EVALUATION OF RESEARCH IN AGRICULTURAL AND LIFE SCIENCES IN INDIA

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Abstract: Research is an investment for the future. Better investment in agricultural and biological sciences research and education is necessary to entirely capture the gains of new tools and technologies. Research in agricultural and life sciences has offered great potential to increase food quality and safety. It also helps to develop methods for sustainable resource utilization, management strategies, preservation and protection of the biodiversity, predict and remediate the impacts of pollution and global climate change.

This research paper attempts to provide present indicators on research and innovation in 'Agricultural and biological sciences' thereby enabling policy makers to measure and evaluate the country's progress in research.

The study uses 17 years publications data in Agricultural and biological sciences on India. Their publications data has been drawn from Scopus database covering the period 1996 to 2012. The study examines the country's performance on several measures including the country's publication share in world research output and country publication share in various subjects in the national context and in the global context. It also determines patterns of research communication in core Indian and foreign journals, share of international collaborative papers at the national level. The study compares similarities of Indian research profile with other Asian countries like China and Japan. The findings of the study should be of special significance to the planners and policy-makers.

On the whole it is noticed that the vastness of Indian research output in agriculture and life sciences, is being published in medium to low quality journals. The quantity of international collaborative papers contributed by the nation is also very less when compared to other Asiatic region. Lack of adequate funds, infra structure, political instability, corruption, caste based reservations and unethical practices are found to be major hurdles for India's downfall in Innovation in Agricultural and biological sciences. On the basis of above findings we recommend to enhance the gross domestic expenditure on research and development (GERD) and encourage strong interactions between research centers and industry, so that new Indian patents and systems based on new ideas emerge in a competitive world and India emerges as a global leader in this field.

Keywords: Innovation, Agricultural and biological sciences' Research and Innovation.

Introduction: Basic research donates to our national security and welfare. Innovation and competitiveness have a dynamic, mutual relationship. Innovation generates economic value, new jobs in the economy and cultures of entrepreneurship. By good quality of its relationship with competitiveness, Innovation emerges as a factor in promoting economic growth [1]. Research in agricultural and life sciences has offered great potential to increase food quality and safety. It also helps to develop methods for sustainable resource utilization, management strategies, preservation and protection of the biodiversity, predict and remediate the impacts of pollution and global climate change.

The United States has long been a universal leader in agricultural and biological research. Such leadership has contributed to economic growth as investments in the agricultural and biological technology sectors have led to increased productivity, encouraged new industries, and improved the lives of millions.

India has a great history of scientific research and achievement. Since independence, there has been a shown effort to generate reliable scientific research infrastructure and institutions, even though this attempt has not kept pace with rapidly evolving scientific objectives. Global Innovation Index 2013 places India at the 66th position amongst 142 nations. In scientific research, while India's contribution to the global output has increased, it still remains only at a modest level with no sign of a major upward swing in quantity or quality. Despite the fact that India is progressing, others are moving ahead faster. Thus, some of our neighboring countries have spent much more in people, institutions and infrastructure, and returned the benefits of science, technology and innovation (STI) to achieve spectacular economic growth and to provide for better education and health-care, and have moved ahead quickly towards becoming members of the developed world. India's performance in research and innovation has also not been overall satisfactory, and we have very few institutions that can be found in the top class in international positions. Obviously, we have to make a serious attempt to recover the situation, if we have to move towards becoming a global competitor.

The total annual expenses on science and technology is now close to 0.8% of the Gross National Product (GNP). If the government's dream at present is to be believed, the size of the education sector will grow almost 10-fold during the current XI Five-Year Plan.

Given these projections in the R&D sector in the country, S&T infrastructure in India is certain to witness significant expansion too in the near future.

Keeping in view the overall size of the S&T infrastructure in the country and its steady growth in S&T investments, it is desirable that India comes out with a program to measure and monitor its performance in S&T on a regular basis. This task certainly requires building appropriate indicators of S&T performance, designed to understand the dynamics of research at institutional, sectoral, geographic and at subject level. Besides, indicators are required for illustration how Indian science is performing vis-à-vis select similarly placed countries and against countries from the developed world. S&T indicators are also required for understanding how collaborative research at national and international level is used to improve the quality and capability building in the country. For understanding the current status of India's S&T, there is a need to produce latest S&T indicators, based on publications data for comparatively longer duration. Therefore for this purpose we collected the S&T data of 17 years. It is examined, analyzed and compared with other neibouring countries like China and Japan.

Objectives: The main objective of this study is to produce current Indian S&T indicators by measuring progress of research in India using publications output data. Such indicators are of special significance and helpful for the planners & policy-makers.

Methodology and Data Source: This study used Scopus database for drawing publications data on India and select countries leading in science and technology. Scopus is an international multidisciplinary database indexing over 15000 international peer reviewed journals in science and technology, besides more than 500 international conference/seminar proceedings. So far Scopus is the single largest international multidisciplinary database in the world [1].

The study uses 17 years publications data from 1996 to 2012 on India and other Asian countries like China and Japan. The study has purposely used larger data set covering 17 publication years in order to ensure that the study reflects a more accurate and reliable results as possible. In addition, it used citations data for measuring quality and visibility of Indian research output. The study has used a number of absolute publications, citation and collaborative measures for developing S&T indicators as needed for illustrating India's status in science and technology from 1996 to 2012.

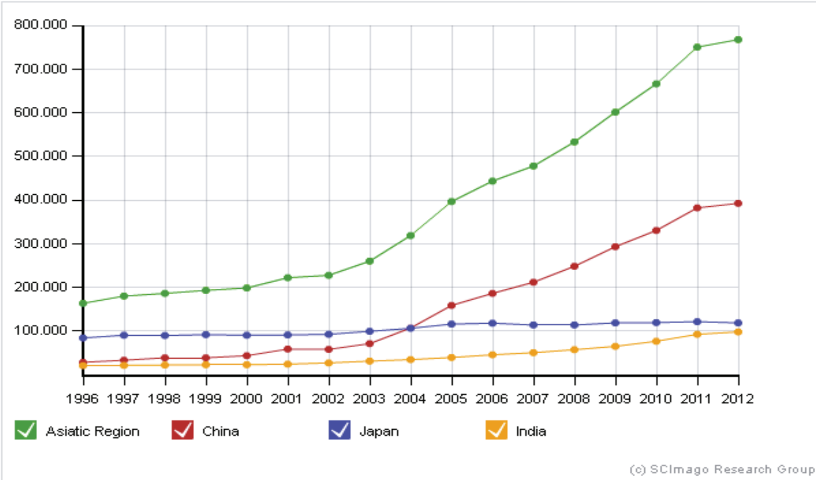
Results and Discussion: Tab.1. *India's Publication Share and Rank in World.*

Country	Documents	Citable documents	Citations
1	United States	7.063.329	6.672.307
2	China	2.680.395	2.655.272
3	United Kingdom	1.918.650	1.763.766
4	Germany	1.782.920	1.704.566
5	Japan	1.776.473	1.734.289
6	France	1.283.370	1.229.376
7	Canada	993.461	946.493
8	Italy	959.688	909.701
9	Spain	759.811	715.452
10	India	750.777	716.232
11	Australia	683.585	643.028
12	Russian Federation	586.646	579.814
13	South Korea	578.625	566.953
14	Netherlands	547.634	519.258
15	Brazil	461.118	446.892

India's Publication Share and Rank in World: India ranks 10th among the top 20 productive countries in science and technology, with its global publications share of 2.11% as computed from cumulative world publications data for 1996-2012 (Table 1&Fig.1).

The United States tops the list with its global publication with 7063329 publications and followed by China (2.680.395), United Kingdom (1.918.650), Germany (1.782.920) and Japan (1.776.473). India is far behind with 10th rank with 750.777 publications. The share of citable documents is 95.4% and cites per document is 0.26 while it is 0.36 in Asiatic region. International collaboration of India is 16.28 while it is

18.14 in Asia.



Asiatic Region	China	Japan	India	
1996	163,495	28,555	84,394	20,600
1997	180,076	32,928	90,527	21,542
1998	186,372	38,388	89,718	21,992
1999	193,113	38,671	91,764	23,060
2000	198,361	43,729	90,296	22,764
2001	221,945	58,451	91,424	24,492
2002	227,403	58,260	92,628	26,676
2003	260,318	71,365	99,661	31,157
2004	318,524	107,185	106,324	34,224
2005	396,630	158,750	116,067	39,240
2006	443,652	186,360	118,037	45,442
2007	478,146	211,472	113,811	50,205
2008	533,060	248,611	113,757	57,158
2009	601,277	293,405	118,362	64,747
2010	666,208	330,204	119,674	76,594
2011	750,298	381,897	121,261	92,803
2012	767,503	392,164	118,768	98,081

Table.2. Comparison of Total research publications of China, Japan, India with Asiatic region.

China, in particular, has shown strikingly significant rise in its publications share, rising from 28,555 in 1996 to 392,164 in 2012. Correspondingly China improved its world ranking from 8th position in 1997 to 5th in 2002 and to 2nd in 2007[1]. Japan has also improved its world share with 84,394 publications in 1996 to 118,768 in 2012.India also witnessed rise in its world publications share. The shift in its global share was 20,600 publications in 1996 while in 2012 it was 98,081 (Table.2) correspondingly, it improved its world ranking from 13th position in 1997 to 12th in 2002 and to 10th in 2012 (Table 2, Fig.1).

India achieved annual average growth rate in publications output at 7.76% as seen from its publications output data for 1996-20012. China showed growth rate of 20.96% per annum, the highest amongst top 20 countries. Indian ranks last among the developing countries in terms of pace of growth in its publications output [2]. (Table 2).

Status of International collaborations: India is having international collaboration with developed and developing countries for research pursuits in science and technology .The number of international collaborative papers contributed by India in 1996 was 16,922 in 1996 while it was even less with 16,278 publications. In Japan it was 16,062 publications in 1996 and in 2012 it was 24,805 (Tab.3). Compared to India's share, developed countries share of collaborative output in their total national output during 1996-2012 was significantly higher .The H index rate is also less in India among all three Asian countries (Fig.3). India's output in high impact journals (with IF range from 10 to 47.4 citations per journal) which much less than other developed countries [3]. (Fig.4).

Tab.3. Comparison of International collaboration publications of China, Japan, India with Asiatic region

	Asiatic Region	China	Japan	India
1996	17.608	18.484	16.062	16.922
1997	16.645	18.398	15.436	15.890
1998	17.145	17.005	16.649	17.338
1999	15.881	16.845	15.307	15.104
2000	15.607	16.234	15.362	14.997
2001	13.442	11.976	14.207	12.947
2002	14.881	15.110	15.130	13.259
2003	19.766	19.795	20.573	18.031
2004	19.226	17.374	21.428	19.007
2005	17.950	14.314	21.694	19.121
2006	18.074	14.378	22.523	18.998
2007	18.728	14.884	24.086	19.408
2008	18.539	14.819	25.085	18.550
2009	17.406	14.376	23.009	17.998
2010	17.316	14.656	23.053	16.958
2011	17.160	14.507	23.805	15.999
2012	18.141	15.577	24.805	16.278

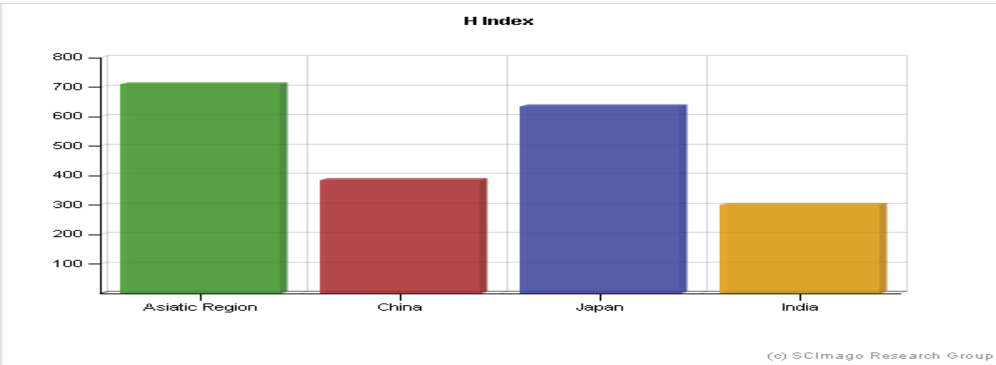


Fig.3. Comparison of H index of publications of China, Japan, India with Asiatic region

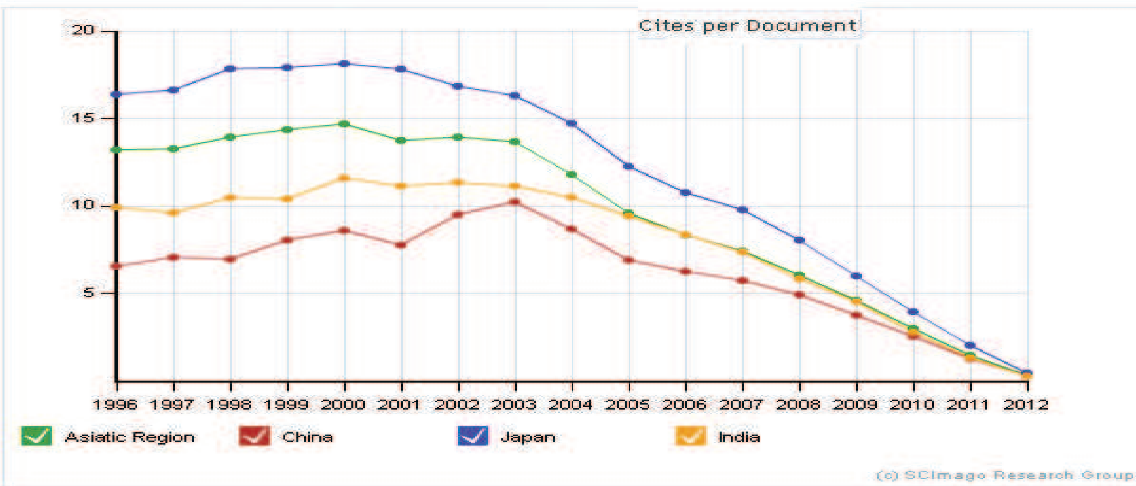


Fig.4. Comparison of Cites per document of China, Japan, India with Asiatic region

Discussion: Taken as a whole, it is seen that the bulk of Indian research output is being published in medium to low quality journals. The country seriously needs to improve quality of research output so that we are able to publish more and more in top quality journals. The country needs to especially improve publications productivity in the university sector as its average productivity, compared to national institutes of importance and research institutions, is still the lowest. This is an issue that policy makers in India need to address seriously so that universities, colleges and the knowledge centers of the country, are able to improve their quality and productivity in science . The report said that India continues to be penalized for its disappointing performance in the areas considered to be the basic factors behind competitiveness [4].

Results also indicate that India has been able to publish only 100 high-cited papers in science and technology in 17 years. This figure needs to improve in the immediate future. This should be one of the objectives of the national plan aimed at improving Indian science.

Why India lags behind:

- India's low ranking in parameters such as political stability (rank 123), ease of starting business (rank 128), school life expectancy (rank 109), pupil-teacher ratio (rank 108), and knowledge absorption (rank 122) were instrumental in its downward journey.
- India's infrastructure is largely "insufficient" and "ill-adapted" to the needs of the economy. Moreover the country also faces problem areas such as corruption and bureaucracy [5].Diversion of public funds to companies, individuals or groups due to corruption, India ranks pretty poorly.
- Lack of good governance
- Fundings: India invested US$3.7 billion in science and technology in 2002–2003. For comparison, China invested about four times more than India, while the United States invested approximately 75 times more than India on science and technology [3].
- India is lagging in science and technology compared to developed countries (Wikipedia). India has only 140 researchers per 1,000,000 populations, compared to 4,651 in the United States.
- Unethical practices, the urge to make illegal money, misuse of power bouncy publications and patents, faulty promotion policies, victimization for speaking against wrong or corrupt practices in the management, praise and brain drain [6].
- Falling behind R&D**:** Ever since the UPA came to power, Dr. Singh has promised to increase the gross domestic expenditure on research and development (GERD) [7]. He committed two per cent of GDP and reiterated it every year since 2007 at the annual session of the Indian Science Congress Association (ISCA). In the last nine years, Indian GERD to GDP either stagnated at 0.9 per cent or even relatively declined adjusted to inflation; 58 per cent of GERD is consumed by the strategic sectors (atomic energy, defence and space research) and about 29 per cent is met by the private sector. So, what is left for civilian R&D, spanning a dozen or so science agencies, is rather pathetic. Look at what is happening in Asia! The Chinese GERD witnessed a dramatic increase from one per cent to 1.84 per cent of GDP in the last decade. In 2012, Japan spent 3.26 per cent, South Korea 3.74 per cent, and Singapore 2.8 per cent. After a decade, the government announced a new Science, Technology and Innovation Policy 2013 or STIP 2013. The scientific community and the nation were left disappointed as the government had failed to fulfill its earlier commitment. There has been no commitment to increase public R&D. The government will only match the private R&D investment to bring it to the level of two per cent of GDP. When is this going to happen? [2].
- Scientist also blames caste for India's backwardness in research [2].

Recommendations:

- Create a strong innovation ecosystem that nurtures science-led innovation.
- Encourage strong interactions between S&T and industry, so that new Indian products and systems based on new ideas emerge in a competitive world market and India emerges as a global leader in STI.
- Increase investment in science and technology and education, including higher education in general.
- Support outstanding individuals, groups and institutions with sufficient long-term funding so that they are able to contribute significantly and become internationally competitive.
- Identify and generously support major national S&T initiatives that can lead to game-changing solutions to our pressing problems.
- Eliminate bureaucracy and outdated procedures
- Freedom for the management of education, science and technology.

Conclusions: The progress in science and technology should be linked closely to the country's real needs. Technical skills not only in institutions of higher learning but also in the rural areas, in farms and workshops and factories should be recognised, encouraged and provided adequate avenues. Technology and engineering skills should not be narrowly linked to any vested interests but instead should be directed towards serving the country's high priority needs.

If we go on board on focused efforts to accomplish the objectives stated above, we will not remain spectators in a world that will be progressing at fast pace in economic, social and educational sectors, but will carve for ourselves a position in the league of global leaders. There is every reason to believe that the science and technology sector will happily bear the increased responsibility needed today.

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