM analysis of biotechnology research

A PVM analysis of public agricultural biotechnology research in India should help to identify the links (or lack thereof) between biotechnology research activities and products, and expected and desired social outcomes and public value. It should thus highlight the hurdles and challenges to maximizing the public value of biotechnology research and use in the agricultural sector in India. Moreover, it should reveal the distinct challenges and hurdles to utilizing a PVM framework in a developing country context, if any.

As suggested by its elaborators, the PVM approach is explicitly intended to be prescriptive and to aid in program planning, design and implementation (Gaughan and Bozeman 2001, 12). The analysis should thus have clear implications for program planning, design and implementation of publicly supported biotechnology research in India.