scientists, have helped raise productivity of crops through efficient use of natural resources, but these were mostly published in local journals.

The contribution of technologies developed by PAU is more than evident from a comparison of productivity levels of three principal crops, namely wheat, rice and maize with other states (Table 1).

Punjab has achieved high levels of productivity in these three major crops under intensive agriculture (cropping intensity of 190%). It continues to march ahead on the productivity front in the 21st century. This has been made possible due to the development of high-yielding varieties and matching production and protection technologies developed by the agricultural scientists. So, it is not only the publications which are important, but the contributions/impact of technologies (that may not have been published in high-ranking journals) are equally important and need to be given due credit.

In brief, citation is an important index of quality of research work, but it cannot be applied blindly across disciplines. The citation of papers in agricultural sciences could not be compared with other sciences (basic biological, chemical or physical sciences) due to different research priorities in agriculture, which have the main focus on product development that should have direct relevance to the farming systems. Practicability of research experiments is given more favour and consideration over the outputs of merely academic nature. Wide-scale adoption of the technology by the end-users is more important than high citation of the publications based on this technology. In this light, where Garg and Kumar[1] have done an important task, we feel that low/no citation of papers in agricultural sciences is not an index of quality of research in this area.

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Information and communication technology for effective integrated pest management

The launch of the World Wide Web in 1991 revolutionizing global information system[1] and National e-Governance Plan[2] of 2006 followed by the Digital India project[3] of 2014 to transform India into a digitally empowered society, facilitate wider dissemination of knowledge and technological products and processes for inclusive development of our nation. In agriculture, 25%, 5%, 15% and 50% yield loss in rice, wheat, pulses and cotton respectively, due to insect pests has been reported[4]. All studies in pest management, be it basic or applied, involve the process of collecting and recording data on pest occurrence, abundance using sampling plans and observation procedures devised based on the behaviour of the study organisms and the crops they are associated with. Pest surveillance has the components of survey and monitoring for use in pest risk analyses, establishment of pest-free areas, preparation of region and commodity-based pest lists and field-level pest management[5].

Integrated pest management (IPM), being inclusive with nutrient and holistic crop management, and knowledge-intensive requires timely processing of temporal and spatial information gathered out of e-pest surveillance for quicker need-based management actions to be disseminated by the extension functionaries for adoption by farmers. Information and communication technology (ICT) allows not only assimilation of database on pests over time and space, but also quickly processes data to facilitate a decision on pest management using the available knowledge base and critical inputs that can be mobilized and adopted for plant protection on an area-wide basis.

The Indian Council of Agricultural Research (ICAR)-based National Research Centre for IPM has been using ICT as a vehicle for launching IPM through e-pest surveillance vide its website: http://www.ncipm.org.in/. The ongoing programmes, viz. (1) crop pest surveillance and advisory project (CROPSAP) across crops of rice, soybean, cotton, pigeonpea and chickpea, and (2) horticulture pest surveillance and advisory project (HortSAP) for banana, mango, pomegranate, Nagpur mandarin, sweet orange and sapota are successful examples for large-scale area-wide implementation of IPM across Maharashtra. On-line pest monitoring and advisory services (OPMAS) for cotton are being implemented with the support of 16 co-operating centres of state agricultural universities, ICAR and *Krishi Vigyan Kendras* across 10 major cotton-growing States of India.The highlight of the programmes is the digital delivery of the pest management advisories to the farmers as short message service. Impact analyses have shown increased socio-economic benefits and absence of pest outbreaks. National Innovations on Climate Resilient Agriculture (NICRA) on pest dynamics in relation to changing climate is a strategic-cum-applied research programme, wherein ICT for pest surveillance has been used as a tool for real-time database development on pests and weather through electronic networking of identified locations from different agro-climatic zones of the country for rice, pigeonpea, groundnut and tomato, and offers web-enabled pest forecasting for major pests and select locations.

Integration of ICT for IPM implementation in our country is simple. The requisites for ICT-based pest surveillance include: (i) an organized sampling plan for selection of fields; (ii) scientifically based sampling methodology for pests, including the monitoring tools (global positioning system device, traps and lures for insects, data sheets (books));

(iii) ICT infrastructure (server, computers, customized software for data entry-cum-upload and reporting, and modems for internet connectivity); (iv) fixed schedule for pest surveillance, issue and dissemination of pest management advisories (based on economic threshold levels), and (v) manpower for pest observations, data entry and issue of advisories. Awareness creation among farmers and skill development for pest scouts/monitors and data entry operators provide strong foundation for e-pest surveillance. There needs to be continuous co-ordination among all the stakeholders right from programme formulation to field-level implementation in terms of knowing the pests status, recommendation of pest management advisories and their dissemination to farmers during each cropping season.

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CSIR in SIR 2015

The latest (2015) version of the SCImago Institutions Rankings (SIR) report[1] has just been released on-line. SIR itself is a secondary evaluation exercise using primary bibliometric data from *SCOPUS*, but with the help of indirect surrogate indicators[2] it is possible to now see the time evolution of progress of leading Council of Scientific and Industrial Research (CSIR) institutions over a seven-year window (2009–15).

Last year, we reported in these pages[2] the progress of CSIR institutions which appeared continuously in all the report years from 2009 to 2014. SIR 2015 has revised data even for earlier years and so we can have a fresh look over the 2009–15 Window. For each of these years, the data used to generate the indicators cover a five-year period; thus, data for the year 2012 cover the five-year period 2008–2012. All indicators have been normalized on a scale of 0–100, with the top institution globally having the 100 grade. In each year, only those institutions that have published over 100 scholarly articles indexed in the *SCOPUS* database during the last year of the period of time are counted. By 2015, 27 out of the 38 constituent laboratories of CSIR make this cut. CSIR as a whole is counted as a 'parent' institution and the 27 'children' are listed separately.

In the present analysis we shall look at one input dimension and two output dimensions. First, we look at the quantity or size dimension: This is the number of articles published during the five-year window, normalized on the 0–100 scale. We indicate this normalized quantity indicator by Q. For this entire cycle from 2009 to 2015, the Centre National de la Recherche Scientifique (CNRS), France was listed as the top ranking institution in the world with a score of 100. The second dimension is quality. SIR gives several field-normalized size-independent indicators which are in varying ways proxies for this, but we shall restrict attention to only one – excellence rate, which is the proportion (in %) scientific output of an institution that is included into the set of 10% of the most cited papers in their respective scientific fields, and is a measure of high-quality output of research institutions. Again, for each year, these values are normalized so that the highest ranking performer has a score of 100. The first position has changed hands during the 2009–15 period: the Broad Institute of MIT and Harvard occupied the top rank with an excellence rate score of 100 in 2010 and from 2012 to 2015, while the Research Institute of Molecular Pathology in 2009 and the Whitehead Institute for Biomedical Research in 2011 were credited with the 100 score. We indicate this normalized quality indicator by q.

The one size-dependent input indicator, the so-called scientific talent pool (STP), is the total number of authors from an institution in the total publication output of that institution during a particular period of time. This can be asumed to be a meaningful measure of the input into research activities. This is also normalized in the same manner as above and again for the period from 2009 to 2015, CNRS was listed as the largest institution in the world with the score of 100. We indicate this normalized input indicator by STP.

We can compute a single-valued composite outcome indicator by introducing the second-order indicator called the exergy term from the quantity and quality indicators, $X = q^2Q$. Productivity is then computed as X/STP and this becomes a plausible performance indicator, where the performance chain follows the scheme given in Box 1.

Table 1 lists this surrogate measure of productivity for the two 'parent' agencies, CSIR and CNRS and the 27 'daughter' institutions of CSIR that made the cut in 2015. CNRS as a whole maintains a productivity indicator that is larger than that of CSIR increasing from 1.8 to 2.3 times that of CSIR during the period. CSIR has also been declining faster: by 2015, CSIR has dropped to 62.2% of the value in 2009. During that same time, CNRS has declined to only 80.9% of its 2009 value in 2015. Note that these relative declines have to be rationalized in term of the very high standards set by the Research Institute of Molecular Pathology with an excellence rate score of 100 in 2009 and the Broad Institute of MIT &

Box 1. Scheme.

Input – STP
Output – O = Q
Excellence – Exc = q
Outcome – $X = q^2Q$
Productivity – X/STP.