Regional Collaboration in S&T among South Asian Countries

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Abstract
The science and technology is being practised today in a collaborative manner with participation of scientists from different disciplines, institutions and countries. To combat the problems of pollution, environment, energy, biodiversity, health, nutrition, etc., many countries in the world, particularly the developing countries, need the cooperation and support of other countries. In this paper, a study on the outputs of S&T collaborations among South Asian countries is presented through the analysis of co-authored research papers published during the period 1994-2004 in the journals covered by the *Web of Science (Extended Science Citation Index).* The study analysis these collaborations from various angles, viz, nature, S&T areas, institutions involved and their impact on individual fields.

Introduction

The present day South Asia, known previously as the Indian subcontinent, comprises the states of India, Bangladesh, Bhutan, Maldives, Nepal, Pakistan, and Sri Lanka. It represents 3 per cent of the world's area, but houses 22 per cent of the earth's population. It accounts for 1.65% of the world's GDP and 1.12% of global trade during 1995.The importance of developing S&T and its applications to meet the economic, industrial, trade and societal challenges has been recognized in most South Asian countries, as is evident from the emphasis placed in their development plans and policies. In national endeavors for developing S&T, importance has also been accorded to the creation of wide spectrum of S&T infrastructure in terms of research laboratories, R&D institutions, and in-house units in industry covering several disciplines. Yet the scale of S&T activity in most South Asian countries measured in terms of proportion of national income spent on R&D activity or the proportion of population engaged in its R&D activity is marginal, if at all significant. .

South Asian countries have recognized the importance of international collaboration as a major factor in their development of science and technology capabilities. There is a wide scope of cooperation and collaboration in science and technology among South Asian countries. Each country can share with others the advantage it has in its S&T base and knowledge. The collaboration among South Asian countries is being undertaken through bilateral, regional and multilateral agreements[1]. Among bilateral collaborations, India has taken the maximum initiatives and has signed bilateral agreements in science and technology with Bangladesh (1982), Pakistan (1983), Sri Lanka (1975) and Nepal. A majority of actual collaborations are undertaken under the umbrella of regional and international cooperation, through various agencies of the United Nations and other international organizations in the form of training of S&T personnel, exchange of scientists, and conduct of joint research and development projects.

The idea of regional cooperation was also conceived under the South Asian Association for Regional Cooperation (SAARC). India played a major role in promoting collaboration under SAARC. At present there are twelve areas of cooperation under SAARC, which include agriculture, communications, environment, health and population activities, and science and technology[2]. Regional cooperation is also fostered through other international agencies and their regional programs. These agencies and programs are playing significant role in exchange of information, training of technical personnel and scientists, and conducting of joint research and development projects among developing countries, including those pertaining to S&T.

The collaboration among South Asian countries has resulted in different kinds of outputs, which include joint research publications, technology development and transfer and development of products

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and processes. The joint research publication is an important indicator of the strength of research collaboration and its impact on different fields. This particular information on collaborated output is comparatively well documented in printed and computerized databases. However, there are hardly any sources through which other outputs of these collaborations could be easily documented and studied.

Some studies have been undertaken in the past on the collaborative linkages of Indian science, using publication data from Science Citation Index. The study by Nagpaul[3] was focused on the analysis of the trans-national linkages of Indian science in eleven scientific fields, with 35 most significant partner countries during 1990 and 1994. The author in collaboration with his colleagues[4-5] has conducted some studies analyzing India's collaborative linkages, both at bilateral and multilateral level, with Russia and China. The present study analysis the collaboration linkages among South Asian countries.

Objectives

The main aim of the study is to analyze research collaborations among South Asian countries with following objectives: (i) To study of the nature of collaboration in S&T, as reflected in co-authored research papers, (ii) To identify the subject areas of collaboration, (iii) To evaluate the impact of collaborative research, and (iv) To identify the major institutions involved in these collaborative research activities.

Databases and Methodology

The data for the study was culled from the *Web of Science (Extended SCI)* database from 1994 to 2004 (11 years). This database covers around 6,000 significant journals of the world in all major fields of science and technology. However, it covers only a few domestic journals published from the South Asian countries. The journals covered by *Web of Science (Extended SCI)* represent the mainstream science and technology. As a result, the study is restricted to the co-authored articles generated from collaboration among five South Asian countries. The articles were classified under 13 major disciplines and sub-disciplines, according to the classification scheme suggested by ISI, Philadelpia,USA. In this scheme, each article is classified into a main discipline and a sub-discipline using the subject title of the journal in which it is published. For impact factor data, we have used the *Journals Citation Report* brought out by Institute of Scientific Information (ISI) annually. Since the minimum and maximum value of IF varies across broad subjects, we have normalized the impact factor data using the methodology suggested by Nagpaul.

S&T Research Output of South Asian Countries

Table 1 presents the publication data for five South Asian countries from 1994 to 2004, as reflected in the *Web of Science (Extended SCI)* database. It is clear from Table 1 that there is a wide gap between the research output of India and other South Asian countries. The normalized average number of publications per year from these countries during 1994 to 2004 was: 20496 for India, 744 for Pakistan, 442 for Bangladesh, 355 for Sri Lanka, and 134 for Nepal.

Table 1: S&T research output of South Asian countries, 1993-2004

Year	India	Bangladesh	Pakistan	Sri Lanka	Nepal
1994	15652	299	499	134	58
1995	16373	349	615	136	84
1996	16486	337	581	130	68
1997	16269	355	537	122	83
1998	17740	368	671	150	108
1999	18726	398	637	189	125
2000	17501	389	648	205	132
2001	19,339	433	613	186	154
2002	20405	454	759	212	168
2003	23135	532	862	310	181
2004	23336	507	1024	281	178

Collaboration in S&T among South Asian Countries

The collaboration among South Asian countries during 1994 to 2004 has resulted in 466 co-authored papers in different fields of science and technology. The average number of co-authored papers (42) per year is very small as compared to the scientific output of all these five countries. These papers have appeared in different formats: research articles (394), review articles (17), letters (17) and the rest as letters to the editor, notes, meeting-abstracts, editorial material and discussion.

Of the five countries of South Asia, India has played a central role in encouraging collaboration among themselves. In 466 co-authored papers among South Asian countries from 1994 to 2004, India's collaboration with all the other four countries was the largest, with the joint output of 410 papers. It has 222 co-authored papers with Bangladesh, followed by Nepal (97), Pakistan (67), and Sri Lanka (53). The exclusive collaboration among Bangladesh, Pakistan, Nepal and Sri Lanka was, however, very small and resulted in only 56 co-authored papers. Table 2 presents the distribution of collaborative papers among South Asian countries.

Table 2:Collaborative papers among South Asian countries

Country	Number of co-authored papers				
	India	Bangladesh	Pakistan	Nepal	Sri Lanka
India		222	67	97	53
Bangladesh	222		27	19	8
Pakistan	67	27		10	20
Nepal	97	19	10		7
Sri Lanka	53	8	20	7	
Total	410	251	106	116	78

Of the 466 co-authored papers among South Asian countries, only 136 (29%) papers were under bilateral collaboration and 330 papers under multilateral collaboration. A comparative stronger bilateral collaboration exists between India and Bangladesh and India and Nepal, which accounts for 32% and 37%, respectively of all co-authored papers. In contrast, India's co-authored papers with Pakistan and Sri Lanka involve mainly multilateral collaboration, which accounts for 91% and 88.7%, respectively of their total co-authored papers. Except with India, Bangladesh has strong multilateral collaboration with Pakistan, Nepal and Sri Lanka, accounting for 96%, 95% and 87% of their total co-authored papers. In case of Pakistan, it has comparative higher bilateral collaboration with Nepal and Sri Lanka and strong multilateral collaboration with India and Bangladesh, accounting for 91% and 96%, respectively of their total co-authored papers. Nepal has comparatively higher bilateral collaboration with India and Pakistan, but strong multilateral collaboration with Bangladesh and Sri Lanka, accounting for 95% and 86 % of its total co-authored papers.

The break-up of 466 co-authored papers under 13 major disciplines indicates the following picture. Basic life science and clinical medicine had the largest and almost equal number of co-authored papers (19% each), followed by biomedical research 46 (9.9%) papers, chemistry 45 (9.6%) papers, physics 41 (8.8%) papers, agriculture 41 (8.8%) papers, engineering 37(7.9%) papers, and earth & environment science 27(5.6%) papers. Rest of the subject disciplines was contributing less than 5% papers.

As compared to other countries, India's collaboration with Bangladesh is more widespread across all major disciplines. It indicates: (a) larger collaborative efforts in basic life science accounting for 25% of their co-authored papers; (bi) modest size collaborative efforts in clinical medicine, physics, engineering, biomedical research and agriculture, accounting for 14%, 12%, 11%, 10% and 8%, respectively of their co-authored papers; (c) smaller collaborative efforts has been observed in all other disciplines. In contrast, India's collaborative efforts with Pakistan, Nepal and Sri Lanka are focused in few disciplines, namely clinical medicine, basic life sciences, biomedical research and agriculture.

The impact of these co-authored papers was analyzed through the impact factor of journals in which these papers were published. Considering all co-authored papers, the normalized average impact factor per paper was observed to be 0.83. It was 0.46 for bilateral papers and 0.98 for multilateral papers. Except for multidisciplinary sciences, which had exceptionally high normalized average IF per paper (3.86), the normalized average value of IF per paper under various disciplines, in

terms of ranking were: 1.53 for clinical medicine, 1.03 for basic life sciences , 0.85 for biomedical research, 0.44 for biology, 0.40 for physics and agriculture each, 0.37 for chemistry, and 0.34 for earth & environment science, social sciences (0.29), engineering (0.20), computer science (0.17), and mathematics (0.10).

The highest normalized average value of IF was 2.33 under Nepal-Sri Lanka collaboration, followed by 1.43 under India-Pakistan, 1.22 under India-Sri Lanka, 1.17 under Pakistan-Nepal, 1.06 under Bangladesh-Sri Lanka, 0.96 under Bangladesh-Pakistan, 0.90 under Bangladesh-Nepal, 0.75 under India-Bangladesh, 0.60 under India-Nepal and 0.59 under Pakistan-Sri Lanka

There were 194 journals in which these 466 collaborative papers were published. Of these journals, 194 journals have published only 1 paper, 53 journals 2 papers, 24 journals 3 papers, 4 journals 4 papers, 8 journals 5 papers, 2 journals 6 papers and 12 and 14 papers 1 journal each. A list of journals in which more than 5 collaborated papers were: (i) *Journal of Clinical Microbiology* (14 papers), (ii) *British Medical Journal* (12 papers), (iii) *Lancet* (6 papers) and (iv) *Leprosy Review* (6 papers).

In all, 412 institutions from South Asian countries were involved in the collaborative research during the period under study. Of these, 202 were from India, 68 from Bangladesh, 49 from Pakistan, 60 from Nepal and 33 from Sri Lanka. The names of major South Asian institutions along with their individual collaborated publications were as follows:

India - (i) National Institute of Cholera & Enteric Diseases, Kolkata (49 papers), (ii) Jadavpur University (28 papers), (iii) All India Institute of Medical Sciences, New Delhi (25 papers), (iii) Banaras Hindu University, Varanasi (18 papers); (iv) Society for Applied Sciences, Kolkata (16 papers), (v) Christian Medical College & Hospital, Vellore (12 papers), (vi) Indian Agricultural research Institute, New Delhi (11 papers), (vii) Indian Institute of Technology, New Delhi (11 papers), and (viii) Indian Institute of Technology, Kharagpur (10 papers).

Bangladesh – (i) International Centre of Diarrhoeal Disease Research (ICDDR), Dhaka (78 papers), (ii) University of Dhaka (38 papers), (iii) Jahangirnagar University, Dhaka (13 papers), (iv) University of Chittagong (12 papers), and (v) Rajshahi University (11 papers).

Nepal – (i) Tribhuvan University, Kathmandu (33 papers) and (ii) B.P.Koirala Institute of Health Sciences, Dharan (12 papers),

Pakistan – (i) Aga Khan University, Karachi (18 papers), (ii) University of Karachi, Hej Research Institute of Chemistry (18 papers), and (iii) International Water Management Institute, Lahore (10 papers).

Sri Lanka – (i) University of Colombo (20 papers), (ii) International Water Management Institute, Columbo (16 papers), and (iii) University of Peradeniya (15 papers).

Bilateral S&T Collaborations among South Asian Countries

Bilateral collaboration among South Asian countries had resulted in 136 co-authored papers. India's collaboration with South Asian countries had resulted in 120 co-authored papers. The maximum (72) papers were published through the collaboration of India with Bangladesh, followed by with Nepal (36 papers), Pakistan (6 papers), and Sri Lanka (6 papers). Of the remaining 16 bilateral co-authored papers, Pakistan collaboration with Nepal and Sri Lanka resulted in 4 and 8 papers each. Bangladesh bilateral collaboration with Pakistan, Nepal and Sri Lanka resulted in only 1 co-authored paper each.

The 136 bilateral co-authored papers were in 13 major disciplines. The subject-wise and country-wise break-up of these papers is given in Table 4 along with their normalized average IF values. The largest number of papers was published in the area of chemistry (23), engineering (23 papers), and physics (22 papers) and the least in social science (1 paper).

It was observed that the normalized average impact factor per paper based on bilateral co-authored papers was 0.46. The highest normalized average value of IF (1.60) was under India-Pakistan, followed by 1.01 for Pakistan-Nepal papers, 0.93 for Bangladesh-Sri Lanka papers, 0.59 for Bangladesh-Pakistan papers, 0.47 for India-Bangladesh papers, 0.33 for Pakistan-Sri Lanka papers, 0.28 for India-Nepal papers, 0.26 for Nepal-Sri Lanka papers, 0.24 for Bangladesh-Nepal papers and 0.10 for India-Sri Lanka papers. It was also observed that India-Bangladesh bilateral co-authored

papers had the highest normalized average values of IF in six disciplines: multidisciplinary sciences (3.40), computer science (0.22), social sciences (0.21), engineering (0.18), earth & environmental science (0.17), and mathematics (0.15); India-Nepal bilateral co-authored papers had the highest normalized average values of IF in three disciplines: biomedical research (0.63), physics (0.45), and engineering (0.18); Pakistan-Sri Lanka bilateral co-authored papers had the highest normalized average values of IF in two disciplines: agriculture (0.49) and biology (0.31); Bangladesh-Pakistan, Bangladesh-Sri Lanka and Pakistan-Nepal bilateral co-authored papers had the highest normalized average values of IF in one discipline each: chemistry (0.59), basic life sciences (0.93), and clinical medicine (2.44) (Table 4)

Multilateral S&T Collaborations of India with South Asian Countries

Of the 330 multilateral co-authored papers, 305 involved the participation of at least two South Asian country and one or more other countries outside the South Asia region. 23 papers had the participation of three South Asian countries simultaneously and one or more other countries. 2 papers had the participation of five South Asian countries simultaneously and one or more other countries. As a result on counting the total number of co-authored papers under 12 subjects, it comes as more number than the actual total.

Among multilateral collaborative papers, the largest contribution (150 papers) was from India–Bangladesh, followed by India–Pakistan (61 papers), India–Nepal (61 papers) and India–Sri Lanka (47 papers), Pakistan-Bangladesh (26 papers), Bangladesh-Nepal (18 papers), Pakistan-Sri Lanka (12 papers), Bangladesh-Sri Lanka (7 papers), and Pakistan-Sri Lanka (6 papers) (Table 5).

The 330 multilateral co-authored papers were in 12 major disciplines. The largest number of papers was published in the area of basic life sciences (77 papers), followed by clinical medicine (75 papers), biomedical research (42 papers), agriculture (31 papers), earth & environment science (23 papers), chemistry (22 papers), physics (19 papers), engineering (14 papers), biology (13 papers), social sciences (7 papers), multidisciplinary sciences (5 papers), and mathematics (2 papers). The subject-wise and country-wise break-up of these papers is given in Table 5 along with their normalized average IF values.

The normalized average impact factor per paper based on multilateral co-authored papers was 0.98. The highest normalized average value of IF was 2.33 under Nepal-Sri Lanka collaboration, followed by 1.42 under India-Pakistan, 1.37 under India-Sri Lanka, 1.29 under Pakistan-Nepal, 1.08 under Bangladesh-Sri Lanka, 0.97 under Bangladesh-Pakistan, 0.93 under Bangladesh-Nepal, 0.89 under India- Bangladesh, 0.79 under India-Nepal, and 0.76 under Pakistan-Sri Lanka.

It was also observed that India-Bangladesh and India-Pakistan multilateral co-authored papers had the highest normalized average values of IF in three broad disciplines each: India- Bangladesh in biomedical science (1.04), agriculture (0.64), and mathematics (0.05); India- Pakistan in multidisciplinary sciences (9.85), basic life sciences (2.05), and physics (0.81). India-Nepal multilateral co-authored papers had the highest normalized average values of IF in two broad disciplines: biology (0.58) and engineering (0.36). Similarly India-Sri Lanka, Pakistan-Nepal, Pakistan-Sri Lanka and Nepal-Sri Lanka multilateral co-authored papers had the highest normalized average values of IF in one broad discipline each: social sciences (0.46), chemistry (1.25), earth & environmental science (0.59) and clinical medicine (3.31).

In all 123 countries participated in multilateral collaborated papers, of which 118 countries were from outside South Asian region. These countries participated in various combinations, ranging from 3 to 61. Around 37.27 per cent of the multilateral collaborative research papers emanated from the team efforts of 3 countries. The participating teams comprising 11 to 61 countries accounted for about 9.39 per cent of the total multilateral papers.

In these papers, there was a noticeable involvement of international and regional organizations/centers, such as World Health Organization (29 papers), International Rice Research Institute, Manila, Philippines (10 papers), International Atomic Energy Agency (6 papers), UNFPA (7 papers), UNICEF (6 papers), International Maize & Wheat Improvement Center, Kathmandu (5 paper), Word Bank (3 papers), CIMMYT, S Asia (5 papers), International Center for Agricultural Research in Dry Areas, Aleppo, Syria (2 papers), There was also an active involvement of international organizations located in South Asian countries, such as International Center for Diarrhoeal Disease Research, Dhaka (19 papers), International Water Management Institute, Columbo

(11 papers), International Water Management Institute, Lahore (6 papers), ICRISAT, Patancheru (4 papers), International Center for Integrated Mountain Development, Kathmandu (5 papers).

The influence of different regions and countries on the collaborations was also analyzed. In these papers, the USA had participated in maximum 199 (60.30%) papers, followed by The United Kingdom 96 papers, Japan 91 papers, China 63 papers, Thailand 45 papers, Switzerland 37 papers, Indonesia 35 papers, South Korea 34 papers, Italy 34 papers, Philippines 29 papers, Malaysia 28 papers, Canada 25 papers and Australia 22 papers.

The number of institutions collaborating per paper from various participating countries in multilateral papers ranged from 3 to 55. The participation of 3 institutions was in more than 32.60% (30 papers) of the total papers. On the other hand, the participation of 11 to 55 institutions accounted for 15.22% (14 papers) of all papers. Only in one multilateral paper, the number of participating institutions was 55. The number of participating institutions was less than 21 in other papers.

Areas for Future Cooperation

There are many areas of science and technology where cooperation among South Asian countries would be mutually beneficial. These include food and fermentation technology, ore processing, metallurgy, glass and ceramics, paints and plastics, fine chemicals and leather. Other common areas could be: utilization of common eco-system, preserving region's rich genetic bio-diversity, hydropower resources and transmission of the generated electricity; maintaining surveillance on seismic, climatic and other environmental changes for sending advance warning against draught, flood and other environmental changes; undertaking joint space programs for the survey of natural resources and sharing of traditional knowledge in different subject areas. In addition, complimentary technological relations are necessary to sustain commercial relations, recognizing that technology would dominate the development challenges in the 21st century. A SAARC study group on economic cooperation has also prescribed regional technological cooperation to meet the requirement of global competitiveness. India - contributing 78 per cent of the total manufacturing value in the region - has an unmistakable technological superiority in both capital and intermediate technology. Compared to western technologies, India's expertise would be more suitable to South Asian countries[6].

Conclusions

A study on S&T collaboration among five South Asian countries (India, Bangladesh, Pakistan, Nepal and Sri Lanka) has been presented through the analysis of joint co-authored research papers published during 1994-2004 in journals covered by Extended SCI under Web of Science database. As an outcome of these collaborations, a total of 466 joint co-authored papers were published in which only 136 under bilateral collaborations and 330 under multilateral collaborations. In all 412 institutions from South Asian countries were involved in the collaborative research during the period under study. Of these, 202 were from India, 68 from Bangladesh, 49 from Pakistan, 60 from Nepal and 33 from Sri Lanka. Amongst India's collaborations with fellow South Asian countries, India-Bangladesh joint collaborative research produced maximum number of papers through bilateral (71 papers) as well as multilateral (47 papers) research. The most favourite area for collaboration has been found to be "basic life science", "clinical medicine", and "biomedical research" both in terms of joint research output and citation impact, probably because of marked growth in the research in health-related problems world over and application of these research results for solving environmental health hazards during the last decade. However under bilateral collaboration, the preferred areas of collaboration were chemistry, engineering and physics. USA, as expected, had the maximum share amongst participating countries outside the South Asian arena in all co-authored papers. The need for further cooperation has been indicated in areas such as biotechnology, biodiversity, environment, floods and droughts, etc., and above all, in traditional knowledge on medicines and healthcare of the region.

References

1. India, Department of Science and Technology, Technology Information, Forecasting and Assessment Council(1995). *Status of S&T in India*. New Delhi.
2. Thomas, Jibby (2000). Science and technology cooperation in SAARC. In. B.C. Upreti, ed. *SAARC: Dynamics of Regional Cooperation in South Asia (225-265).* Vol.2. New Delhi: Kalinga.
3. Nagpaul, P.S. (2000). International collaboration in Indian scientific papers. *Scientometrics*, 48(3), 381-402

4. Gupta, B.M., Dhawan, S.M. & Walke, Rajpal (2002). Indo-Russian collaboration in S&T: An analysis through co-authored publications, 1995-99. *Current Science*, 82(9), 1075-77.
5. Gupta, B.M. & Dhawan, S.M. (2003). India's collaboration with People's Republic of China in science and technology: A scientometric analysis of co-authored papers during 1994-99. *Scientometrics*, 57(1), 59-74.
6. Das, Suranjan (2 December 2000). Regional security through constructive bilateralism: Prospects for South Asian stability. *Economic and Political Weekly*, 4349-4359.

Table 4. Major areas of bilateral collaboration with output of collaborative papers and the corresponding normalized average impact factor

	Total papers	**Number of papers with the values of normalized average impact factor (in parenthesis) in different subjects**												
		Agr	**BLS**	**Biol**	**BMR**	**Chem**	**CM**	**CS**	**EES**	**Engg**	**Math**	**MS**	**Phys**	**SS**
Total papers	**136 (0.46)**	**10 (0.18)**	**14 (0.53)**	**2 (0.23)**	**4 (0.56)**	**23 (0.27)**	**15 (1.35)**	**5 (0.17)**	**4 (0.16)**	**23 (0.17)**	**8 (0.12)**	**5 (2.12)**	**22 (O.33)**	**1 (0.21)**
Ind-Bang	**72 (0.47)**	**1 (0.42)**	**10 (0.54)**		**1 (0.99)**	**10 (0.20)**	**4 (1.44)**	**4 (0.22)**	**3 (0.17)**	**15 (0.18)**	**5 (0.15)**	**3 (3.34)**	**15 (0.27)**	**1 (0.21)**
Ind-Nepal	**36 (0.28)**	**6 (0.12)**	**1 (0.12)**	**1 (0.14)**	**2 (0.63)**	**5 (0.18)**	**5 (0.49)**	**1 (0.00)**	**1 (0.13)**	**2 (0.18)**			**7 (0.45)**	
Ind-Pak	**6 (1.6)**					**1 (0.13)**	**4 (0.34)**			**1 (0.14)**	**3(0.07)**	**2 (0.20)**		
Ind-Sri Lanka	**6 (0.10)**	**2 (0.07)**			**1 (0.00)**					**3 (0.15)**				
Bang-Pak	**1 (0.59)**					**1 (0.59)**								
Bang-Nep	**1 (0.24)**						**1 (2.44)**							
Bang-Sri Lanka	**1 (0.93)**		**1 (0.93)**											
Pak-Nepal	**4 (1.01)**					**3 (0.53)**								
Pak-Sri Lanka	**8 (0.33)**	**1 (0.49)**	**2 (0.44)**	**1 (0.31)**		**2(0.39)**				**2 (0.12)**				
Nep-Sri Lanka	**1 (0.26)**					**1(0.26)**								

Agr = Agriculture, BLS = Basic life sciences, Biol = Biology, BMR = Biomedical research, CM = Clinical Med, CS = Computer Science,
EES = Earth & Environment Science, MS = Multidisciplinary sciences, SS= Social science

Table 5. Major areas of multilateral collaboration with output of papers and their normalized average impact factor values

	TP	Number of papers with normalized average impact factor (in parentheses) in different subjects											
		Agr	BLS	Biol	BMR	Chem	CM	EES	Eng	Math	MS	Phy	SS
Total	330(0.98)	31(0.47)	77(1.12)	13(0.47)	42(0.88)	22(0.46)	75(1.56)	23(0.37)	14(0.26)	2(0.05)	5(5.6)	19(0.47)	7(0.30)
Ind-Pak	61(1.42)	8(0.45)	12(2.05)	3(0.24)	3(0.83)	4(0.25)	21(1.86)	3(0.22)	-	-	1(9.85)	5(0.81)	1(0.30)
Ind-Bang	150(0.89)	17(0.64)	45(0.99)	2(0.54)	21(1.04)	6(0.25)	27(1.64)	7(0.39)	9(0.25)	2(0.25)	2(0.22)	12(0.32)	-
Ind-Nepal	61(0.79)	9(0.27)	5(0.64)	4(0.58)	8(0.55)	2(0.59)	21(1.42)	7(0.50)	2(0.36)	-	-	1(0.35)	2(0.09)
Ind-Srl	47(1.37)	2(0.26)	11(1.08)	3(0.55)	9(0.99)	-	11(1.93)	4(0.19)	3(0.22)	-	2(8.87)	-	2(0.46)
Bang Pak	26(0.97)	5(0.56)	3(0.4)	-	-	6(0.63)	7(2.22)	2(0.25)	-	-	-	1(0.75)	2(0.34)
Bang Nepal	18(0.93)	5(0.29)	1(0.22)	-	2(0.81)	-	10(1.35)	-	-	-	-	-	-
Bang Srl	7(1.08)	2(0.48)	-	-	2(0.48)	-	5(1.32)	-	-	-	-	-	-
Pak-Nepal	6(1.29)	2(0.18)	-	-	-	2(1.25)	2(2.44)	-	-	-	-	-	-
Pak Srl	12(0.76)	1(0.18)	3(0.46)	1(0.35)	1(0.36)	2(0.19)	3(1.95)	1(059)		-	-	-	-
Nepal Srl	6(2.33)	-	1(0.30)	-	-	-	4(3.31)	1(0.42)	-	-	-	-	-

Agr = Agriculture, BLS = Basic life sciences, Biol = Biology, BMR = Biomedical research,
CM = Clinical Med, CS = Computer Science,
EES = Earth & Environment Science, MS =Multidisciplinary sciences, SS= Social science