ASTI Agricultural Science & Technology Indicators

Agricultural Science and Technology Indicators (ASTI) Initiative

Summary Report of the Consultation Workshop on Identifying Supplementary Indicators

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Nienke Beintema
Head ASTI initiative

Summary

The objective of the ASTI Consultation Workshop was to give guidance on how to improve and expand the ASTI initiative's activities so that it responds better to the information needs of policymakers and stakeholders. The discussion during the workshop focused on the following five topics: (1) Adopting an agricultural innovation system perspective; (2) Deepening agricultural R&D input indicators (the traditional focus of the ASTI initiative); (3) Agricultural R&D output indicators; (4) Agricultural R&D process indicators; and (5) Beyond the national perspective.

With regard to the agricultural innovation system perspective, the outcome of the discussion was that the ASTI initiative will continue to focus on agricultural R&D agencies, but try to better capture the 'embeddedness' of those agencies in the wider agricultural innovation system.

Specific recommendations were made for agricultural R&D input, output, and process indicators respectively. In all cases, additional requests for data should be first piloted. Moreover, it was suggested to differentiate between baseline data (i.e., necessary in order to produce regional and global aggregates and make cross-country comparisons) and additional data – the latter only to be collected when there is a clear demand for such data from policymakers, donors, or other relevant stakeholders. This requires a flexible survey instrument that can be tailored to the specific needs of the users of the data.

Three areas were identified that could complement the national perspective, namely: (a) International and regional agricultural research organizations; (b) Donor support; and (3) Agricultural R&D investments by multinational companies.

In addition to recommendations on additional indicators, the workshop participants also stressed the need for: (a) Keeping the ASTI dataset more up-to-date; (b) Improving the global coverage (in particular Central Asia and the Caucasus and the Middle East and North Africa are poorly covered); (c) Mobilizing more capacity to analyze and use the ASTI data; and (d) Capacity building at the national level.

1. Introduction

The Agricultural Science and Technology Indicators (ASTI) initiative is a project with a long history within the CGIAR. It started at the International Service for National Agricultural Research (ISNAR) in the mid-1980s and became a joint project with the International Food Policy Research Institute (IFPRI) from the mid-1990s to early 2004. Since then the program has been managed by IFPRI. While policy interest in ASTI-type indicators has been quite constant through time, donor interest has fluctuated considerably. When it comes to statistics a classic (international) public good problem arises – everyone agrees on the need for such statistics but few want to pay for them. In particular during the past few years, the ASTI initiative has encountered difficulties mobilizing sufficient funding for its activities.

A generous grant provided by the Bill and Melinda Gates Foundation (BMGF) in 2008 is giving the ASTI initiative substantial additional resources for the coming three years. It not only will help to finance updates of the ASTI data in sub-Saharan Africa and South Asia, but also to explore whether additional data can be collected. It is for the latter reason that the ASTI initiative organized a workshop to consult with its stakeholders. This report is presenting the outcomes of this ASTI consultation workshop, which was held in Entebbe on 20-21 January 2009. It was attended by a mix of national, regional and international stakeholders (see list of participants – Annex A). Besides this workshop, the consultation will continue in the coming months with those who could not attend the workshop and would like to comment on the consultation outcomes presented in this report.

The overall objective of the consultation workshop has been *to give guidance on how to improve and expand the ASTI initiative's activities, so that it responds better to the needs of policymakers and stakeholders*. The discussion during the workshop focused on the following five topics:

1. Adopting an agricultural innovation system perspective;
2. Deepening agricultural R&D input indicators (the traditional focus of ASTI);
3. Agricultural R&D output indicators;
4. Agricultural R&D process indicators; and
5. Beyond the national perspective.

The structure of this report basically follows the structure of the workshop program (see Annex B) and the background note that was prepared prior to the workshop (Annex C). The report focuses in particular on the five discussion sessions that followed after the two more generic presentations: 'An overview of the ASTI Initiative' (Annex D) and 'GFAR's perspective on the ASTI Initiative' (Annex E)[1]. Each discussion session was introduced by one or more presentations and sometimes backed by background notes. Recommendations were formulated at the end of each discussion session. During the concluding session these recommendations were once again reviewed and amended, but now with a more complete picture in mind.

[1]For the workshop PowerPoint presentations see the ASTI website: www.asti.cgiar.org.

2. Some general observations

The presentation and discussions during the workshop brought some critical issues to the table that are beyond the question of what type of additional indicators the ASTI initiative should collect. Most importantly these are:

1. An update of the ASTI datasets is urgently needed. Dated datasets undermine the relevance of the findings and recommendations.
2. Certain regions like Central Asia and the Caucasus and for most countries of the Middle East and North Africa have not been covered by the ASTI initiative (for a long time).
3. Underutilization of the ASTI data at both the national and international level. The ASTI initiative currently lacks the capacity to engage in more in-depth analysis of the data and to bring the findings of the ASTI initiative under the attention of the relevant policymakers and research managers. Partnerships will be needed in order to mobilize more analytical capacity and capacity to disseminate the results.
4. Capacity at the national level to collect, analyze and use ASTI data is still rather weak. Intervals between surveys (5 years or more) make that capacity/experience get lost in the mean time.
5. GFAR strongly advocated the need for more and better documentation of the impact of agricultural R&D. The role of the ASTI initiative is to provide some of the key data needed for impact studies, but does not consider conducting impact studies to be part of its present mandate.
6. Rather than expanding the number of indicators to be collected by the ASTI initiative, it was recommended to invest more in the analysis and use of the current set of indicators.
7. Information on agricultural extension/advisory services and agricultural development organizations is weak for most countries. FAO is working on securing funding for collecting such information and the ASTI initiative participates in the discussion.

3. Adopting an agricultural innovation system perspective

When the ASTI project started at ISNAR in the mid-1980s, the dominant opinion at that time was that lack of agricultural R&D capacity at the national level (both in volume and quality) constituted the most critical bottleneck in agricultural innovation in developing countries. Hence the dominance of the *national agricultural research system* (NARS) concept at that time. In more recent years, however, the *agricultural innovation system* (AIS) concept has taken over as the dominant analytical concept. It takes a far more holistic view of the innovation process and acknowledges the fact that the creation of new knowledge is not the exclusive domain of agricultural R&D agencies only and that there are many other factors that shape up innovation processes and determine their success.

The dilemma for the ASTI initiative is how to deal with this shift in perspective. Should it stay focused on agricultural R&D or should it adopt the far broader AIS concept and start collecting indicators on the various components and dimensions of the agricultural innovation system? In order to answer this question, two on-going lines of work dealing with agricultural innovation systems and measuring innovation performance indicators were presented and

discussed during the consultation workshop. One is the work by Judith Francis of CTA and the other is by David Spielman and his colleagues of the ISNAR division of IFPRI.

The Agricultural Science, Technology and Innovation Capacity Building project of CTA[2] comprises three major components:

1. Training of ACP experts in innovations systems (IS) thinking and how to apply the IS concept to understand innovation processes in the agricultural sector;
2. Support to case studies in ACP countries on the agricultural, science, technology and innovation system. These studies usually focus on one particular commodity or cluster of commodities; and
3. Engaging the ACP community in identifying indicators for measuring innovation performance.

The latter is a new activity and the first meeting was held in May 2008 at which the experts agreed that there was need to consider input, output and process indicators for measuring the performance of agricultural innovation systems. The questionnaire used in the conduct of the case studies was presented at the workshop. What became clear during the presentation and later in the discussion is that the concrete examples of AIS analysis (the CTA case studies, but also others) nearly always focus on a specific sub-sector or commodity. At a higher level of aggregation, however, the IS concept starts to lose its attractiveness as an analytical tool as differences between sub-sectors and commodities are being lost.

The Agricultural Development and Innovation Index (ADII) has recently been developed by Spielman and Birner (2008) and Spielman and Kelemework (2009). It is a composite index consisting of more than 40 indicators, derived from some 25 different sources. ADII is modeled after the EU Innovation Index and other similar performance indices. The indicators have been clustered in four distinctive domains of the agricultural innovation system, namely: (a) Knowledge and education; (b) Bridging institutions; (c) Business and enterprise; and (d) The enabling environment.

The data collection costs for the index are being kept low by exploiting existing data sources. However, this approach has its limitations as the choice of indicators is steered strongly by the availability of data. Often (far away) proxies are being used to capture a certain aspect. At the same time, important aspects or characteristics of the agricultural innovation system are not being captured due to lack of data. For example, the index does not capture the quality of the linkages between the different agricultural innovation stakeholders / domains. There are no ready-to-take indicators available that capture this important aspect. In order to improve the ADII on this aspect, Spielman and Kelemework (2009) set out to measure the quality of the linkages between the different domains of the agricultural innovation system in two case study countries – Ethiopia and Vietnam. They opted to focus on one sub-sector or commodity only in each country and take that as representative for the whole agricultural innovation system. Adding 'system' indicators to the index improved the ADII score for both countries. All-in-all, these 'system' indicators constitute an important addition to the ADII, but they also show that such fine-tuning will be costly as it requires a substantial amount of data collection. This is also because innovation system linkages seem to be best captured at the commodity or sub-sector level.

[2] The Technical Centre for Agricultural and Rural Cooperation (CTA) is based in the Netherlands, but targets African, Caribbean and Pacific (ACP) countries that have historical ties with the European Union.

During the discussion that followed the two presentations, the workshop participants agreed that it would be wise for the ASTI initiative to limit itself to agricultural R&D rather than expanding to collect indicators on the multiple dimensions of agricultural innovation processes. The AIS concept is now being piloted as an analytical tool at the sub-sector or commodity level and the role of agricultural R&D in the framework of its contribution to agricultural innovation performance needs to be further developed and piloted. However, this makes full coverage of the agricultural sector in terms of AIS indicators very time-consuming and expensive

Nevertheless, the ASTI initiative should try to provide a better picture of how agricultural R&D agencies are embedded in the overall agricultural innovation system. The suggested approach of mapping the intensity and quality of the linkages of the agricultural R&D agencies into the overall agricultural innovation system was rejected during the workshop as too cumbersome. Ideally, it would require surveying both sides of the linkage, which would increase the number of agencies to be surveyed drastically. In this way it becomes a study in itself, which goes far beyond the current ASTI survey tools. Moreover, informal networks are not being captured, averages may easily obscure the identification of the real bottlenecks, and there is the question of how to compare the mapping results across countries. Further study and discussion is needed of how best the ASTI initiative can capture the 'embeddedness' of the agricultural R&D system into the overall agricultural innovation system.

Linkages between national agricultural R&D agencies and between national and international agricultural R&D are a lot easier for the ASTI initiative to capture. Some of it is already being covered by the institutional description of the NARS, but it could be improved / expanded by more targeted survey questions. It was recommended that these linkages are best covered under the heading of the agricultural R&D process indicators.

4. Deepening agricultural R&D input indicators

Nienke Beintema's (ASTI initiative) presentation on agricultural R&D input indicators (see ASTI website) gave an overview of: (a) The agricultural R&D input indicators currently collected by the ASTI initiative; (b) The recent experience with more in-depth data collection on research staffing (gender, age, vacancies, etc.); and (c) Improving the coverage of private-sector R&D activities.

The following discussion questions were put forward at the end of the presentation:

- Are the input indicators in the "traditional" ASTI survey rounds still relevant for today's policy questions?
- Are there input indicators missing from the "traditional" set that should be included to improve ASTI's overall policy relevance?
- Which input indicators will need deepening to better address today's policy questions?

There was general agreement at the workshop that the input indicators in the 'traditional' ASTI survey rounds are still highly relevant. Suggested improvements are: (a) To collect additional indicators on research capacity such as age, staff turnover, vacancies, etc.; (b) To collect additional indicators on research infrastructure; (c) To collect data on salaries (has been done in the past but resulted in unsatisfactory results due to exchange rate distortions and large variations in non-monetary benefits); and (d) To consider a more complete thematic

classification of research staff rather than identifying upcoming themes (such as bio-energy, biotechnology, and global warming) only. The latter has been a recent modification of the survey questionnaire as the traditional thematic classification resulted in a rather static picture rather than revealing any of the dynamics going on in the agricultural R&D domain.

It was recommended that additional input indicators only be collected when there is a clear demand for it from national policymakers or donors as it often constitutes significant additional work for the in-country collaborators to collect these data. This would tie in well with another suggestion to tailor the survey instrument so that it can address specific country needs / policy questions. The survey instrument should always cover the minimum baseline data needed for cross-country comparisons, but offers the possibility to add in additional questions. For some topics, ready-to-use survey modules could be created and added to the survey on demand. In this way the ASTI initiative may improve its relevance to policymakers, research managers and research analysts.

With regard to indicators on research infrastructure, not only the volume (i.e., number of research stations, hectares of experimental fields, laboratory facilities) but also the quality of the research infrastructure is of relevance. For example, it would be useful to know whether laboratory facilities have been certified (locally or internationally) or not.

5. Agricultural R&D output indicators

Emmanuel Tambi (FARA) started this session with a presentation (see ASTI website) on the Forum for Agricultural Research in Africa (FARA), which has been mandated by the African Union and NEPAD to implement Pillar IV of the Comprehensive Africa Agricultural Development Programme (CAADP). This pillar deals with agricultural research and technology dissemination and adoption. Its implementation is guided by a Framework for African Agricultural Productivity (FAAP), which has the following main objectives: (a) Evolution and reform of agricultural institutions and services; (b) An increase in the scale of investments towards Africa's agricultural productivity; and (c) Aligned and coordinated financial support.

FARA has an M&E unit that is led by an M&E specialist. It monitors and evaluates the implementation of FAAP as well as the ultimate outcome and impact of FAAP. In this task it relies on many others to contribute, including the SROs, the NARSs and the ASTI Initiative. For that reason, FAAP promotes the strengthening of M&E capacity at the national, sub-regional and continental level.

In summary, one can conclude that FARA/FAAP constitutes a very important partner to the ASTI initiative as user and promoter of the ASTI data but also because of its advocacy role.

Gert-Jan Stads (ASTI initiative) introduced the topic of output indicators by giving an overview of the various agricultural R&D output indicators that could be collected, such as:

- New varieties / technologies released
- Patents
- Scientific publications
- Citation frequency
- Number of presentations at scientific congresses
- Number of brochures / user manuals
- Number of farmer field days
- Consultancy services rendered

All these indicators relate to direct research outputs, but do not capture the ultimate outcome and impact of such an output in terms of new knowledge or technology actually being used in agricultural production and the impact in terms of higher or better production. Documenting the ultimate outcome and impact is a far more difficult issue that cannot be tackled with a simple questionnaire form. Nevertheless, measuring research outputs could help others to document the research impact pathway. To date, the ASTI initiative has not collected agricultural R&D output indicators other than on an ad-hoc basis. So this will be the first time that the ASTI initiative will engage itself in collecting R&D output indicators.

The discussion that followed the presentation focused in particular on which output indicators should be included in the activities of the ASTI initiative and how to measure them.

1. *New varieties:* There was general support to collect indicators on the number of new varieties released. In those countries that have variety legislation in place, there is usually an independent agency that is in charge of variety registration. There are two options when trying to collect variety release data, namely asking the agricultural R&D agencies or asking the variety registration office. Other than just the number of varieties registered per crop during a particular period (say the past 5 years), one may want to obtain additional information regarding the varieties, such as: (a) Which part of the breeding was done by the R&D agency that applied for registration; and (b) An indication of the uptake of the new varieties by farmers. The latter piece of information would get us further down the impact pathway, but will be difficult (if not impossible) to get as this information is usually not readily available. In addition, an interest was expressed to know the number of varieties in the pipeline for registration. Given the long time it takes to develop a new variety, it is important to identify a slowdown in variety development early on.

2. *New technologies:* The great disadvantage when trying to measure new technologies is that there is no internationally accepted standard for what constitutes a new technology (this in contrast with new varieties for which such a standard does exist). Therefore, in order to construct a meaningful output indicator, it is necessary to develop a definition of what constitutes a new technology and the various forms that it can take. Such a definition should be easy to understand and transplantable across agricultural R&D agencies and countries. It is something that will require some further study by the ASTI initiative.

3. *Patents*. Not everybody at the workshop was convinced that collecting patent data constitutes a relevant output measure as there are still a significant number of countries that do not have patent legislation in place or a proper functioning patent registration and protection system. Moreover, patenting seems to be only relevant in certain parts of the agricultural R&D spectrum. However, in countries that have a proper functioning patent registration system, the question needs to be answered who is responsible for (and who is going to gain from) the registration of a patent – the funding agency, the R&D agency, or the individual researcher. As the experience in the US and Europe has shown, the intensity of patenting can be influenced by the incentive system in place. In other words, the contextual setting matters when measuring patents and making cross-country comparisons. In addition to the number of patents registered per agency and by technology field, one may want to know the royalty income that a patent has generated as a way to differentiate patents according to their economic impact. It is generally known that many patents never generate royalties of any significance.

4. *Publications*. All types of publications should be considered (ranging from an article in an international journal to a simple brochure for farmers) when measuring the publication output. If needed, they could be aggregated by giving each type of publication a certain weight. Only focusing on publications that are included in international scientific databases may give a highly distorted picture as they only represent the tip of the iceberg. The same is true when it comes to measuring scientific citations as they are based on the same international scientific databases.

5. *Other output indicators*. Other relevant agricultural R&D output indicators were identified: (a) Attendance of scientific conferences and workshops (both national and international); and (b) Number of farmer field days, exhibitions, and agricultural shows and the number of farmers reached per event. A special category of outputs that will be worthwhile to capture are web-based outputs, such as electronic publications, training modules, databases, and on-line question & answer services. In addition to the existence of such outputs, one could also measure the use of them by number of visits or downloads.

6. Agricultural R&D process indicators

Nienke Beintema (ASTI initiative) started this session with a brief presentation (see ASTI website). During the discussion that followed three clusters of R&D process indicators were identified that are considered of relevance, namely:

1. *Indicators related to good management and organization practices*. Possible survey questions: Does the agency have a research strategy in place and how up-to-date is it? / Does the agency have a functioning M&E unit in place? / Does the agency publish an annual report regularly? / Number of research proposals submitted versus number of research proposals funded; etc. This set of indicators was discussed only very briefly and needs further development;

2. *Indicators related to linkages, collaboration, and participation in networks*. Suggested survey questions include: (a) the number of joint research projects; (b) the number of joint publications; (c) membership of professional organizations; (d) participation in

international research networks; (e) recipient of external funding; (f) number of partners; etc.

3. *Indicators related to the use of information and communication technology (ICT).* Most of the discussion focused on this cluster of indicators. In addition to questions related to ICT hardware (number of computers and telephones, Internet connection and bandwidth, servers, GPS, etc.) and software (e.g., which software packages are being used for research analysis), also questions regarding the use of ICT and Internet could be asked such as: (a) Does the agency have its own website? / How up-to-date is the website? / What type of information is being made available on the website? / etc.; (b) Subscriptions (paid or for free) to electronic databases and scientific publications; (c) Is staff sufficiently trained in using ICT applications; etc. Ajit Maru of GFAR has a more detailed survey questionnaire on this topic that could be very useful to the ASTI initiative in order to identify key indicators that give a good indication of the use of ICT by the agricultural research agencies.

7. Beyond the national perspective

This topic was briefly introduced by Han Roseboom (facilitator) and the discussion clustered around the following topics:

1. *Coverage of the ASTI initiative*: The ASTI survey tools only cover national agricultural R&D agencies that implement research (funding agencies are deliberately not surveyed in order to avoid double-counting). International agricultural R&D agencies are excluded from the national surveys and reported separately. The CGIAR Secretariat produces quite comprehensive overviews of the funding, spending, and staffing of the CGIAR centers. However, it only provides a breakdown of resources per region. Furthermore, international, non-CGIAR agencies are not being covered.

2. *The regional and sub-regional agricultural R&D organizations* primarily coordinate and promote cross-border agricultural R&D, but leave the implementation of the research to the national agricultural R&D agencies. This assumption was confirmed at the workshop. Therefore, there is no need to survey the regional and sub-regional organizations in order to capture the volume of resources going into agricultural R&D. However, the ASTI initiative still may want to provide some descriptive information on these organizations and their role in the regional and global ASTI overview papers. In addition, some quantitative information could be collected on the number of training events organized by the regional and sub-regional organizations and the size of the competitive funding schemes managed by some of them. The latter could help to establish an indication of the relative intensity of regional collaboration.

3. *Foreign assistance*. Multilateral and bilateral assistance to agricultural R&D in developing countries is in principle covered by the national surveys. However, there is some interest (particularly in donor circles) in knowing the volume of this source of funding, how it develops, and who contributes what. The OECD Development Assistance Committee (DAC) database has improved a lot in recent years and provides far more detail than in the past. Development assistance going into overseas agricultural R&D can now be recorded as such to the level of a specific program or project. However, not all DAC members provide the necessary detail so that the

aggregate donor funding picture remains incomplete. Data for the World Bank, for example, is missing in the present dataset. A study into donor funding for agricultural R&D should not only focus on the volume of resources, but also on the research priorities donors have set for themselves. What do they want to achieve and how? Another important issue is that of pooling donor support to finance an agricultural R&D research program based on local priorities. There are apparently mixed results regarding this approach, so it may be useful to find out when it works and when not. The ASTI initiative should consider commissioning a study on donor support to agricultural R&D when there is sufficient interest from policymakers, donors and other stakeholders.

4. *Multinational companies*. The latest global ASTI estimates show that private-sector agricultural R&D in developed countries represents some 39% of global agricultural R&D expenditures. These figures are based on very rough calculations using OECD S&T statistics. Furthermore, we know very little of the companies that make up this large block of R&D investment as their names are not being revealed by the statistical agencies. One way of getting a better handle on this is by complementing the OECD S&T statistics with another approach and that is the 'company R&D scoreboard' approach. This approach tries to identify the best scoring companies in terms of R&D investment with headquarters in a particular country or continent. Also global rankings can be made. Usually the top 10 companies in a particular industry are good for a large part of the global R&D investment in that industry. This is certainly true for the agro-chemical and agricultural machinery industry. Hence the company R&D scoreboard could provide some interesting additional insights into private agricultural R&D investments and developments. This is not only of interest to the agricultural sector in developed countries, but also in developing countries as many of these large multinationals operate globally and sell the technology embodied in their products worldwide. A strict territorial approach to R&D (the classic statistical approach) does not make sense for companies that have a global outlook. In that sense there is a good parallel with the CGIAR – we also do not attribute the CGIAR research efforts to specific countries.

8. Conclusions

The most important conclusions of the two-day workshop are summarized below.

<u>General observations</u>

Important general observations/recommendations made during the workshop are:

- Improve the dissemination and use of the ASTI data at national and other levels.
- Greater need for analysis. This requires an expansion of the ASTI team, but also more and closer partnerships with other groups interested in agricultural R&D policy analysis within the CGIAR, the (S)ROs, and the national agricultural research agencies.
- Incorporate strengthening of national capacity to collect, analyze and use ASTI data.
- Expansion areas for data collection and analysis should be first piloted before they are being adopted on a global scale. Moreover, one should think of more in-depth data collection and analysis to be conducted only upon request for specific countries.

- It is important to make a distinction between time series data collection and ad hoc snapshots. The latter are one-time studies, while the former require a long-term commitment.

Expansion Area 1: Measuring the 'embeddedness' of agricultural R&D agencies into the wider agricultural innovation system

There was general agreement that this is an important topic, but there was no clear consensus on how this can be done best. Measuring the intensity and quality of the linkages between agricultural R&D and the wider AIS was considered as too complex and too cumbersome. Additional discussion/research is needed to find alternatives of how to measure the 'embeddedness' of the agricultural R&D system into the overall agricultural innovation system. One could think about practices such as stakeholder participation in research problem formulation, co-financing of research, etc.

Expansion Area 2: Deepening agricultural R&D input indicators

The most important recommendations regarding agricultural R&D input indicators are:

- Additional input indicators to be considered: more detail on the capacity of research staff (age, gender, vacancies) and research infrastructure (not covered at present);
- Introduce the flexibility to tailor the country survey instrument to specific country needs. Modules on specific topics could be developed to be added to the survey upon request;
- Re-introduce the more complete thematic classification of research staff.

Expansion Area 3: Agricultural R&D output indicators

The most important recommendations regarding agricultural R&D output indicators are:

- Registration and adoption of new varieties: Information on the registration of new varieties should be relatively easy to obtain. Information on the adoption of new varieties, however, is far more difficult to obtain and is not a question that can just be added to the current ASTI survey tools. It basically represents a survey in itself. Are there other (CGIAR?) sources that can be used? This requires further study.
- Release and adoption of new/improved technologies: To measure the release of new technologies requires a standard definition of what constitutes a new technology and the various forms that it can take. Again, the adoption of new technologies is a far more complex question to answer and is beyond the reach of the ASTI initiative.
- Publications: All publications should be included, ranging from articles in international journals and research reports to leaflets and user manuals for farmers. In order to aggregate the publications, a weighting system could be used. Citation frequencies were rejected.
- Patents: Not everybody at the workshop was convinced that this constitutes a relevant output measure as there are still a significant number of countries that do not have patent legislation and a proper functioning patent registration system in place. Moreover, patenting is only relevant in certain parts of the agricultural R&D agenda. For the time being this should be considered a relatively low priority output indicator.
- Other relevant agricultural R&D output indicators are: (a) Attendance of scientific conferences and workshops (both national and international); and (b) Number of

farmer field days, exhibitions, and agricultural shows and the number of farmers reached per event.

- A special category of outputs that will be worthwhile to capture are web-based outputs, such as electronic publications, training modules, databases and on-line question & answer services. In addition to the existence of such outputs, one could also measure the use of them by number of visits or downloads.

Expansion Area 4: Agricultural R&D process indicators

The following three clusters of R&D process indicators were identified as relevant:

- Indicators related to good management and organization practices;
- Indicators related to linkages, collaboration, and participation in networks; and
- Indicators related to the use of information and communication technology (ICT).

How to define and measure these R&D process indicators needs further discussion and study.

Expansion Area 5: Complementing the national perspective

Three areas of attention were identified:

- Regional and sub-regional agricultural R&D organizations usually do not implement research themselves, but play an important role in coordinating and promoting cross-border research activities. Quantitative data that may be worthwhile to collect are: (a) the number of researchers attending regional training events; and (b) the volume of (competitive) funding available for joint, cross-border research.
- Multilateral and bilateral donor support. There is not only an interest in the volume of support provided, but also in the priorities of the different donors and how they change over time; and
- Agricultural R&D investments by multinational companies. A 'company R&D scoreboard' approach could add more insight into the substantial private investments in agricultural R&D. Most of these companies have their headquarters in developed countries, but they sell their products (and the technology embodied in them) worldwide.

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Annex B: Workshop program

Time	Session	Topic introduction by
Tuesday 20 January 2009		
09:00-09:30	1. Opening	
09:30-10:10	2. Overview of the ASTI Initiative	Nienke Beintema/ Gert-Jan Stads
10:10-10:30	3. GFAR's perspective on the ASTI initiative	Ajit Maru
10:30-11:00	Coffee break	
11:00-13:00	4. Innovation System Perspective	Judith Francis Han Roseboom (*note from David Spielman*)
13:00-14:00	Lunch	
14:00-15:30	5. Deepening agricultural R&D input indicators	Nienke Beintema
15:30-16:00	Tea	
16:00-17:30	6. Agricultural R&D output indicators	Gert-Jan Stads / Emmanuel Tambi
19:30	Dinner	
Wednesday 21 January 2009		
09:00-10:30	7. Agricultural R&D process indicators	Nienke Beintema
10:30-11:00	Coffee break	
11:00-13:00	8. Complementing the national perspective	Han Roseboom
13:00-14:00	Lunch	
14:00-16:00	9. In which direction should we expand: prioritizing the recommendations / implementation plan (topics/coverage)	
16:00-17:00	Closure and drinks	

Annex C: Background note prepared for the Workshop

Improvement and Expansion of Quantitative Information Provided by the Agricultural Science and Technology Indicators (ASTI) Initiative

Introduction

After several years of operating with limited resources, the Agricultural Science and Technology Indicators (ASTI) Initiative has received a substantial grant from the Bill and Melinda Gates Foundation (BMGF) for a three-year project, which comprises the following components:

Updating the full ASTI database for sub-Saharan Africa and South Asia and conducting monitoring survey rounds on key indicators in other regions of the world;
Expanding the ASTI data collection to cover new areas of relevance to national, regional and international policymakers; and
Strengthening the ASTI stakeholder network and improving the impact of the ASTI materials and findings on agricultural R&D policy issues.

The present position paper focuses on the second component of the project. How can the quantitative information provided by the ASTI initiative to be further improved and expanded, so that it responds better to the needs of policymakers and stakeholders? For this purpose a round table consultation will be organized in January 2009 in order to identify, discuss and prioritize new variables that will give policymakers a better and more complete insight into the performance of agricultural R&D.

Possible areas of expansion and improvement

The indicators that have been covered by the ASTI initiative focus primarily on the input side of national agricultural R&D and measures the financial and human resources invested in agricultural R&D over time (see the appendix table for a list of current ASTI indicators and coverage in terms of years/regions). By collecting the data at the level of the implementing agencies, the ASTI Initiative also provides succinct institutional profiles of the national agricultural research systems (NARS).

1. Expansion and improvement of the institutional profiles of NARS

In addition to the implementing agencies, ASTI country reports usually also report on the policy-making, coordination, and funding agencies that are part of the NARS. In recent years, however, we have seen a rapid rise of the agricultural innovation system perspective and new initiatives are underway to measure the agricultural innovation performance of countries based on a variety of variables, including agricultural R&D investments. While applauding these new initiatives, the ASTI Initiative deliberately limits itself to the R&D component of the agricultural innovation system. However, one of the areas of possible expansion for the ASTI Initiative is to describe and, if possible, measure the intensity and quality of the forward and backward linkages of the agricultural R&D system into the overall agricultural innovation system, such as linkages with research clients (e.g., involvement of farmers and other stakeholders in priority setting), linkages with research partners (e.g., collaboration with other local or foreign research organizations), and linkages with technology transfer agencies. Some

of this information can already be found in the ASTI country reports, but it may be useful to do this in a more coherent and structured way. Moreover, it is necessary to identify possible quantitative indicators that can measure the intensity and quality of such linkages.

2. Deepening / improving the agricultural R&D input indicators

One of the breakdowns the ASTI survey aims to provide for each country is research staff by research orientation – i.e. by commodity and, until recently, by research theme (crop/livestock genetic improvement or pest and disease management, soil, water, etc.). The latter breakdown has been dropped because it was often difficult to compile and not really that relevant from a policy point of view. Instead, the new survey tool asks to identify the researchers working on new emerging research themes such as biotechnology, bio-fuels, climate change, water management, etc. In this way we can monitor upcoming research themes. During the consultation, we would like to get some feedback on this new approach.

Another area for potential deepening of the data collection is that of more detailed statistics on research staff turnover, unfilled positions, age and gender structure, etc. Many research organizations in Africa seem to have difficulties filling vacancies and keeping qualified staff. An uneven age structure often also complicates the continuity of research organizations. More detailed data on such aspects could be collected during the upcoming surveys in sub-Saharan Africa and South Asia if there is a clear demand for it from national and regional policymakers. During the consultation we would like to get feedback whether this is a relevant policy issue worthwhile pursuing.

For the past 4-5 years, the ASTI initiative has been trying to expand its agricultural R&D data collection activities towards the private sector. This has turned out to be quite a challenging exercise and the results have been quite mixed due to: (a) lack of reliable information regarding the private companies that are active in agriculture in a country (who should be included in the survey?); (b) low response by private companies (R&D expenditure is often considered sensitive information and there is no obligation to respond); and (c) quite a bit of confusion regarding the definition of agricultural R&D.

In order to get a better insight into the position of private agricultural R&D in the overall agricultural innovation picture, the ASTI Initiative will need to develop a clear strategy on how to improve the coverage of the private sector. In part this strategy will be based on the outcomes of a separate pilot project on this topic. Nevertheless, during the consultation we would like to discuss: (a) solutions for the problems collecting business R&D investment data; (b) the advantages and disadvantages of conducting our own survey or relying on the work of others; and (c) a relevant and workable definition of what constitutes private agricultural R&D.

3. Agricultural R&D output indicators

To date, the ASTI Initiative has focused primarily on agricultural R&D input indicators. One area for possible expansion is to start collecting data on agricultural R&D output. Possible indicators to be considered are scientific publications, patents, release of new varieties, release of new technologies, presentations, leaflets, etc.

EMBRAPA in Brazil has quite a bit of experience of measuring agricultural R&D outputs of its 37 research centers. We may learn from them which outputs to look at and how to measure

them. In addition, FARA is trying to setup an M&E system for African NARS as part of the Framework for African Agricultural Productivity (FAAP). In order to do so, they will also need to define performance indicators.

During the consultation we would like to discuss: (a) the relevance of collecting agricultural R&D output indicators; and (b) which type of agricultural R&D output indicators the ASTI Initiative should take on board.

4. Agricultural R&D process indicators

Here we should start thinking about relevant indicators that can give us an idea about the quality of the research process / environment, such as internet connectivity, library facilities, transport facilities, availability of research inputs, ability to fill staff positions, attendance of international conferences, etc.

During the consultation we would like to discuss: (a) the need for collecting agricultural R&D process indicators; (b) which type of agricultural R&D process indicators the ASTI Initiative should take on board; and (c) whether it is possible to create a composite index regarding the quality of the research process.

5. Complementing the national perspective

The ASTI survey focuses primarily on the NARS. In addition, the ASTI Initiative uses the CGIAR expenditure and staffing datasets to complement the national perspective. However, non-CGIAR entities involved in international agricultural research are largely overlooked. In particular the regional and sub-regional organizations are not covered. How serious is this omission (To what extent do they actually conduct research or is most of it already being captured at the national level?) and what should be done about it?

Another area of interest has been the funding of national agricultural R&D in developing countries by bilateral and multilateral agencies. The World Bank has for many years maintained a dataset on the funding of agricultural research projects. Also USAID has a similar dataset. (How up-to-date are these datasets and are they still being maintained?) There is unfortunately no similar dataset for the EU. The OECD maintains a database on development assistance, but this database does not provide a breakdown of the donor assistance going into agriculture. This may perhaps change in the future, due to a renewed interest of donors in agriculture. Also missing is an overview of private charities investing in agricultural R&D in developing countries, like Rockefeller Foundation and BMGF.

Given that many poor countries still depend heavily on donor funding to finance their agricultural R&D, a better picture of trends in donor policies and funding may be warranted to understand developments at the national level. During the consultation we would like to get some feedback on how best to capture the levels and trends in donor support and whether the ASTI project should actively invest in the data collection of this aspect.

Private multinationals play an increasingly important role in the technology generation and dissemination in the agricultural sector. If we want to understand the impact of these multinationals' R&D capacity on agricultural production worldwide, it is of little use to concentrate on where the R&D is being conducted. It is more relevant to trace where the technology (embodied in products) is being sold. Most multinationals are publicly listed and

are therefore obliged to disclose their R&D expenditures in their annual financial reports. By focusing on the big multinationals in the agricultural input industries, a major component of agricultural R&D investment hitherto largely unnoticed can be disclosed. Moreover, this approach allows us to identify the biggest private players by name and hence to enrich the overall picture considerably. During the consultation we would like to discuss the relevance and feasibility of this approach.

Annex D: Background note on the ASTI Initiative

The Agricultural Science & Technology Indicators (ASTI) initiative: Measuring agricultural R&D investment and capacity trends in low and middle income countries

In recent years, there has been increased emphasis on the critical role of science and technology (S&T) in promoting economic growth, food security and poverty alleviation in low and middle income countries, particularly in the field of agriculture. Information is critical to understand the important contribution of agricultural S&T in promoting agricultural growth, and sound S&T policies require access to up-to-date and reliable data.

One of the few sources of agricultural R&D statistics in low and middle income countries is the Agricultural Science and Technology Indicators (ASTI) initiative, which is managed by the International Food Policy Research Institute (IFPRI).[3] The ASTI initiative compiles, processes, analyzes, and publicizes data on institutional developments, investments, and capacity in agricultural R&D at national, regional, and global levels. ASTI outputs describe trends (progress of agricultural R&D human and financial capacity over time at the national, regional, and global levels) and comparative information (performance of a country or region compared to others). The ASTI initiative entails a large amount of original and on-going survey work focused on low and middle income countries, but also maintains access to relevant data for developed countries. Over the past years, the work has mainly focused on developing and maintaining the ASTI website ((www.asti.cgiar.org); building a network of collaborators at the national and regional levels; and initiating institutional survey rounds in Africa (2001-04), Asia (2002-07), the Middle East (2004-07) and Latin America (2007-08).

The ASTI initiative is generally recognized as the most authoritative source of information on the support for and structure of agricultural R&D worldwide. The initiative has published a wide set of country briefs and regional synthesis reports that have been widely and frequently cited in both national and international agricultural research policy documents.

During the past years, the initiative has established successful collaborations with various regional and sub-regional organizations in facilitating the initiation of the national survey rounds by endorsing the project in their annual meetings and by identifying national partners. The willingness of national partners to collaborate on the survey rounds has been very high, which is also an indication of the interest in quantitative information on agricultural R&D at the national level.

ASTI datasets are collected and processed using internationally accepted definitions and statistical procedures for compiling R&D statistics developed by OECD and UNESCO (e.g., Frascati Manual). This is to facilitate comparisons of the ASTI datasets with other relevant S&T datasets. For each country in which ASTI is active, the research team typically works with the main agricultural research institute or, in a few cases, with consultants. These national partners coordinate the implementation of the survey round, and coauthor and co-

[3] IFPRI is one of the 15 international centers supported by the Consultative Group on International Agricultural Research (CGIAR). Its mandate is to identify and analyze alternative national and international strategies and policies for meeting world food needs in ways that conserve the natural resource bases, with emphasis on low income and on the poorer groups in the countries.

publish the resulting country briefs and fact sheets. Over the years, the ASTI initiative has developed and revised a set of survey tools, one for government and nonprofit agencies, one for higher-education agencies, and one for the private sector. Each survey form has a different set of questions, with those for government agencies and nonprofit institutions requesting the most detail. The more important indicators are collected for a number of subsequent years, while the remaining indicators cover one year only, mostly the year prior to the year in which the benchmark survey is conducted. The list of indicators have been amended and improved based on experiences and consultations with partners during the various national survey rounds (see Table 1 for list of current indicators). It has proven to be difficult to obtain survey returns from private companies; a new approach for data collection on the private sector will be developed and piloted in a number of countries over the next 1-2 years.

The latest global update show that global patterns of agricultural R&D investments are changing considerably. Spending on public global agricultural research totaled $23 billion in 2000 (in 2005 international prices); an increase, in inflation-adjusted terms, of almost one-half from the $16 billion in 1981. Although the share of low and middle income countries has increased over the two-decade period, from 38 to 43 percent, it was still below that of the high-income countries as a group in 2000. Of the 2000 global total, the Asia-Pacific countries were investing $4.8 billion in 2000 compared to $2.7 billion for Latin America and the Caribbean, $1.2 billion for West Asia and North Africa, and $1.2 billion for Sub-Saharan Africa.[4] Agricultural R&D spending for China and the Asia-Pacific has grown considerably since 2000. After a period of declining investments in public agricultural R&D during the second half of the 1990s, the Latin American region also saw an increase and in 2006 regional spending returned to 1996 levels. Public spending in agricultural R&D has become increasingly concentrated in just a handful of countries. In 2000, China, India, and Brazil accounted for 43 percent of all low and middle income countries' total expenditures. The 44 Sub-Saharan African countries combined represented only 12 percent of this total. Private-sector performed agricultural R&D remains small in low and middle income countries; in 2000 the private sector share of total (public and private) investments was only 6 percent.

[4] These regional totals exclude high-income countries.

Table 1—Current ASTI Indicators

	Period coverage[a]	Specific details
Professional research staff	- SSA: 1971 – 2000/01 - APC: 1981/91 – 2002/03 - LAC: 1971 – 1996; 2004 – 06 - WANA: 1991/96 – 2001/03	- By degree level (PhD, MSc and BSc) - Collected for multiple years - Government, nonprofit, higher-education, and private agencies
Professional female research	- SSA: 2000/01, 2008[b] - APC: 2002/03 - LAC: 2006 - WANA: 2001/03	- By degree level (PhD, MSc, and BSc) - Numbers (not by degree level data available) for 14 SSA (1991) and 16 LAC (1996) - Government, nonprofit, and higher-education agencies
Research focus by major sub-sectors	- SSA: 2000/01 - APC: 2002/03 - LAC: 1996 & 2006 - WANA: 2001/03	- Include crops, livestock, forestry, fisheries, post-harvest, natural resources, socio-economics - Government, nonprofit, higher-education, and private agencies
Research focus by crop and livestock items	- SSA: 2000/01 - APC: 2002/03 - LAC: 1996 & 2006 - WANA: 2001/03	- Include ± 20crops items, ± 6 livestock items, and ± 6 other items - Listed crops differ by region - Government, nonprofit, higher-education, and private agencies
Thematic research focus	- SSA: 2000/01 - APC: 2002/03 - LAC: 1996 - WANA: 2001/03	- Include ± 4 crops themes, ± 5 livestock themes, and ± 7 other themes - Themes are currently being adjusted to include emerging themes (i.e., climate change, bio-energy, biotechnology) - Government, nonprofit, higher-education, and private agencies
Expenditures by cost category	- SSA: 1971 – 2000/01 - APC: 1981/91 – 2002/03 - LAC: 1971 – 1996; 2004 – 06 - WANA: 1991/96 – 2001/03	- By salaries, operational costs, capital costs - Government and nonprofit agencies
Funding sources	- SSA: 1991; 2000/01 - APC: 1996 – 2002/03 - LAC: 1996; 2004 – 06 - WANA: 2001/03	- Government, (multilateral & bilateral) donors, producers/marketing boards, public/private enterprises, own income - Sources differ by region and by country - For some countries multiple years available - Government and nonprofit, agencies
Support staff by type	- SSA: 1991 – 2000/01 - APC: 1991/96 – 2002/03 - LAC: 1991 – 96; 2004 – 06 - WANA: 1996 – 2001/03	- By technical, administrative, and other support - Government, nonprofit, and higher-education agencies

[a] SSA includes 27 Sub-Saharan African countries; APC, 11 Asian-Pacific countries; LAC, 15 Latin America & Caribbean countries; and WANA, 6 West Asia and North African countries. Periodic coverage applies for most, but not all, countries.

[b] Together with the CGIAR's Gender and Diversity's (G&D) African Women in Agricultural Research and Development (AWARD) fellowship program, the ASTI team is conducting a benchmarking study on gender-disaggregated data on the staffing and leadership of African agricultural R&D agencies. The study outcomes will provide valuable human resource information to leaders of African research institutions, regional networks, international organizations, policymakers, and donors.

After two years of limited funding, the ASTI initiative received a substantial grant from the Bill and Melinda Gates Foundation for a three-year phase to update and expand its data collection activities. These will entail the following main areas:

- Conduct benchmarking survey rounds in 30 Sub-Saharan African and 5 South Asian countries to update the set of public agricultural R&D indicators collected as part of

the previous survey round. A separate survey round will be conducted in a number of Sub-Saharan and Asian countries to capture the increasing role of the private sector in agricultural research. It is important to juxtapose agricultural R&D capacity and investments levels and trends in Sub-Saharan Africa and South Asia with those in other developing regions as well as globally. The ASTI project will, therefore, also conduct monitoring survey rounds on key indicators in a set of so-called "ASTI focus countries." In order to prepare a new global update, the ASTI initiative will analyze available secondary S&T data from other sources to complete and update the global dataset on basic indicators.`

- To further increase the relevance of the ASTI database to the various stakeholders, the ASTI website (www.asti.cgiar.org) will be enhanced to improve downloads of datasets. Its visibility will be increased within the wider CGIAR community and links will be added to enable website visitors to access all other S&T databases related to agriculture and food.
- Over the years, various stakeholders and users of the ASTI database have requested additional quantitative information that has not been covered by the ASTI initiative or similar projects. To better fulfill the needs of policymakers, S&T managers, donors, and other stakeholders, one of the first activities will be a consultation round to identify relevant supplementary indicators and decide which ones can be taken on under the ASTI umbrella. Potential new areas are output indicators and information on emerging research areas such as climate change, bio-energy, and capacity gaps. For example, the ASTI initiative, as part of the African Women in Agricultural R&D (AWARD) fellowship program,[5] is conducting a benchmarking study on gender-disaggregated capacity indicators. This study will not only provide gender-disaggregated data of agricultural scientists by highest degree and institute type, but will also address many other important questions such as the discipline mix of female and male scientists, the exact share of female graduates that drop out after completing their degree or during their career as a scientist, how many female scientists reach leadership positions relative to their male colleagues, and so on.

Participation of the ASTI initiative in the UNESCO Global Research Seminar would be particularly valuable to discuss common perspectives and challenges on collecting and analyzing investment and capacity S&T indicators as well as institutional developments in non-agricultural sectors. The seminar will also provide an opportunity to learn more on measuring research output indicators and collaboration activities. In turn, the information on the methodology, data collection procedures, and outputs of the ASTI initiative will be of relevance for the researchers, experts, and other participants attending the Global Research Seminar, specifically as agriculture is rightfully designated as one of the important elements of national research systems in low and middle income countries.

[5] The AWARD program, funded through a grant from the Bill & Melinda Gates Foundation, is coordinated by the CGIAR's Gender and Diversity (G&D) program. Competitive two-year fellowships focusing on building capacity in science, mentoring, and leadership will be offered to high-performing female African scientists at one of three critical career junctures: completion of a BSc, MSc, or PhD degree.

Annex E: Background note GFAR

The Global Forum on Agricultural Research and its Needs for Indicators for Agricultural Research for Development

GFAR Secretariat
Rome

Introduction

The Global Forum on Agricultural Research (GFAR) is a platform at the global level for dialogue and action of all stakeholders of agricultural research and innovation for development. Its focus is on agricultural research for development (ARD) that contributes to improving agriculture especially of resource poor farmers and producers in economically developing countries.

GFAR has four sets of cross-cutting objectives for actions through which it aims to improve ARD. These are:

- ***Advocacy and Shaping Tomorrow's Agriculture***
- ***Enabling Institutions for Future Needs***
- ***Fostering Innovative and Strategic Partnerships***
- ***Ensuring Agricultural Knowledge for All***

GFAR's primary advocacy related actions include:

- Increasing and improving investment, both financial and human, in agricultural research and innovation for development and

- Enabling the shift from agricultural research for development from being only through scientists in public funded agricultural research institutes to formation of National Agricultural Research Systems and Agricultural Innovation Systems which includes all its stakeholders from farmers, producers, processors and market intermediaries to consumers and actors which are farmer organizations, community based organizations, non-government organizations, private enterprise, universities and international agencies, including donors, involved in ARD

GFAR considers agriculture research and innovation systems to also include conventional extension and agricultural education.

For GFAR, Institutions for future needs include those that contribute to and enable research and innovation in agriculture through collaboration and partnerships at community, national, sub-regional/regional and global levels. They also include those that foster and enable inclusiveness of all ARD stakeholders in research processes and governance.

GFAR promotes and fosters innovative and strategic partnerships especially those across regions, within and across disciplines and around commodities through networks and

programmes such as the global partnership programs and regional and global initiatives for dialogue and discussions on emerging challenges to agriculture and its development.

GFAR, in its actions for knowledge for all, attempts to ensure, promote and facilitate sharing and exchange of information, skills and knowledge among all ARD stakeholders around the globe. It advocates increased and improved investment in Information and Communications Technology (ICT) enabled information systems for agricultural development, contributes to capacity development related to agricultural information management, bringing greater integration of national, regional and global agricultural information systems and improve the flow of agricultural information and knowledge through its better governance across the world. GFAR also is engaged in improving formal agricultural education and learning in communities for agricultural progress and development.

GFAR and its needs for indicative information for improving ARD

GFAR, by virtue of its objectives and action, require information such as through indicators for current status of agricultural research and innovation for development at global and regional levels. Regional constituents of GFAR require similar information at regional and national levels and to foster institutional change and ensure systems are driven by and centered on the needs of the poor

The most important information such as through indicators required by GFAR is:

1. Investment in ARD, both financial and human, and which includes indication of economic and sociological returns on the investment. This information is to be used by GFAR in its advocacy of research investment needs at global and regional levels. GFAR advocacy also entails assessment of this research and in providing competitive advantages in the development returns obtained from investing in ARD vis-à-vis other avenues of investing for development either through indigenous national investment or through donors who may be foreign countries or philanthropic organizations. This investment may need to be characterized such as for disciplines, commodities, geographic distribution, across time, for research, extension and education etc. GFAR also needs information on investments and resultant capacities to meet emerging challenges to agriculture such as climate change, bio-energy and pandemic diseases and pests affecting agriculture as also in new disciplines such biotechnology, nano-technology, material sciences and information and communications technology as applied to agriculture.

2. In considering indicators, it is important to go beyond the ‘hard’ indicators of development such as numbers of staff or yield increases and also incorporate ‘soft’ indicators of human development such as empowerment through knowledge, access to credit and ability to access new sources of knowledge. These indicators of self-determination and community empowerment can be as important as technologies themselves.

3. Partnerships and collaboration in ARD which requires basic data on research, education and extension organizations and institutions, their expertise and experts, programs and projects and outputs from the projects. This basic data enables establishment of collaboration and partnerships as also of types and strength of the collaborative arrangements. Of special interest to GFAR and the regional

organizations is information within these programs of international, regional, inter-regional and global collaboration and inclusion of farmers, farmer and producer organizations, community based organizations, non-government organizations, private enterprise and Universities along with public sector and government organizations. These also need to cover innovation systems that require multiple investments at different points in a chain to realization and use of a technology or product.

4. State of the substructures and organizations that are required for more efficient and effective sharing of information and knowledge for agricultural development at national, regional and global levels. These include statistical information on ICT infrastructure and connectivity such as investments made in agricultural organizations and rural areas for enabling access to telephony and the Internet, the actual access in terms of the rural and agricultural communities and geographic area covered, the type of connectivity including that of bandwidth, whether ICT enabled agricultural information systems are operative and the type of information shared and exchanged. GFAR also requires investments made in agricultural education, extension and innovation systems.

It is important for GFAR that not only information related to budgets, expenditures, numbers of people employed, products and outputs are made available but also that information on the various processes and their operations such as on programs and activities with various categories of partnerships, networks and their information flows is captured. GFAR requires information also on outcomes of research activities and economic and social returns on investments made not only by the public sector but by all actors in agricultural development.

GFAR consider indicators of these investments and actions as those defining the further development and evolution of agricultural research and innovation systems, institutions and processes and therefore advocates consensus among actors at various levels in defining these indicators.

GFAR is not a stand alone institution and relies for its collective impact on the actions and activities of the ARD stakeholders. It depends on the initiatives of its partners such as the CGIAR through the ASTI initiative and FAO as also OECD, the World Bank, IFAD, the European Union, Regional Development Banks and others to generate, summarize and make this information available, especially in a summarized form. GFAR is and can be instrumental in coalescing not only such information but also the activities of various ARD partners in this information area.

GFAR and ASTI

The information generated by CGIAR ASTI initiative is a very important resource for GFAR. GFAR also recognizes the efforts made by ASTI to make this information universally available. It also realizes that the resources available to this initiative are far more limited than that is needed to generate more precise and timely, relevant data and information and universally relevant.

However, GFAR also observes that there remain crucial gaps in information generated by ASTI especially information related to major actors (and investors in ARD) such as Russia, India and China as also the economically advanced North. Further, it also observes a significant time lag in the information now available for universal access from ASTI

databases. Information at the country level that cannot be used to make advocacy and decisions about improving investments in ARD and enable action, especially through collaboration and partnership is of limited use to GFAR and its partners in terms of convincing policy makers. It is also important that the ASTI initiative embeds its work into associated actions in collecting relevant investment and Institutional information related to agricultural development in general and ARD in particular. This entails direct linkage with GFAR and its constituents, especially Regional Forums, as collaborators in providing information related to ARD. Finally GFAR also expects that ASTI develops capacity in National ARD systems to generate and use information for improving their own NARS and Agricultural Innovation Systems.

GFAR can play a significant role in advocating investment, including that for ASTI, in generating, dissemination and use of indicative information on the state of ARD globally. It can facilitate capacity development at national and regional levels. GFAR can also promote improved flow and governance of information flows between ARD actors and stakeholders of this information. The GFAR platform could thus be much more coherently used by ASTI to link its activities to regional and national needs.

Annex F: Background note on the Agricultural Development and Innovation Index

Beyond Science and Technology Indicators: Measuring Agricultural Innovation System Properties and Performance

by
David J. Spielman[6] and Dawit Kelemework[7]
International Food Policy Research Institute (IFPRI)
January 14, 2008

Introduction

Today, more than ever before, global food and agricultural systems are undergoing a process of rapid change. Growing consumer demand and changing consumer preferences have emerged as key drivers of agricultural prices, technology, and trade. Global integration of agricultural markets, supply chains, and communications networks have created new opportunities for sharing goods, services, and ideas among consumers, farmers, scientists, and entrepreneurs. These changes have been accompanied by new scientific achievements in microbiology, genomics, nanotechnology, bioinformatics, and other fields that have the potential to change both the quantity and quality of food and agriculture produced and consumed worldwide.

With this process of rapid change comes the intensification of conflict over contested claims. Battle lines are being drawn in the fight over allocating public and private resources to food versus fuel, and between high-yielding, input-intensive production versus low-productivity organic production. Similar struggles are playing out over long-term investments in priorities such as climate change mitigation and adaptation, versus short- or medium-term investments in increasing food staple yields.

These rapid changes and emerging conflicts strongly suggest that developing countries will need to develop more responsive, dynamic, and competitive agricultural sectors in the short to medium term to benefit from the changing global system. Agricultural innovation will be the order of the day, and developing countries will need innovative policies, programs, and investments just to keep up.

Unfortunately, there are few tools with which to benchmark innovativeness in the agricultural sector. Thus, few developing countries know how dynamic, responsive, or competitive their agricultural sectors really are. This suggests the need for a measure of agricultural innovativeness, preferably one that extends beyond the "black box" approach to measuring inputs and outputs, and preferably one that focuses on the underlying processes in which capabilities evolve and develop to create an innovative agricultural sector.

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A measure of innovativeness would need to combine policy and investment indicators that foster innovativeness in agriculture (the "inputs") with more systems-oriented indicators that characterize underlying innovation processes (the "process"), and performance indicators such as value addition and productivity in the agricultural sector (the "outputs"). Such a measure would also need to be firmly grounded in an informed theory of innovation that considers supply-side factors such as research and education, demand-side factors such as agricultural business and enterprise, factors such as the institutions that link these two factors, and the wider policy environment that enables innovation.

Efforts to design such a measure might do well to draw on the increasingly popular "innovation systems" conceptual framework (Edquist 1997; Nelson 1993; Lundvall 1992; Dosi et al. 1988; Freeman 1987). This framework examines sets of interrelated actors who engage in the generation, exchange, and use of knowledge in processes of social or economic relevance, and the institutional context that conditions their actions and interactions.

Arnold and Bell (2001) provide a useful description of this system-based framework by describing an innovation system in terms of four distinct domains: the knowledge and education domain, the business and enterprise domain, the bridging organizations that facilitate the transfer of knowledge and information between these two domains, and the formal and informal socioeconomic institutions that enable innovation more widely (Figure 1).

Hidden within this system are the essential processes that facilitate innovation, for example, the development of capacity among individuals and organizations to learn and change the ways in which they organize production, and the iterative learning processes that occur among different actors through different forms of interaction. By highlighting these hidden attributes, the innovation systems framework captures something more than a linear interpretation of innovation as a sequence of research, development and dissemination. Rather, it portrays innovation as a complex web of related individuals and organizations that all contribute to the application of new or existing information and knowledge to production.

Measuring Innovation System Properties and Performance

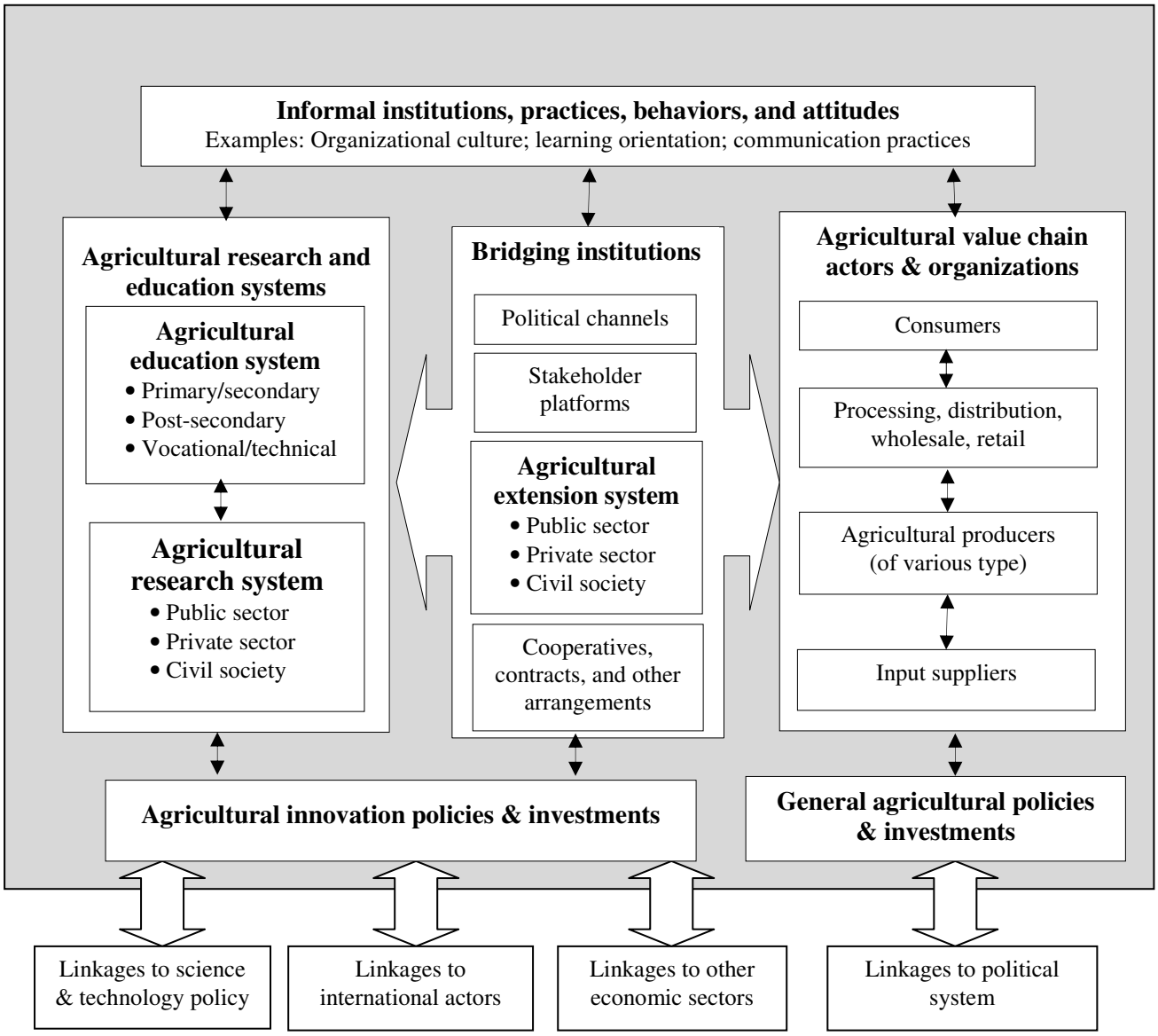
Country and sector-level measurement exercises based on this innovation systems framework have been used with considerable effect to guide innovation policy, improve innovation performance, and inform national and global discourse on science and technology for innovation, particularly in industrialized-country manufacturing (see Spielman and Kelemework 2009). However, measurement exercises are fraught with challenges ranging from the conceptual to the technical. We outline several of these challenges below.

Conceptual grounding

Any attempt to identify and measure innovation indicators requires some form of theoretical framework that is at least minimally ground in the basic concepts of innovation systems thinking (Archibugi and Coco 2005). This framework should somehow recognize that science and technology capabilities and production capacity are distinct domains of an innovation system, and that the generation and dissemination of knowledge are similarly distinct processes. Moreover, the framework should somehow recognize that innovation is much more than knowledge embodied in a technology: Rather, innovation is the generation, exchange,

and use of knowledge in processes of social or economic relevance, where knowledge can be characterized as embodied or disembodied, codified/explicit or tacit/implicit, and scientific/technical or organizational/managerial.

Figure 1. A conceptual diagram of an agricultural innovation system



Source: Spielman and Birner (2008); adapted from Arnold and Bell (2001).

Input and output indicators

Attempts to measure innovation also require a cautious approach to indicator selection. Among other issues is the need to carefully define and separate input, output, and outcome indicators. Inputs can be viewed as variables that affect an individual domain's performance (e.g., public expenditures on agricultural education and training, or private expenditures on agricultural research and development), or parameters that affect these inputs (e.g., the quality of scientific research institutions). Other variables that might be viewed more ambiguously (e.g., number of articles published in scientific journals published, number of plant varietal improvements released) can be taken as measures of a domain's performance, that is, its

outputs to the wider innovation system. While both can be used to characterize a domain, they should be treated as strictly different from the outcomes that measure the performance of the entire system, for example, agricultural GDP per capita, agricultural GDP growth rate, or total factor productivity.

Hard and soft data

Given the somewhat vague conceptual nature of an innovation system, its properties and performance cannot be immediately addressed by conventional "hard" data from formal sources. Hence, measurement efforts such as the World Economic Forum's Global Competiveness Index combines indicators collected from standard national and international data sources with indicators assembled from its annual Executive Opinion Survey (WEF 2007). Similarly, the International Fund for Agricultural Development (IFAD) rural performance indicators are based on grades assigned through a consultative process conducted with key experts and stakeholders (IFAD 2005). In short, reliance on formal data sources is an insufficient means of capturing the subtle nuances that characterize an innovation system.

System-oriented indicators

Even with a combination of hard and soft data, an attempt to measure innovation requires that emphasis be places on more process-oriented systems characteristics. These types of indicators are meant to capture attributes such as heterogeneity, integration, and responsiveness of actors and networks, all of which are critical characteristics of a performant innovation system (see Giuliani 2007; Giuliani and Bell 2005). Conceptually, these attributes are fairly simple to understand: An innovation system is likely to be more productive when a diversity of actors brings new ideas to the innovation process ("heterogeneity"), provided that they are supported by integrative processes of communication, exchange, and learning ("integration"), and provided that sufficient incentives exist—profits, status, or recognition—to stimulate their participation ("responsiveness").

Although there is no simple way to obtain process-oriented indicators, Spielman and Kelemework (2009) propose an integrated, multi-step toolkit that attempts to do just this. This toolkit focuses on measuring and analyzing underlying systems-oriented properties such as the linkages, relationships, and influence among heterogeneous actors by combining participatory data collection tools with expert opinion surveys and organization/firm-level surveys. The resulting data provide both attributional and relational data that add valuable information to their characterization of an innovation system.

Standardization and weighting

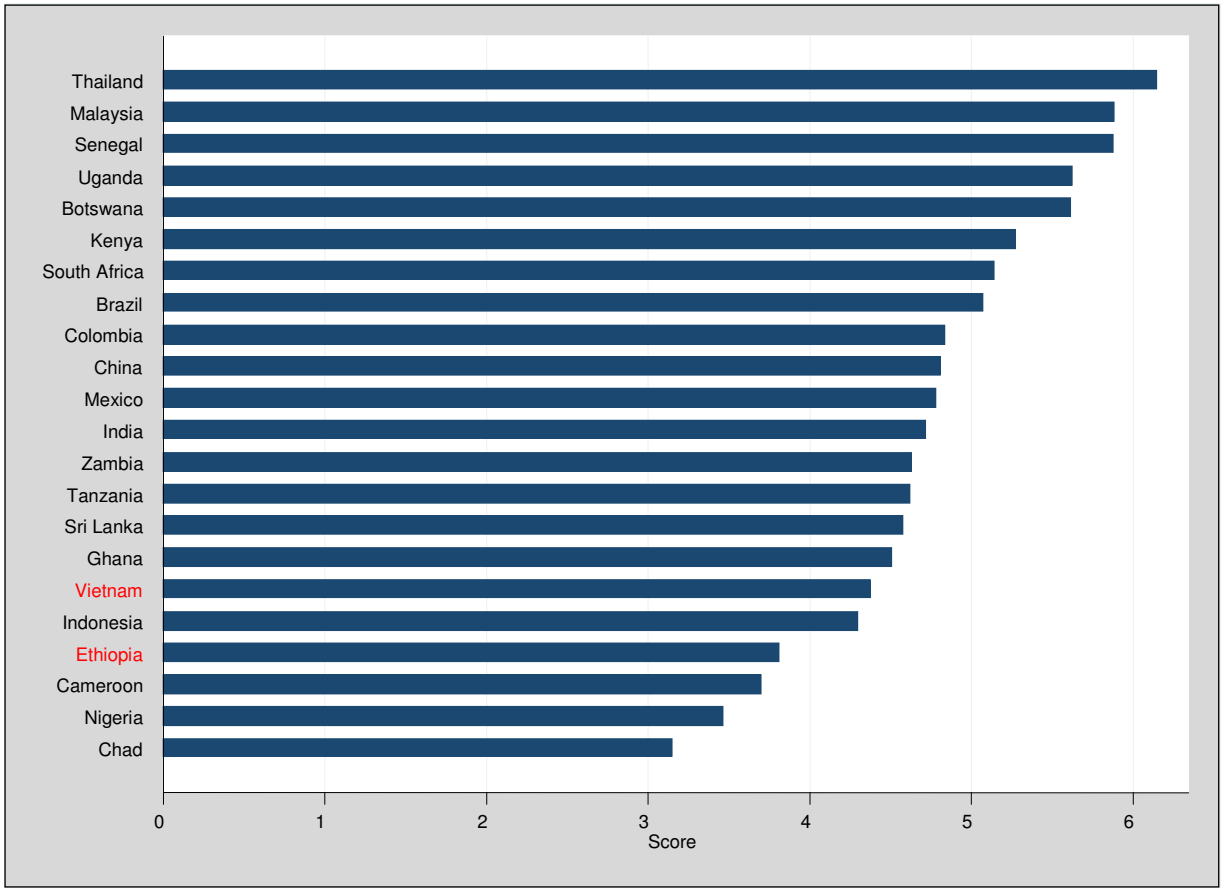
Attempts to measure innovation and design an innovation index also require that close attention be given to the underlying issues of measurement errors, weighting, and statistical properties. For example, indices require that their component indicators be standardized to some intuitive scale to account for different units of measurement (e.g., levels, rates, and intensities; or monetary and scale values) in the underlying data. Similarly, indices require standardization of indicators that measure "goods" for which a higher value is unequivocally better than a lower value, with indicators that are clearly "bads". Finally, indices require consideration of the conceptual and statistical reasons for choosing similar or different weights for component indicators, a challenge that can be addressed with statistical techniques such as factor analysis.

A pilot agricultural innovation index

Figure 2 provides an illustration of one attempt to measure agricultural innovativeness in a manner that extends beyond the "black box" approach to measuring inputs and outputs and highlights the underlying processes that characterize an innovative agricultural sector. This Agriculture, Development, and Innovation Index (ADII) is made up of 41 indicators from 25 secondary data sources.

The ADII was originally developed as a pilot to highlight innovation system properties and performance in two focal countries, Vietnam and Ethiopia. In order to do so in a meaningful way, the index covers an additional 33 developing countries. Six of these additional countries are regional comparators against which Ethiopia and Vietnam could be constructively benchmarked (Kenya, Tanzania, and Uganda for the case of Ethiopia; Malaysia, Philippines, and Thailand for the case of Vietnam). Five of these additional countries are global comparators (China, India, South Africa, Brazil, and Mexico) that were selected for similar purposes. The remaining 22 countries are neighbours or countries with other similarities that make them useful comparators for either Vietnam or Ethiopia.

Figure 2. A pilot "Agriculture, Development, and Innovation Index" (ADII), selected country scores



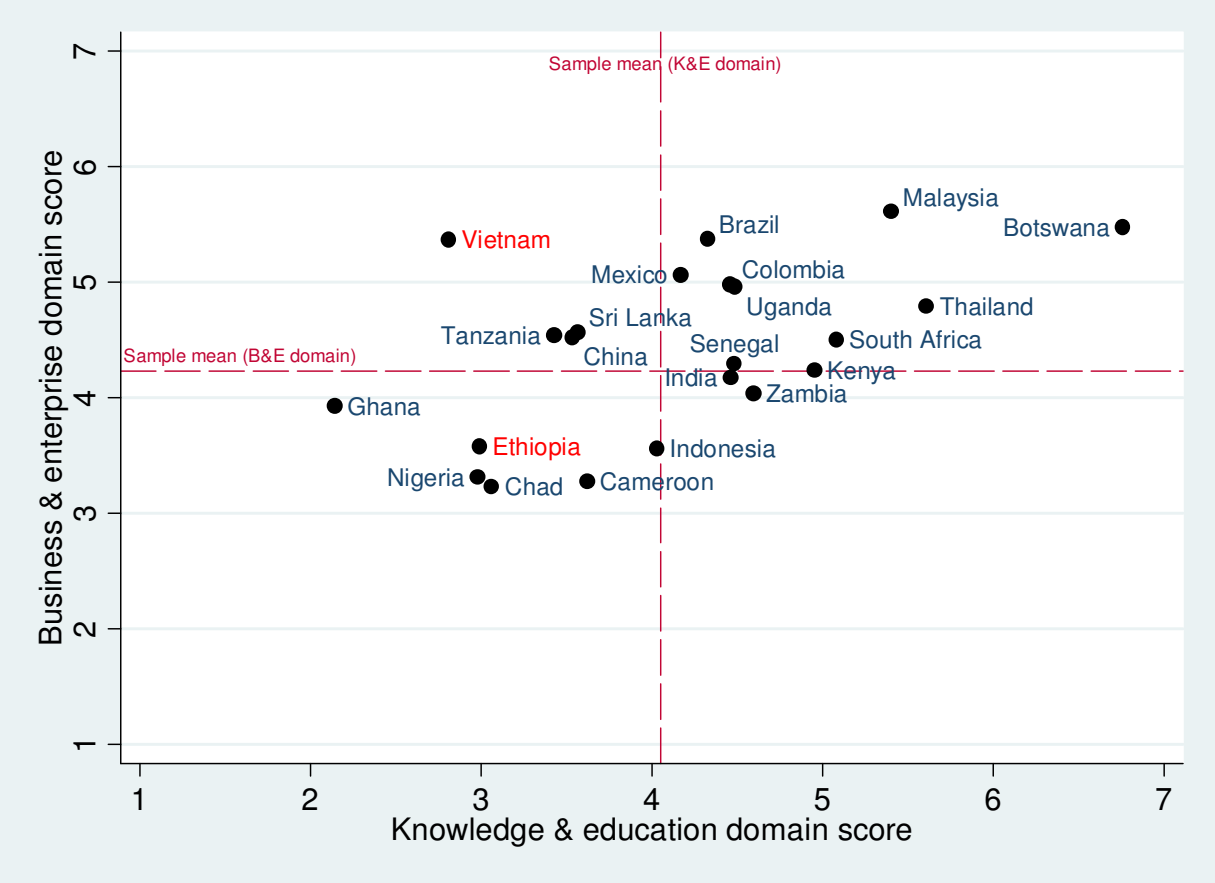
Source: Spielman and Kelemework (2009).

The ADII measures innovativeness across the four domains described earlier and aggregates their scores into an index that is standardized to an intuitive scale of 1 to 10 (ranging from the lowest to highest level of performance). Each domain was assigned an equal weighting in the

ADII for lack of either a conceptual or statistical basis for doing otherwise. See Spielman and Kelemework (2009) for further details.

Among the more useful results from the ADII is the ability to compare domains within and across countries. For example, several countries in the 35-coutnry sample might be described as host to strong knowledge and education domains and weak business and enterprise domains. This describes a country where investments in innovative capabilities—in research institutes, universities, technical training, and other formal knowledge sources—exceed investments in knowledge-based commerce and enterprise. Here, the drivers of innovative performance are more "supply oriented," i.e., more developed in the fields of science and education relative to business. Agricultural innovation systems in Kenya, Zambia, and India may fit into this category relative to the other countries studied here. This might also describe the former Soviet Union and the transitional Eastern European economies that emerged from its collapse, all of which were known for their prowess in science, technology, and education but were rudimentary performers in the fields of business and enterprise.

Figure 3. Science and commerce: Key ADII domain scores



Source: Spielman and Kelemework (2009).

The second type of country might be described as host to a strong business and enterprise domain and a weak knowledge and education domain. This could describe the case of more "demand oriented" countries where technological leap-frogging and imitation in the commercial sector are drivers of innovation performance, and where scientific and education performance lags. Agricultural innovation systems in Vietnam, Tanzania, and China may fit into this category relative to the other countries studied in the countries studied here.

The third and fourth types of countries might be described as "leaders" and "followers," respectively. For example, leaders in the sample—countries such as Thailand, Malaysia, and Botswana—are characterized by relatively strong scores in both the knowledge and education domain and business and enterprise domain. Necessarily, followers in the sample—countries such as Ethiopia, Nigeria, Ghana, Chad and Cameroon—are characterized by relatively low scores in these domains.

Conclusion

Ultimately, the aim of this paper is to offer suggestions on how to measure the properties and performance of an agricultural innovation system, and the importance of combining both "hard" input/output data from conventional secondary data sources with "soft" process-oriented data based on more qualitative methods of data collection. While there is scope for more work on developing appropriate indicators and the tools to measure them, it is hoped that this paper will lay the groundwork for future efforts in this field of inquiry.

With better information and analysis from such efforts, it is hoped that policymakers, donors, practitioners, and other development actors will be able to make decisions that strengthen innovation systems in developing-country agriculture and, ultimately, support national and global efforts to foster agricultural development, economic growth, and poverty reduction.

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