SCOPING STUDY OF RESEARCH TRENDS ON *Nili Ravi* BUFFALO APPLYING SCIENTOMETRIC ANALYSIS AND NETWORK VISUALIZATION

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ABSTRACT

The study elucidates scientometric analysis of published scientific communications on *Nili Ravi* buffalo in journal(s) for having an appraisal of status-quo of the research and scientific activities. Metadata of 383 articles retrieved from Scopus were analysed to identify the most productive author(s), institution(s) *vis-a-vis* countries and to ascertain their collaboration trends. Keyword based analysis was performed to provide an overview of the strength areas of research on *Nili Ravi* for better comprehension. The results revealed that the research efforts on *Nili Ravi* were discernible after the year 2005. All except 1.30% articles have been an outcome of the collaborative authorship. There were only few productive authors with ≥10 records, but others contributed on the subject occasionally. Nearly 90% of the articles have been contributed by Pakistan and its' authors have worked in close collaboration with scientists from United Kingdom, United States of America, China, Canada, and South Korea. They also have conjoint symbiosis on academic/ research endavours on *Nili Ravi* with experts from Austria, Netherlands, India, Germany, Italy, and Australia. Twelve leading institutions contributed to ≥10 articles. Publication outcome of the Animal Sciences Institute, National Agricultural Research Centre, Islamabad, Pakistan; Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi, Pakistan; University of Gujrat, Gujrat, Pakistan and Semen Production Unit, Qadirabad, Sahiwal, Pakistan has higher Relative Citation Impact (RCI), making it obvious that their publication(s) have wider acceptance amongst scientific populace. Most productive *vis-à-vis* impactful journals publishing articles on *Nili Ravi* have also been identified.

INTRODUCTION

India is the home tract of some of the best buffalo breeds. Buffaloes have the major share in milk supply of the country, with contribution of 55% of the milk produced by 47.22 million milch buffaloes, whereas 57.0 million cows contribute to remaining 45% of the total milk production. There are about 10 indigenous standard breeds of buffaloes including *Nili Ravi*, well known for

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their milking qualities (ICAR-CCARI, 2010). *Nili Ravi*, popularly known as *Panch Kalyani* is a breed of domestic water buffalo, primarily spread across Punjab region of both Pakistan and India (Dairy Knowledge Portal, 2021). The home tract of this breed traces to the belt between the *Sutluj* and *Ravi* rivers of Punjab of united India and the term '*Nili*' derived name owing to the blue water of river *Sutlej*. *Nili Ravi* breed emerged as an outcome of intensive crossbreeding of '*Nili*' and '*Ravi*' breeds of buffalo over the period. This is mainly concentrated in Amritsar, Gurdaspur and Ferozepur districts of Western Punjab (India) and in Lahore, Sheikhupura, Faizabad, Okora, Sahiwal, Multan, Bohawalpur and Bahwalnagar districts of Eastern Punjab (Pakistan). The physical characteristics of *Nili Ravi* include mid-sized frame, walled eyes, small horns coiled tightly, long, thin, and fine neck, and usually black colour (though brown is not uncommon) with white markings on forehead, face, muzzle, fore and hind legs and tail. The white markings (*Panch Kalyani*) are the most desired characteristic of female animals, albeit these marking(s) are not consistent and vary with generations, the main breed physical characteristics remain consistent. *Nili Ravi* is comparable to *Murrah*, having average lactation period of 306 days with an average lactation milk yield ranging from 1688 to 2317 kg (Buffalopedia, 2021; Dairy Knowledge Portal, 2021) and an inter calving period of 500 to 550 days (Mathivanan, 2014).

As per the survey conducted by National Bureau of Animal Genetic Resources, Karnal, most of the *Nili Ravi* buffaloes found in Punjab are graded *Nili Ravi* buffaloes and only a few are specimens of true breed. Most of the buffaloes having white marking on feet, forehead or walled in one or both eyes are considered *Nili Ravi* breed, but are grade *Nili Ravi* buffaloes for which no separate class was envisaged in the Livestock Census, 2007 (Buffalopedia, 2021a).

Analysis of prevalent trends and topics in the concerned disciplines is imperative for keeping abreast with the state-of-affairs of the research and scientific activities to supplement the policies and strategies providing a blueprint for plugging the gaps and taking up necessary remedial measures to further give positive flip to the research endavours. Over the period, Bibliometrics/scientometrics, a quantitative technique for getting a snapshot of research trends in concerned disciplines has gained wider acceptance across various subject domains (Khokhlov, 2020). Owing to the fact that journals are the primary carriers of first-hand information, various studies have been conducted to find the evolution, research trends and structure of concerned discipline(s) based on analysis of journal articles. Such studies have also been conducted to explore the prospects for research collaboration(s) for better economic prosperity (Mahi *et al*., 2021; Syed, 2019). Scientometric analysis of primary scientific communications on *Nili Ravi* published as journal articles can assist the academic and research spheres to understand the current state of affairs in research in the subject and would be helpful to them to boost up the *Nili Ravi* farming/entrepreneurship by paying due attention to the research hotspots and filling gaps, if any. The major objectives of this study are:

Identification of prolific author(s), institution(s) vis-a-vis countries having contributed significantly to the scientific communications on *Nili Ravi* and ascertaining the collaboration trends amongst them.

Examination of various facets of *Nili Ravi* explored in publications based on author keywords to have an overview of the research trends in the

subject under study.

MATERIALS AND METHODS

The metadata of articles themed on *Nili Ravi* published in journals was accessed from Scopus. The components of data retrieved include authors, title, year, source title, citation data, affiliations, and author keywords. In total, 383 records were downloaded in tab-delimited text (CSV) format and were used for scientometric analysis.

While performing subject analysis, it was observed that the 'author keywords' were available for 357 article(s). For remaining 26 articles, where author keywords were not available, the terms representing subject matter were extracted from titles of respective articles after removing conjunction and helping verb(s). After amalgamation of all these subject terms (author keywords provided in 357 articles *vis-à-vis* subject representative terms extracted from titles of 26 records), the subject analysis was performed on the total subject representative terms (n=1476) including 822 unique keywords having one or more occurrences in records retrieved. Further, during analysis, occurrence of terms as singulars and plurals, and duplicity of terms conveying same meaning was observed. All such terms were standardised for optimum subject analysis and finally a total of 797 unique keywords attained thereafter were considered for analysis.

The original data file retrieved from Scopus consisted of non-uniform names of even same institutions. This made institutional productivity and collaboration analysis practically impossible. Thus, to facilitate such analysis, reach record was scrutinized manually and institutional name were standardized. Institutions having multiple campuses within the same country were considered as singular institutions. The various scientometric components of research outcome under study have been mapped out using visualization software, and respective clusters were developed for each variable based on co-occurrence of concerned items. The nodes in clusters represent the variables being explored *viz.* authors, institutions, countries, and subject terms, whereas edges reflect the inter-connectivity of nodes based on their co-occurrences. The thickness of edges is reflective of strength of collaboration amongst variables under analysis. The frequency of occurrence of keywords in publications is representative of the prevalence of the facets of research on *Nili Ravi*. The various steps involved from data collection to data analysis are graphically presented below:

RESULTS AND DISCUSSIONS

Chronological trends

The recent span of five years *viz.* 2016-2020 witnessed the highest number of publications (133 out of a total 383 records) on *Nili Ravi*. The years 2011 to 2015 received 29.50% of the articles published on the subject. The first record on *Nili Ravi* indexed in Scopus pertains to the year 1975. During initial 26 years (from 1975 to 2000), only 35 publications on *Nili Ravi* had been indexed in Scopus. The first five years of 21st century (2001 to 2005) also received only 7 articles. Albeit the subject witnessed meteoric rise in number of articles, thereafter, making it obvious that after 2005, the research efforts/publications on *Nili Ravi* have attained substantial attention.

In contrast to the trends in growth of number of publications on *Nili Ravi*, the articles

published earlier witnessed higher number of citations on an average. The records published during 2001 to 2005 witnessed 22.00 citations on an average, followed by the articles published during 1975 to 2000 with average citations of 13.09 per article. The communication published during 2016 to 2020 got average citation score of 2.83 only.

Most productive authors

All except 1.30% articles (5 single-author publications out of a total of 383) have been an outcome of the collaborative authorship. Nearly three-fourth of the publications (73.37%; 281/383) have been contributed under joint efforts of 3 to 7 authors and 15.14% (58/383) of the scientific communications were contributed by 8 to 10 co-authors each. About 03.13% of the articles have been authored by more than 10 authors including two articles having 16 co-authors each. Thirty-four authors of a total of 797 having contributed to least 10 articles each were identified, and their collaboration network was developed (Figure 2). In order to identify authors individually, the Scopus ID *vis-à-vis* institutional names were cross examined. Five clusters comprising of four to twelve authors were developed using cluster schema of visualization software based on co-occurrences of author names in records. The size of nodes represents the contribution of respective authors in terms of number of articles and edges show the strength of links amongst them. The 10 most prolific authors have also been listed and their Relative Citation Impact (RCI) have been calculated (Table 1).

Cluster 1: Abdullah M. (D-27, L-10, LS-58, C-57), Ahmad N. (D-34, L-13, LS-32, C-268), Akhtar M. (D-16, L-9, LS-20, C-16), Aleem M. (D-10, L-5, LS-21, C-126), Bhatti J.A. (D-14, L-7, LS-30, C-32), Ijaz A. (D-12, L-5, LS-22, C-179), Jabbar M.A. (D-21, L-13, LS-40, C-92), Javed K. (D-20, L-9, LS-45, C-49), Nadeem A. (D-11, L-2, LS-3, C-16), Pasha T.N. (D-17, L-9, LS-25, C-23), Shahzad F. (D-10, L-5, LS-19, C-10) and Yousaf M.S. (D-11, L-5, LS-21, C-134).

Cluster 2: Ahmad M. (D-15, L-11, LS-15, C-107), Ejaz R. (D-11, L-8, LS-56, C-104), Husna A.U. (D-12, L-10, LS-58, C-117), Iqbal S. (D-15, L-10, LS-32, C-170), Khan M.A. (D-13, L-14, LS-36, C-106), Qadeer S. (D-11, L-10, LS-59, C-128), Shahzad Q. (D-12, L-12, LS-36, C-86).

Cluster 3: Akhter S. (D-43, L-13, LS-165, C-575), Andrabi S.M.H. (D-27, L-9, LS-86, C-443), Ansari M.S. (D-37, L-11, LS-154, C-544), Anwar M. (D-13, L-6, LS-23, C-112), Rakha B.A. (D-34, L-11, LS-144, C-395) and Ullah N. (D-29, L-11, LS-114, C-505).

Cluster 4: Ahmad I. (D-17, L-12, LS-35, C-54), Akhtar M.S. (D-16, L-5, LS-35, C-83), Farooq A.A. (D-10, L-3, LS-17, C-64), Lodhi L.A. (D-16, L-5, LS-34, C-72) and Qureshi Z.I. (D-12, L-3, LS-16, C-46).

Cluster 5: Khan M.S. (D-15, L-3, LS-8, C-75), Nisa M. (D-12, L-4, LS-23, C-82), Sarwar M. (D-29, L-5, LS-34, C-231) and Shahzad M.A. (D-16, L-2, LS-22, C-110).

Akhter S., Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi, Pakistan; Ansari M.S., University of Education, Lahore, Pakistan; Ahmad N. University of Veterinary and Animal Sciences (UVAS), Lahore, Pakistan; Rakha B.A., Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi, Pakistan; Ullah N., Riphah International University, Lahore, Pakistan and Sarwar M. University of Agriculture, Faisalabad, Pakistan contributed to the highest number of articles *viz.* 43, 37, 34, 34, 29 and 29, respectively (Table 2). Akhter S., Ansari M.S., Ullah N. and Andrabi S.M.H. earned the highest number of

citations. Ullah N., Andrabi S.M.H., Ansari M.S. and Akhtar S. have also obtained highest number of citations per paper, respectively. The Relative Citation Impact of seven of the top ten authors has been found to be >1, depicting that majority of top contributors of articles on *Nili Ravi* have a significant research impact in the subject.

Dr. Shamim Akhtar holds research interest in the preservation of buffalo semen to Artificial Insemination (AI) to improve the genetic potential of buffalo. She is also working on developing techniques to produce in vitro buffalo embryos. Dr. Muhammad Sajjad Ansari's research interests include reproductive biology. Dr. Nasim Ahmad has research interests in improving fertility through enhancing post-thaw semen quality and optimizing protocols of estrus synchronization and ovulation. He holds the credit of introducing the use of ultrasonography in Animal Reproduction research, training, and extension in Pakistan.

Dr. Bushra Allah Rakha has research interest in reproductive biology, conservation biology, cryobiology, and avian biology. Dr. Nemat Ullah has research interests in assisted reproduction in human and domestic animals, and bovine artificial insemination and embryo transplantation.

Major contributing countries

Authors from a total of 25 countries contributed to 383 publications, 13 of which having contributed to 2 or more articles have been visualized here:

Cluster 1: Australia (D-4; LS-5; C-12), Austria (D-2; LS-3; C-5), Germany (D-2; LS-2; C-112) and India (D-20; LS-6; C-177).

Cluster 2: Canada (D-7; LS-9; C-56), China (D-18; LS-8; C-113) and Italy (D-2; LS-3; C-15). Cluster 3: Netherlands (D-3; LS-3; C-37), Pakistan (D-343; LS-58; C-2279) and South Korea (D-4; LS-4; C-28).

Cluster 4: Turkey (D-4; LS-4; C-38).

Cluster 5: United Kingdom (D-15; LS-15; C-171).

Cluster 6: United States (D-16; LS-12; C-226).

Nearly 90% of the articles have been contributed by Pakistan and its' authors have worked in close collaboration with scientists from United Kingdom, United States, China, Canada, and South Korea. They also have joined hands for academic/ research endavours on *Nili Ravi* with experts from Austria, Netherlands, India, Germany, Italy, Turkey, and Australia. Scientists from India have collaborated with their counterparts from Pakistan, Canada, United States, Austria and Germany. Though the scientists from Pakistan have contributed to higher number of publications comparatively, the RCI of articles published by authors from United States, United Kingdom and India was found to be >1, making it clear that publications from these countries are cited more frequently. The RCI of China is also <1, depicting below average expected citations.

Institutional productivity

Authors from 160 institutions contributed to a total of 383 articles. Three institutions *viz*. University of Veterinary and Animal Sciences, Lahore; University of Agriculture, Faisalabad and Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi contributed to 80.67% of the total publications. The collaboration map of 24 institutions having contributed to ≥5 articles is given in figures 4 and 5. Scientometric data (number of articles, number of links, link strength) of twelve institutions with contribution of ≥10 publications has also been tabulated (Table 4).

Seven clusters as given below were detected representing institutional collaborations: Cluster 1: University of Agriculture, Faisalabad, Pakistan (D-111; L-14; LS-71; C-722), Islamia University of Bahawalpur, Bahawalpur, Pakistan (D-23; L-10; LS-49; C-33), Bahauddin Zakariya University, Multan, Pakistan (D-22; L-12; LS-46; C-70), Cholistan University of Veterinary and Animal Sciences, Bahawalpur, Pakistan (D-9; L-6; LS-18; C-0), Livestock and Dairy Development Department, Lahore, Punjab, Pakistan (D-7; L-5; LS-12; C-20), Allama Iqbal Open University, Islamabad, Pakistan (D-5; L-6; LS-11; C-7), Government College University, Faisalabad, Pakistan (D-5; L-b7; LS-11; C-6) and Nuclear Institute for Agriculture and Biology, Faisalabad, Pakistan (D-5; L-4; LS-9; C-8).

Cluster 2: Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi, Pakistan (D-55; L-14; LS-89; C-567), Buffalo Research Institute, Pattoki, Kasur, Pakistan (D-49; L-15; LS-85; C-220), Semen Production Unit, Qadirabad, Sahiwal, Pakistan (D-19; L-11; LS-34; C-132), University of Gujrat, Gujrat, Pakistan (D-14; L-4; LS-20; C-133), The Royal Veterinary College, United Kingdom (D-9; L-7; LS-22; C-128), University of Sargodha, Sargodha, Punjab, Pakistan (D-9; L-6; LS-18; C-42), University of Education, Lahore, Pakistan (D-6; L-5; LS-15; C-6) and Shaheed Benazir Bhutto Women University, Peshawar, Pakistan (D-5; L-5; LS-14; C-15).

Cluster 3: University of Veterinary and Animal Sciences, Lahore, Punjab, Pakistan (D-143; L-17; LS-121; C-642), Animal Sciences Institute, National Agricultural Research Centre, Islamabad, Pakistan (D-43; L-10; LS-37; C-503), Quaid-I-Azam University, Islamabad, Pakistan (D-12; L-3; LS-7; C-66), University of Agriculture, Peshawar, Pakistan (D-8; L-8; LS-12; C-84) and Lasbela University of Agriculture, Water and Marine Sciences, Uthal, Pakistan (D-5; L-2; LS-6; C-19).

Cluster 4: Buffalo Research Institute, Nanning, China (D-10; L-2; LS-3; C-57) and Guangxi University, Nanning, China (D-5; L-2; LS-3; C-64).

Cluster 5: Livestock Production Research Institute, Bahadurnagar, Okara, Punjab, Pakistan (D-17; L-5; LS-17; C-114).

Though the University of Veterinary and Animal Sciences, Lahore and University of Agriculture, Faisalabad, Pakistan have contributed to the maximum number of articles, the publication outcome of the Animal Sciences Institute, National Agricultural Research Centre, Islamabad, Pakistan; Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi, Pakistan; University of Gujrat, Gujrat, Pakistan and Semen Production Unit, Qadirabad, Sahiwal, Pakistan have higher Relative Citation Impact (RCI), making it obvious that their publications have wider acceptance amongst scientific populace, as their works are more frequently referred to in scientific communications. The RCI of Islamia University of Bahawalpur, Bahawalpur, Pakistan and Bahauddin Zakariya University, Multan, Pakistan was found to be even less than 0.5.

Subject analysis based on keywords

Nine clusters as given below were detected representing subject(s) of the articles:

Cluster 1: Blood metabolites, body measurements, buffalo calves, buffalo heifers, concentrate, digestibility, feed efficiency, growth, hematology, milk replacer, ndf, nutrient intake, nutrient utilization, protein, udder measurements and weight gain.

Cluster 2: Behavior, body weight,

calcium, dairy buffalo, dcad, feed intake, heat stress, lactating buffalo, milk composition, milk production, oxytocin, performance, physiological response, and reproduction.

Cluster 3: Anoestrus, artificial insemination, biostimulation, CIDR, estradiol, estrous cycle, estrus synchronization, gnrh, ovulation, pregnancy per AI, pregnancy rate, progesterone and synchronization.

Cluster 4: Antioxidant, cryopreservation, extender, fertility, glutathione, motility, osmotic pressure, semen, semen quality, spermatozoa, and viability.

Cluster 5: Bull, cattle manure, corn steep liquor, intake, milk, N balance, rdp, ruminal characteristics, urea, and wheat straw.

Cluster 6: Age, l-cysteine, lactation, mastitis, nili ravi buffalo bull, pcr-rflp, polymorphism, prediction.

Cluster 7: Animal model, heritability, linear type traits, milk yield, Pakistan, polymorphisms, productive traits, and repeatability.

Cluster 8: Copper, season, selenium, service period, soil, sperm, water, and zinc.

Cluster 9: *In vitro* fertilization, *in vitro* maturation, and oocytes.

The co-occurrence of keywords in cluster 1 reflects the work(s) on growth in calves and heifers, making it apparent that the major area of research is oriented towards growth trait. The correlation of blood metabolites, feed efficiency with weight gain has been tried to establish certain blood parameters or blood metabolites found in rapidly or slow growing animals which can act as a marker for growth. The keywords behaviour, heat stress and lactating occurring together in Cluster 2 depict the topics of animal behaviour in heat stress, feed intake and its effect on milk composition, milk production and physiological response to stress and its effect on reproduction. Cluster 3 represents the scientific works on the reproductive status and its associated traits along with various measures used for correcting the reproductive cycle. The keywords under Cluster 4 are interlinked and represent the scientific activities on male reproductive system, its abnormalities, and remedial measures to be taken to avoid this. Cluster 5 depicts the criteria for maintaining bulls by balanced nutrition and various treatments of straw to maintain nutrition balance in feed. Cluster 6 deals with the fertility of bulls and its association with markers has been tried to be established along with works and association with mastitis. Cluster 7 takes in its ambit the works on Genetic variability. It contains works on polymorphs m, linear type traits and productive traits, quantitative analysis of the genetic parameters and factors affecting these traits. Cluster 8 encompasses role of minerals, season, semen in controlling female reproductive efficiency. The least work has been done on embryo transfer technology by in vitro fertilization and in vitro maturation of oocytes (Cluster 9).

Most productive/ impactful journals

'Buffalo Bulletin', dedicated specifically to disseminate scientific knowledge and research activities on buffalo published highest number of articles on *Nili Ravi* during the period under study, followed by Journal of Animal and Plant Sciences and Pakistan Veterinary Journal respectively. Since, majority of the articles have been contributed by scientists from Pakistan, it apparently is easy for them to publish articles in journals of their own homeland. However, none of the journals published from Pakistan earned RCI ≥1. On the other hand, comparatively, the journals published from United Kingdom, United States, Netherlands, and South Korea have higher RCI.

Table 1. Number of records and citation pattern.

Year	No. of records	Percentage	Total citations	Average citations
2021	6	1.57	0	0
2016-20	133	34.73	376	2.83
2011-15	113	29.50	644	5.70
2006-10	89	23.24	1004	11.28
2001-05	7	1.83	154	22.00
1975-2000	35	9.14	458	13.09
Total	383	100	2636	6.89

Table 2. Prolific authors and their research impact.

Sr. No.	Name of the author	Institution	TP	TC	CPP	RCI
1	Akhter S.	Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi, Pakistan	43	575	13.37	1.94
2	Ansari M.S.	University of Education, Lahore, Pakistan	37	544	14.70	2.14
3	Ahmad N.	University of Veterinary and Animal Sciences (UVAS), Lahore, Pakistan	34	268	7.88	1.15
4	Rakha B.A.	Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi, Pakistan	34	395	11.62	1.69
5	Ullah N.	Riphah International University, Lahore, Pakistan	29	505	17.41	2.53
6	Sarwar M.	University of Agriculture, Faisalabad, Pakistan	29	231	7.97	1.16
7	Abdullah M.	University of Veterinary and Animal Sciences, Lahore, Pakistan	27	57	2.11	0.31
8	Andrabi S.M.H.	Animal Sciences Institute, National Agricultural Research Centre, Islamabad, 45500, Pakistan	27	443	16.41	2.38
9	Jabbar M.A.	University of Veterinary and Animal Sciences, Lahore, Pakistan	21	92	4.38	0.64
10	Javed K.	University of Veterinary and Animal Science, Lahore, Pakistan	20	49	2.45	0.36

(TP - Total Publications; TC - Total Citations; CPP - Citations Per Publication; RCI - Relative Citation Impact).

Table 3. Top contributing countries and their relative citation impact.

Country	TP	%	TC	CPP	RCI
Pakistan	343	89.56	2279	6.64	0.97
India	20	5.22	177	8.85	1.29
China	18	4.70	113	6.28	0.91
United States	16	4.18	226	14.13	2.05
United Kingdom	15	3.92	171	11.40	1.66

Table 4. Most prolific institutions and their relative citation impact.

S. N.	Institution name	TP	%	TC	CPP	RCI
1	University of Veterinary and Animal Sciences, Lahore, Punjab, Pakistan	140	36.55	634	4.53	0.66
2	University of Agriculture, Faisalabad, Pakistan	111	28.98	722	6.50	0.95
3	Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi, Pakistan	55	14.36	567	10.31	1.50
4	Buffalo Research Institute, Pattoki, Kasur, Pakistan	49	12.79	220	4.49	0.65
5	Animal Sciences Institute, National Agricultural Research Centre, Islamabad, Pakistan	43	11.23	503	11.70	1.70
6	Islamia University of Bahawalpur, Bahawalpur, Pakistan	23	6.01	33	1.43	0.21
7	Bahauddin Zakariya University, Multan, Pakistan	22	5.74	70	3.18	0.46
8	Semen Production Unit, Qadirabad, Sahiwal, Pakistan	19	4.96	132	6.95	1.01
9	Livestock Production Research Institute, Bahadurnagar, Okara, Punjab, Pakistan	17	4.44	114	6.71	0.97
10	University of Gujrat, Gujrat, Pakistan	14	3.66	133	9.50	1.38
11	Quaid-I-Azam University, Islamabad, Pakistan	12	3.13	66	5.50	0.80
12	Buffalo Research Institute, Nanning, China	10	2.60	57	5.70	0.83

Table 5. Most productive journals and their relative citation impact.

| Sr. No.	Title of the Journal	Country	TD	%	IF	Scimago H-index	TC	CPP	RCI
1	Buffalo Bulletin	Thailand	47	12.27	0.172	11	70	1.49	0.22
2	Journal of Animal and Plant Sciences	Pakistan	41	10.70	0.49	28	81	1.98	0.29
3	Pakistan Veterinary Journal	Pakistan	28	7.31	1.318	29	161	5.75	0.84
4	Italian Journal of Animal Science	United Kingdom	23	6.01	2.217	37	131	5.70	0.83
5	Pakistan Journal of Zoology	Pakistan	23	6.01	0.831	23	104	4.52	0.66
6	Theriogenology	United States	23	6.01	2.74	133	477	20.74	3.01
7	Animal Reproduction Science	Netherlands	22	5.74	2.145	104	370	16.82	2.44
8	Asian-Australasian Journal of Animal Sciences	South Korea	21	5.48	2.509	59	194	9.24	1.34
9	Tropical Animal Health and Production	Netherlands	13	3.39	1.559	49	76	5.84	0.85
10	Revista Veterinaria	Argentina	12	3.13	-	7	6	0.5	0.07
11	Livestock Science	Netherlands	8	2.09	1.943	111	89	11.13	1.62
12	Journal of Dairy Science	United States	7	1.83	4.034	191	97	13.86	2.01
13	Reproduction in Domestic Animals	United Kingdom	6	1.57	2.005	66	149	24.83	3.61
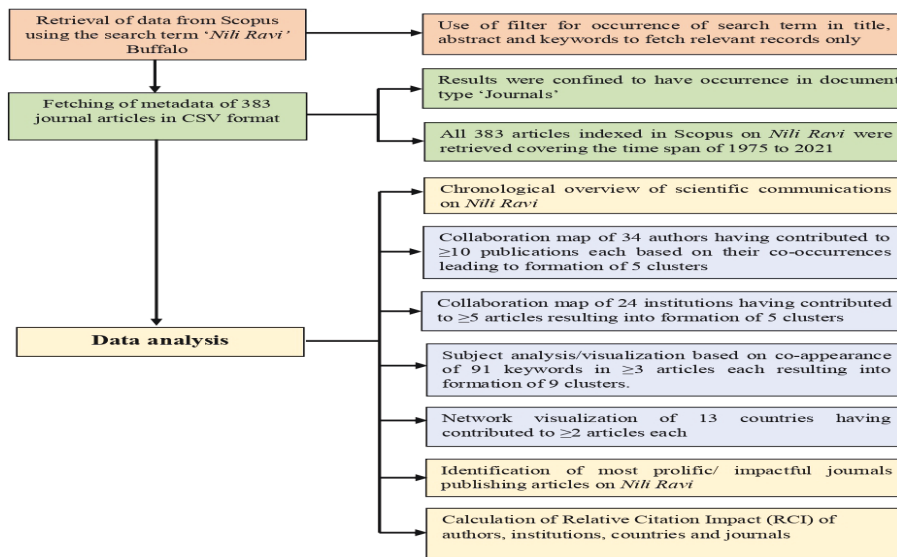
Figure 1. Material and methods.
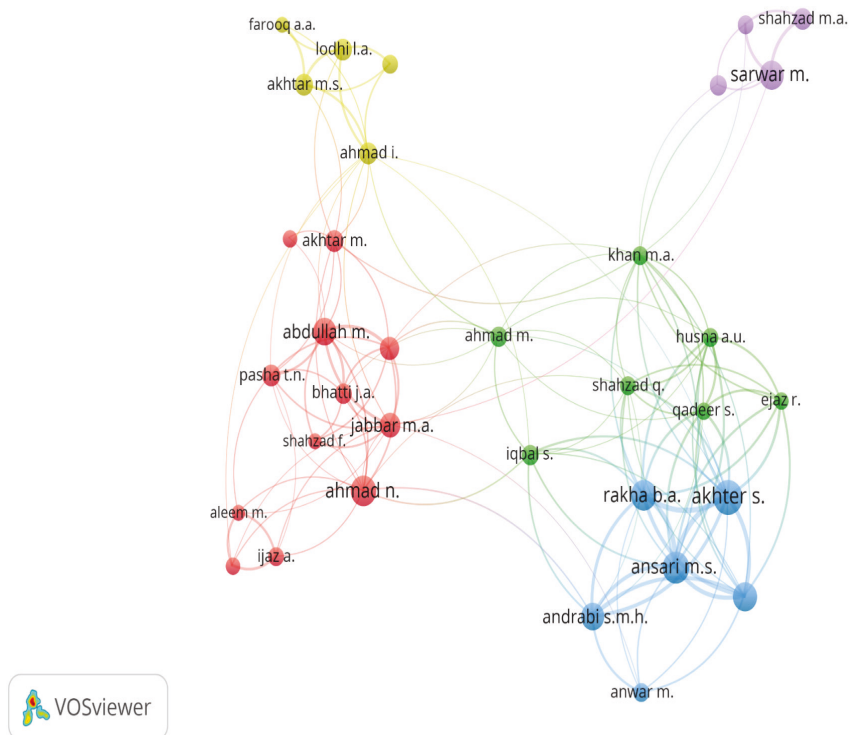
Figure 2. Authors' Collaboration(s).
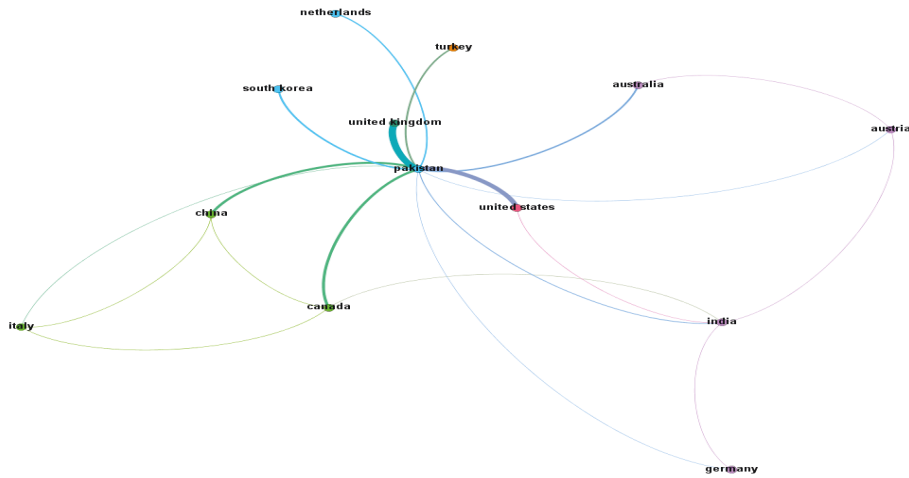(D-Total documents; L-Links; LS-Total Link Strength; C-Citations).

Figure 3. Most productive countries on *Nili Ravi*.

Figure 4. International collaborations.

Figure 5. Inter-institutional collaborations within Pakistan.

Figure 6. Keyword visualization map.

CONCLUSION

There has been a steep ascendancy in research publications on *Nili Ravi* indexed in Scopus after 2005 which may be attributed to the growing awareness and competitive spirit to publish in high impact journals *vis-à-vis* growing visibility of publications with technological interventions. Albeit the main research on *Nili Ravi* is centered in Pakistan, the study has shown strong collaboration trends of Pakistani scientists with United Kingdom, United States and China. The research articles published in journals published from Pakistan are higher in number, but the RCI of commercial journals is comparatively higher, attributed to their repute, trust, wider circulations *vis-à-vis* marketing strategies adopted by commercial publishers. University of Veterinary and Animal Sciences, Lahore; University of Agriculture, Faisalabad; and Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi are at the pinnacle of research on *Nili Ravi* with contribution to 4/5th of the total number of scientific publications. The articles encompass diverse aspects of *Nili Ravi*, however, research on embryo transfer technology by *in vitro* fertilization and *in vitro* maturation of oocytes needs attention.

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