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# Scientometric Analysis of Dairy Research (2001-2010) in Top Three Milk Producing Countries with Special Reference to India

Amrendra Kumar[1] and Kumar Avinash Bharati[2]

[1]Amul (Banaskantha District Co-operative Milk Producers Limited), Gujarat.

[2]CSIR-National Institute of Science Communication and Information Resources (NISCAIR), New Delhi - 110012.

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ABSTRACT

The study measures dairy research in in top three milk producing countries (i.e. India, USA and China) and identify leading players in dairy research during 2001-2010, based on number of parameters, including publication, citation, impact, p-index, h-index and global publication share. The 20 most productive countries were selected and evaluated. The status of research output and milk production in G-7 countries and developing countries were examined. The data on publication citation and h-index were drawn from two databases i.e. Web of Science and Scopus. USA is giving maximum output in quantity and quality of publications, Other major players are UK, France, Germany, Netherland, Canada, Switzerland and Australia. Production of milk is highest in India and it has 10th rank in GDP but lagged behind in dairy research. The developing countries like India, China, Pakistan, Brazil, Poland, Mexico, Argentina and Romania are producing significant amount of milk but share in the research output is very less.



## Introduction

India is rank first in milk production, followed by USA and China (Table 1; Fig. 1). In India, more than 5% of growth has been observed in dairy sector during last three decades (Economic Survey, 2012-13). Dairy sector plays significant role in employment and income in rural areas. About 730 million tons of milk produced every year worldwide (FAO, 2011). It is the major source of nutrition.

Most of the milk is processed before consumption both at household and plant level. Milk goes through different processing methods before it's converted into different products such as market milk, sterilized milk, fermented milk products, cheese, curd, yoghurt, dried milk powders, sweets, etc. The research activities are necessary to meet vital needs, ongoing challenges and force for social and economic change (Kademani et al, 2007; White paper, 2010).

Counting of publications and citations is most fundamental and best method to measure scientific activity scientifically (Garfild, 2006). Although, the quality of research may not be evaluate fully and fairly by bibilometric tools but the alternatives are not better than it (White paper, 2010). The new tools like, h-index and p-index have been added new dimensions to scientometric for better and precise evaluation of research output (Hirsch, 2005; Pratap, 2010).

The review of literature revealed that bibilometric study on milk or milk based research has been not published so far. Therefore, in present study of milk based research has measured through Science Citation Index (SCI) and Scopus databases. The scientometric study of milk based research (2001-2010) was done to address following questions: (1) Is the leading milk producers are also leading in milk based research? (2) What are the status of research activities in major milk producing counties? (3) Who is the on the top in dairy research?

The specific objectives of the study were to: (1) determine quantity and quality of publication in leading milk producing nations; (2) find out most productive countries in milk based research; (3) analyze the status, publication share, rank and growth of research output in highest milk producing country (India) among 20 most productive counties in dairy research.

## Methodology

The Science Citation Index expanded (SCI) and Scopus databases were used for bibilometric study. The SCI database is well recognized and strictly monitors the quality of journals, whereas Scopus gives better coverage to regional journals. Two databases are used during present study because it will give better mapping of research.

Further, an additional information we may get, if the rank of country is better in SCI database with compare to Scopus, it means most of the articles have find reputed journals.

Similarly, the reverse (rank is better in Scopus than SCI) situation indicates that most of the publications are in regional journals because Scopus include more journals and have better coverage to regional journals.

Information on number of publications, citations and h-index was collected. The impact is calculated by C/P and p-index is calculated by (C*C/P)^(1/3), where P is number of publications and C is number of citations.

Ten year window (2001-2010) has been taken for comparative study of leading milk producers, whereas 20 years window (1991-2010) was selected for India.

The concept of "relative measure, not just absolute count" was applied during the study (white paper, 2010). Therefore, various indicators of scientometric are used: counting of publications and citations, impact of publications, h-index and p-index.

The top 20 productive counties are ranked according to p-index because it gives better picture of publication and impact (Pratap, 2010).

Tele:

E-mail addresses: kumaravinashbharati@rediffmail.com

## Analysis

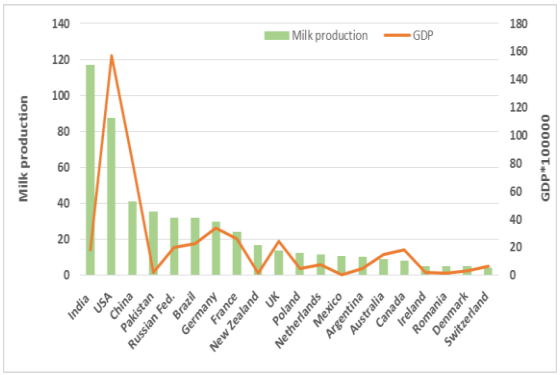


**Fig 1 . Top 20 milk producing nations and their GDP. Milk production, 2010 (Million tonnes); GDP, 2012 (Million US dollars)**

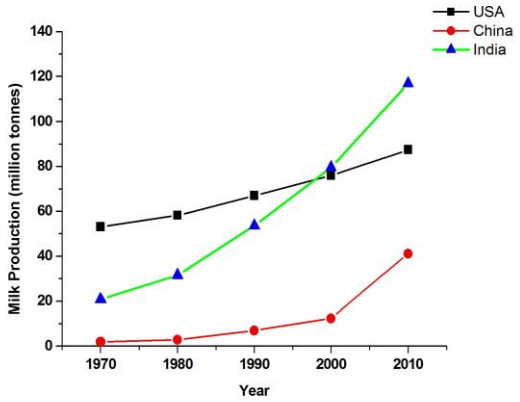


**Fig 2. Trends of milk production in top 3 milk producing counties**

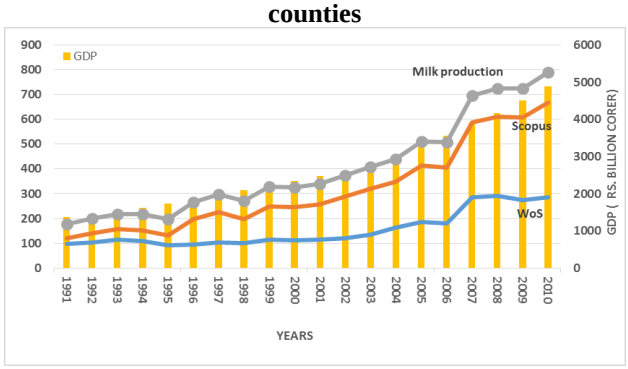


**Fig 3. Trends of India's milk production, GDP and publications (1991-2010). WoS (Web of Science), Milk production in million tones and GDP in Rs billion corer**

## Science Citation Index Expanded databases

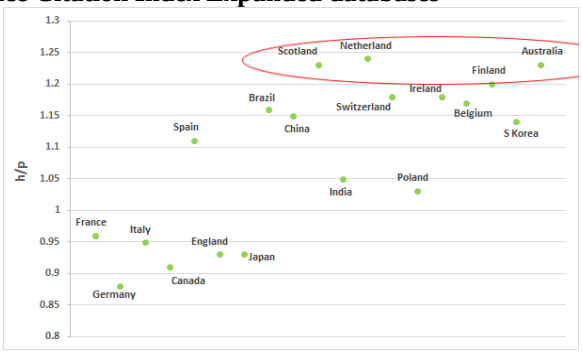


**Fig. 4. Ratio of p-index to h-index. The counties are arranged according to no. of publication in descending order (left side highest). USA has maximum publications but h-index was not available. Netherland, Australia, Scotland and Finland have comparatively less number of publications are below h-index**

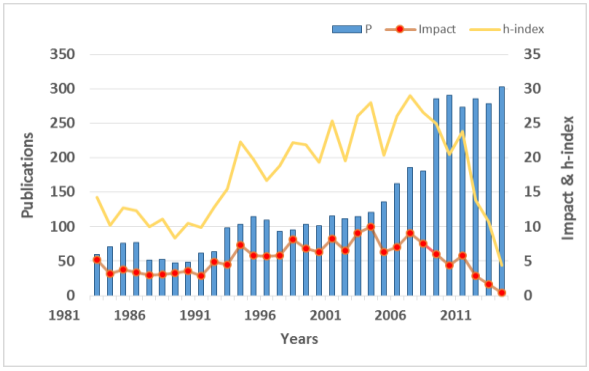


**Fig 5. Dairy research output of India (1981-2010). P, publications**

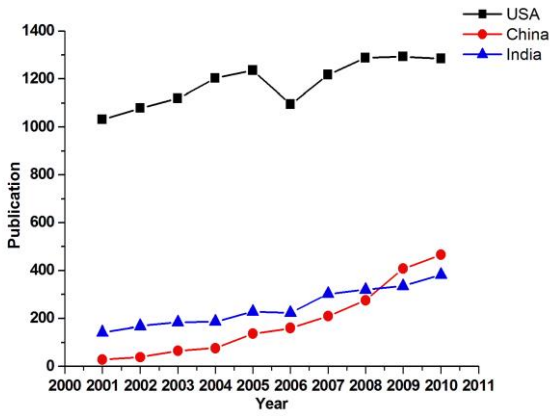


**Fig 6. Comparative analysis of dairy research output in top 3 milk producing countries (2001-2010)**

## Scopus databases


**Fig 7. Ratio of p-index to h-index. The counties are arranged according to no. of publication in descending order (left side highest). Denmark, Switzerland, New Zealand, Brazil, Sweden, Turkey and Finland have comparatively less number of publications below h-index.**

**Table 1. Top 20 milk producing countries in year 2010 (National dairy development board, India; http://www.nddb.org), GDP in year 2012)**

| Countries | Milk production (Million tonnes) | | GDP, 2012 (Million US dollars) | | Rank in publications (Web of Science), 2001-2010 |
|---|---|---|---|---|---|
| | Milk | Rank | GDP | Rank | |
| India | 117.00 | 1 | 1,841,717 | 10 | 12 |
| USA* | 87.46 | 2 | 15,684,800 | 1 | 1 |
| China | 41.14 | 3 | 8,227,103 | 2 | 10 |
| Pakistan | 35.49 | 4 | 231,182 | 44 | 40 |
| Russian Fed. | 32.14 | 5 | 2,014,775 | 8 | 34 |
| Brazil | 31.82 | 6 | 2,252,664 | 7 | 9 |
| Germany* | 29.67 | 7 | 3,399,589 | 4 | 3 |
| France* | 24.21 | 8 | 2,612,878 | 5 | 2 |
| New Zealand | 17.01 | 9 | 139,768 | 57 | 22 |
| UK* | 13.96 | 10 | 2,435,174 | 6 | 7 |
| Poland | 12.30 | 11 | 489,795 | 24 | 15 |
| Netherlands | 11.65 | 12 | 789,257 | 18 | 13 |
| Mexico | 10.84 | 13 | 1,77,271 | 14 | 26 |
| Argentina | 10.50 | 14 | 474,865 | 26 | 27 |
| Australia | 9.02 | 15 | 1,520,424 | 12 | 11 |
| Canada* | 8.24 | 16 | 1,821,424 | 11 | 5 |
| Ireland | 5.24 | 17 | 210,331 | 46 | 20 |
| Romania | 5.06 | 18 | 169,396 | 55 | 43 |
| Denmark | 4.91 | 19 | 314,242 | 33 | 21 |
| Switzerland | 4.11 | 20 | 632,194 | 19 | 14 |

*Member of G-7

**Table 2. According to p-index research output of 20 most productive countries in milk based research (2001-2010)**

| Rank | Country | P | C | Impact | h-index | p-index | p/h | % share of publications |
|---|---|---|---|---|---|---|---|---|
| 1. | USA* | 23328 | 258213 | 11.07 | NA | 141.91 | NA | 38.86 |
| 2. | Netherlands | 1806 | 40459 | 22.40 | 78 | 96.77 | 1.24 | 3.01 |
| 3. | England* | 4836 | 60889 | 22.23 | 98 | 91.52 | 0.93 | 8.06 |
| 4. | Finland | 983 | 25860 | 26.31 | 73 | 87.94 | 1.20 | 1.64 |
| 5. | Canada* | 5899 | 56952 | 17.30 | 90 | 81.92 | 0.91 | 9.83 |
| 6. | France* | 6353 | 58595 | 16.35 | 85 | 81.45 | 0.96 | 10.58 |
| 7. | Switzerland | 1254 | 25480 | 20.32 | 68 | 80.29 | 1.18 | 2.09 |
| 8. | Germany* | 6267 | 56399 | 16.31 | 91 | 79.76 | 0.88 | 10.44 |
| 9. | Belgium | 1050 | 22086 | 21.03 | 66 | 77.44 | 1.17 | 1.75 |
| 10. | Australia | 2045 | 30798 | 15.06 | 63 | 77.4 | 1.23 | 3.41 |
| 11. | Scotland | 742 | 16771 | 22.60 | 59 | 72.37 | 1.23 | 1.24 |
| 12. | Ireland | 1096 | 20094 | 18.33 | 61 | 71.68 | 1.18 | 1.83 |
| 13. | Italy* | 5939 | 44752 | 13.30 | 73 | 69.6 | 0.95 | 9.89 |
| 14. | Spain | 5667 | 43260 | 14.02 | 62 | 69.12 | 1.11 | 9.44 |
| 15. | China | 2150 | 25393 | 11.81 | 58 | 66.93 | 1.15 | 3.58 |
| 16. | Japan* | 4773 | 37138 | 14.19 | 71 | 66.11 | 0.93 | 7.95 |
| 17. | S Korea | 947 | 9517 | 10.05 | 40 | 45.73 | 1.14 | 1.58 |
| 18. | Brazil | 2390 | 14889 | 6.23 | 39 | 45.26 | 1.16 | 3.98 |
| 19. | India | 2034 | 12673 | 6.23 | 41 | 42.9 | 1.05 | 3.39 |
| 20. | Poland | 1206 | 8145 | 6.75 | 37 | 38.03 | 1.03 | 2.01 |

*Member of G-7. Abbreviations: P, publications; C, citations; p/h, p-index/h-index

**Table 3: According to p-index research output of 20 most productive countries in milk based research (2001-2010)**

| Rank | Country | P | C | Impact | h-index | p-index | h/p | % share of publication |
|---|---|---|---|---|---|---|---|---|
| 1. | USA* | 23709 | 545490 | 23.01 | 215 | 232.39 | 1.08 | 41.15 |
| 2. | UK* | 7664 | 33375 | 4.35 | 70 | 52.57 | 0.75 | 13.30 |
| 3. | Germany* | 5653 | 29833 | 5.28 | 74 | 53.99 | 0.73 | 9.81 |
| 4. | France* | 5468 | 28307 | 5.18 | 61 | 52.72 | 0.86 | 9.49 |
| 5. | Canada* | 4668 | 33299 | 7.13 | 70 | 61.93 | 0.88 | 8.10 |
| 6. | Italy* | 4464 | 23357 | 5.23 | 57 | 49.62 | 0.87 | 7.75 |
| 7. | Japan* | 4449 | 27096 | 6.09 | 62 | 54.85 | 0.88 | 7.72 |
| 8. | Spain | 4122 | 26682 | 6.47 | 56 | 55.68 | 0.99 | 7.16 |
| 9. | India | 3558 | 11149 | 3.13 | 39 | 32.69 | 0.84 | 6.18 |
| 10. | Australia | 3148 | 33494 | 10.64 | 68 | 70.89 | 1.04 | 5.46 |
| 11. | Netherlands | 2865 | 54624 | 19.07 | 94 | 101.36 | 1.08 | 4.97 |
| 12. | Brazil | 2670 | 14970 | 5.61 | 39 | 43.78 | 1.12 | 4.63 |
| 13. | Sweden | 2469 | 53076 | 21.50 | 94 | 104.49 | 1.11 | 4.29 |
| 14. | China | 2049 | 20018 | 9.77 | 54 | 58.04 | 1.07 | 3.56 |
| 15. | Switzerland | 1901 | 48211 | 25.36 | 93 | 106.93 | 1.15 | 3.30 |
| 16. | Turkey | 1683 | 12144 | 7.22 | 39 | 44.41 | 1.14 | 2.92 |
| 17. | Poland | 1676 | 11782 | 7.03 | 42 | 43.59 | 1.04 | 2.91 |
| 18. | New Zealand | 1639 | 34405 | 20.99 | 79 | 89.71 | 1.14 | 2.84 |
| 19. | Denmark | 1639 | 38737 | 23.63 | 80 | 97.10 | 1.21 | 2.84 |
| 20. | Finland | 1587 | 45539 | 28.70 | 96 | 109.32 | 1.14 | 2.75 |

*Member of G-7. Abbreviations: P, publications; C, citations; p/h, p-index/h-index

**Scopus databases**

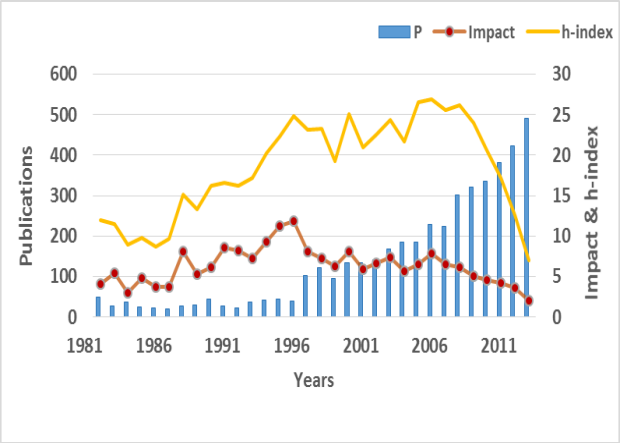


**Fig 8. Dairy research output of India (1981-2010). P, publications**

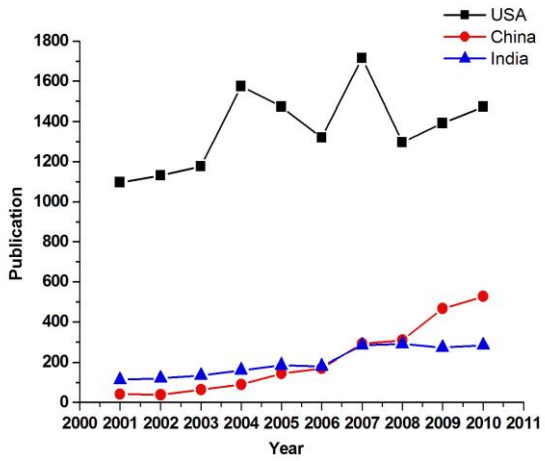


**Fig 9. Comparative analysis of dairy research output in top 3 milk producing countries (2001-2010)**

**Discussion**

After independence in 1947, India has achieved notable success in milk production. It has been observed that milk production, GDP, and publications are positively correlated (Fig. 3). As Fig 3 indicates, since 2007, milk production is above the GDP bar, it means share of milk in GDP is increased rapidly after the year 2007 (Economic Survey, 2012-13; FAO, 2011). Despite this achievement, India lags behind in milk based research (Table 2 & 3). The research and developmental activities are necessary to meet on going challenges and economic growth (Kademani et al., 2007). India's substantial growth in milk production has been achieved after 1980, especially from 2006 onwards. The growth in publication is also being rising steadily after 2006 (Fig. 6 & 9) but it is not up to the mark.

The SCI expanded databases indicates that India is on 19$^{th}$ rank with 2034 research publications, China is at 15$^{th}$ position and USA is on the top. About 95.61% of world's publications are shared by G7 counties. The impact of publications of USA and China is about 1.9 times higher than India. Further, p-index of USA is 3.3 times and China is 1.5 times higher than India (Table 2). Till 2007, India was ahead than China in quantity of publication output but growth for China has been rapid after 2006 (Fig 6).

Scopus databases indicates that India is at 9$^{th}$ rank, China is at 14$^{th}$ and USA is on the top again. The difference in ranking is due to inclusion of more regional journals in Scopus databases (http://www.scopus.com/). According to Scopus database 97.33% of world's publications are shared by G7 counties. It has been observed that annual quantity of publication of China is again better than India after 2007 (Fig 9). Further, impact is 7.3 and 3.12 times higher for USA and China, respectively. The p-index of USA is 74.24 times and China is 3.12 times higher than India (Table 3).

In both the databases impact of Indian publications are less than both the counterparts (i.e. USA and China), it indicates that quality of publications by Indian researchers is not as good as USA and China, hence collecting less citations (Glänzel & Moed, 2002). Further, p-index for India is also less in both the databases. The p-index rank of India is low in SCI expanded databases and comparatively high in Scopus databases, it means most of the Indian publications are in regional journals. Because Scopus has wide coverage of regional journals. In Fig 6 & 9, the line for publication is showing upwards movement whereas line for citations, impact and h-index is decreasing, it is due to accumulative counting of citations. The old publications have relatively more years to collect citations and new publications get less time.

The higher value of h-index than p-index indicates better quality of publications (Pratap, 2010). England, Canada, France, Germany, Italy and Japan have high h-index than p-index in both the databases. In addition, Scopus add two more countries in this categories are Spain and India (Table 2 & 3). Furthermore, the ratio of p-index to h-index provide a notable information, if the ratio of p-index to h-index is more means not many papers are below h-index (i.e. small tail). Similarly, if ratio is less, it means large number of papers that have not been cited (Fig. 4 & 7).

All the members of G-7 countries are dominating in dairy research (Table 2 & 3). In milk production except Italy and Japan developed countries (G-7) are in the list of top 20 milk producing countries (Table 1). Some of the developing countries are in the list of 20 most milk producing counties (i.e. India, China, Pakistan, Brazil, Poland, Mexico, Argentina and Romania) but in research lagged behind (Table 1 & Fig 1). The developing countries are not performing well in dairy research may be due to the limited funding and poor research infrastructure. They divert most of their GDP towards basic amenities, defense and payment of interest (www.worldbank.org).

**Conclusion**

In dairy research USA is on top and UK, France, Germany, Netherland, Canada, Switzerland and Australia are leading counties. India is leader in milk production but research output is not up to the mark. Research output of China is better than India. The developing countries like India, China, Pakistan, Brazil, Poland, Mexico, Argentina and Romania are producing significant amount of milk but share in the research output is very less.

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