

Use of Information Sources by the Soil Scientists in Kerala: A Case Study of the Citations in the Master's Degree Theses of the Kerala Agricultural University

Sarala Raman

M Varghese

Abstract

The Department of Soil Science and Agricultural Chemistry, College of Agriculture, Vellayani, Thiruvananthapuram, one of the constituent colleges of the Kerala Agricultural University, has been offering M Sc Degree in Soil Science since 1963. As part of the programme the students have to carry out research on an approved topic and submit the thesis. During the period of 1963 to 2010, 129 theses have been submitted in soil science. A study of the citations in a sample of 18 theses, selected at 10 year intervals is carried out with a view to ascertaining the characteristics of the information sources used by the scholars. The 18 theses selected as sample, altogether carries 1794 references distributed among different categories such as monographs and reference books (8.58%), papers in learned journals (68.84%), conference papers/ proceedings (4.12%), government publications (4.35%), theses (6.4%) and other (7.69%) which include technical reports, statistical bulletins and research reports. Analysing the age of cited items, the obsolescence rate of literature in soil science was calculated. Median citation age is found to be 11.13 years. Chronological variation in the various characteristics of the cited literature was also examined.

Keywords: Soil Science, Citation Analysis, Obsolescence, Half-life

1. Introduction

The soil that covers the terrestrial surface of the earth as a continuum has a crucial role in supporting life on the planet. The huge numbers of organisms such as bacteria, fungi, worms, insects, and small mammals that are seen below the surface have a prominent role in the formation and maintenance of soil. It provides a medium for plants to grow, supporting their roots and providing them with nutrients for growth. The layers of soil on earth filter the precipitation from the sky recharging the aquifers and ground water reserves, which in turn provides the drinking water. The pores, which comprise nearly 50% of the volume of soil, holds air and provides oxygen to the plant roots and the millions of organism inhabiting in it. Soil receives and thrives in organic matter as it dies assuring that it returns to a form useful to subsequent living organisms. The significance of soil in supporting life on earth is evident from the plethora of subject areas of academic pursuit formed with soil as the central component. The subject 'Soil science' encompasses the study of the soil as a constituent of natural and man-made systems. Soil science is the key factor in food production and is at the forefront of environmental and natural resource issues such as land use, soil contamination, ground water quality and waste disposal.

Because the Soil has been considered as one of the major conditions contributing to the production of crops, one of the earliest branches of soil science developed was agricultural soil science or edaphology. In Kerala, the College of Agriculture, Vellayani, Thiruvananthapuram, established in

1955, as the premier institution for agricultural teaching, research and extension, has a separate Department for Soil Science and Agricultural Chemistry. Originally the college was affiliated to the erstwhile University of Travancore, and subsequently it became one of the constituent colleges of the Kerala Agricultural University, on its establishment in 1971. Research is a mandatory function of the college, and the research activities of the college include post graduate courses with research as a mandatory component, and plan projects as well as research projects taken up by the faculty members. As part of the Master's Degree programme and also for Doctoral Degree, the scholars have to carry out research on a topic approved by a committee comprising of three or four faculty members, under their supervision and submit a thesis. The theses therefore form true records of academic research activity of the college. The supervising teachers have a major role in the selection of the topic for research, the actual conduct of research and also in the choice and use of information sources to support the work. Further, the scholars cite the sources that they used; and an analysis of the bibliographical references would give a true picture of the information sources in the domain to which the institution has to ensure access to the patrons. Moreover an analysis of the characteristics of the cited items would reveal the attributes such as the nature of scattering of information, the nations and institutions that have more influence on the scientists and rate of obsolescence of literature on the domain. These data will be of immense help in the planning and organisation of information centres and systems.

Citation analysis is an indirect method to assess the information used by various categories of users. Martyn has defined citation analysis as "the analysis of citations or references or both which form part of the scholarly apparatus of primary communications (Martyn, 1976). Paul Mohan Roy (1983) considers the documents cited in a paper a more visible and distinctive record than the use shown by transaction records of an issue section. So the process of information use can be studied by analyzing the characteristics of documents and their distribution by statistical methods. Review of previous citation analysis studies based on citations appended to theses include Agriculture (Arjun Lal 1989; Humayoon Kabir, 1990; Arjun Lal and Krushna, 1999), Chemistry (Mubeen, 1996), English Language and Literature (Deo et al, 1995), Environmental sciences (Madkey and Rajyalekshmi, 1994), Geography (Doraswamy and Pulla Reddy, 2001), Mathematics (Bandyopadhyay, 1996), Organic Chemistry (Barooah et al, 1999), and Physics (Rajan Pillai and Sudhier, 2007).

2. Objectives

The present study has been carried out with the following primary objectives.

- a) To identify the different types of information sources that the researchers in soil science use and the extent of use of each,
- b) To study the authorship pattern in soil science literature and to estimate the proportion of collaborative authorship,
- c) To identify the core journals in soil science and to prepare a ranked list
- d) To study the scatter of learned papers in soil science among journals,

- e) To ascertain the country-wise distribution of learned journals used by soil scientists, and
- f) To find out the obsolescence of literature in soil science and ascertain the median citation age.

3. Methodology

The first batch of M Sc degree scholars of the College of Agriculture, Trivandrum (CAT) completed their course and came out in 1963. Recognising the fact that Soils provide the starting point for successful agriculture, Soil science is one of the first areas given thrust in the post-graduate courses in the College by way of conducting research in the area. The total number of Masters as well as Ph D Degree theses, in all the branches of Agriculture submitted in CAT till 2010 comes to 1470. Out of these, 129 are on Soil Science, produced from the Department of Soil Science and Agricultural Chemistry. A sample consisting of all the theses produced in the Department during the years at 10 year intervals starting from 1963 was drawn for the present study. Accordingly, the theses submitted in 1963, 1973, 1983, 1993 and 2003 form the source of data. The total number in the sample is found to be 18. Bibliographic details (title, names of authors, the category of the item, publication details, age of the item as on the year of the thesis etc) of all the references appended to the 18 theses were collected in a predefined data sheet. Altogether there are 1794 citations, which formed the base line data for this study. The citations were subjected to further analysis and inferences were drawn in the light of the objectives formulated for the study.

4. Analysis and interpretations

The study aims at ascertaining the use pattern of information sources by soil scientists and the characteristic features of the sources as, taking the references in the Master's degree theses generated from the College of Agriculture, Trivandrum as a case. The distribution of theses in the sample selected and the number of references in them are given in table 1.

Table 1: Chronological distribution of theses and the number of references in them

Year	Number of theses	Total no. of citations	Average no. of citations per thesis
1963	4	293	73
1973	3	291	97
1983	1	137	137
1993	9	839	93
2003	1	234	234
Total	18	1794	99.67

The number of theses on the subject of the present study produced from the CAT per year varies from 1 to 9, with 1993 as the most productive year. The actual number of references in a thesis is seen to be in the range of 50 to 234. The average number per thesis comes to approximately 100, and while estimating year-wise, it is in the range of 73 to 234. The number of references shows an

increasing trend except for 1993. The subsequent sections give the results of further analysis of the references.

4.1. Types of information sources used

The 1794 citations are spread over a variety of categories of information sources. They include monographs, papers in learned periodicals, conference papers, government publications, bulletins, and theses (fig 1). Papers in learned journals account for more than 68% of the total references. Learned periodicals, even in the present electronic age, function as a very significant medium in the process of scientific communication. Monographs and reference books occupy the second position with nearly 9% references. This is followed by references from theses (6.41%), government publications (4.35%), and papers from conferences (4.12%). Sources like statistical bulletins, research reports and technical bulletins account for 7.69%.

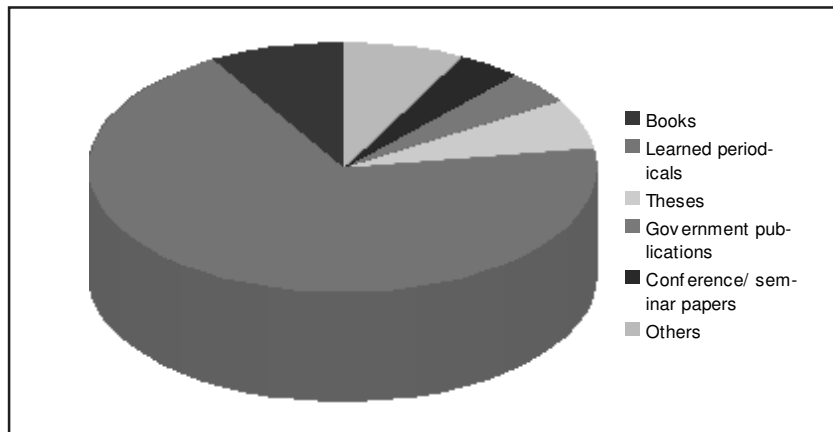


Figure 1: Distribution of types of document cited

Out of 1794 references 68.84% are from learned journals, and nearly 49% are from foreign journals (table 2). Indian journals account for only 19.5 % of the total references. Out of 8.58% references to books, 6.19% are from books published in foreign countries. As regards the use of earlier theses, those generated from the Kerala Agricultural University is used by all researchers. Publications from government and other corporate bodies contain a lot of authentic information relevant to all facets agricultural research, including soils. Government publications are seen consistently cited in the theses in soil science. Papers presented in conferences and subsequently published in proceedings after deliberations, form an important vehicle of information transfer. The number of citations to this category of sources is at an increase, indicating their role as a key channel of communication in soil science research.

Though agriculture and soil science are subjects of rather localized nature, citations to literature of foreign origin are seen to be profuse in the theses generated from the CAT. This is found to be true both in the case of monographs and learned periodicals. Most probably the lack of indigenous

literature on local problems may be the reason that prompts the scholars to depend more on foreign sources for their background study of the topic. Availability of foreign publications in the college library and easy access to e-resources of foreign origin are other reasons for their heavy use in research.

Table 2: Distribution of references by their form of publication

Forms of publications		Number of references					Total citations	Percentage
		1963	1973	1983	1993	2003		
	Books	Indian	2	4	6	25	6	43
		Foreign	14	16	6	58	17	
Learned periodicals	Indian	30	63	22	165	69	349	68.84
	Foreign	170	123	75	392	126	886	
Theses	KAU	6	21	7	42	4	80	6.41
	others	2	22	nil	10	1	35	
Government publications		19	20	3	35	1	78	4.35
Conference/ seminar papers		5	9	10	41	9	74	4.12
Others		45	13	8	71	1	138	7.69
Total		293	291	137	839	234	1794	100

The inferences from this study, in respect of distribution of cited items, which in turn can be viewed as generalisations about literature in soil science as a whole, agree to some extent with the findings many of the earlier studies. The preference of learned journals as the major medium of science communication is a well established fact. But unlike in other subject areas, agricultural scientists in India prefer Indian periodicals to publish their papers (Arunachalam, 2001; Sarala, 2009). But the use of papers from periodical of Indian origin, as per the present study, account for less than 20% of the total usage. The high preference towards foreign publications leads to the conclusion that though much research in agriculture is being carried out in India, only a small percentage of them get published in learned journals. Researchers in soil science do not consider the bulk of the literature available in Indian sources worth citing, may be due to doubt about their authenticity. Hence they prefer to cite more of international publications.

4.2 Authorship Pattern

Authorship is an important facet of scientific research. A detailed analysis of the authorship of citations would help arrive at inferences about the extent of collaboration by scientists in the subject area, inter-institutional collaboration, international collaboration etc. Research is, now a days a team works rather than a work in isolation. Therefore in a large majority of scientific publications we find more than one names in the author statement. Collaborative authorship is often considered

to be indicative of authenticity of the contents of the document. Scientists choose to engage in collaboration for a variety of reasons, such as access to equipment, finance, expert guidance and information support. Table 3 gives the distribution of the cited items with respect to the number of authors. Out of 1794 references cited, 1165 (65%) are multi-authored documents. Citations to single author contributions are more in number in theses submitted in 1963 and 1973. From 1983 onwards there is a decrease in the citation to single author publications. Among the multiple author publications, the share of two author contributions is found to be more. And it comes to more than 37% of the total references. The study reveals that team research is on the increase soil science. Single author contributions, even though shows a decreasing tendency, is still on stage. This may be due to the fact that agricultural scientists undertake research projects which do not require team work. However, the idea of single authorship disappearing as predicted by Price is certainly not observed in this study.

Table 3: Authorship Pattern of Cited Items

Number of authors	Number of citations per year					Total citations	Percentage
	1963	1973	1983	1993	2003		
One	131	147	36	270	45	629	35.06
Two	113	95	48	331	85	672	37.46
Three	41	34	33	143	57	308	17.17
Four & above	8	15	20	95	47	185	10.31
Total	293	291	137	839	234	1794	100

4.2 Core journals in Soil Science

As already mentioned 1235 (68.84%) references in the theses are to papers in learned journals. This is a clear indication of the importance of journals in scientific communication. Altogether 270 journals account for these references. While analysing the share of each journals it is observed that 10 journals account for almost 50% of the citations to learned papers. Nineteen titles which have been cited more than 10 times account for 62%. The remaining 32% (472 references) are from 251 journals. Table 4 gives a ranked list of the first 19 titles indicating their rank number, country of origin, number of citations and percentage along with cumulative number and percentage.

Table 4: Ranked list of cited journals

Sl no	Rank No.	Name of Journal	Country of origin	Number of citations	Percentage	Cumulative No. of citations	Cumulative percentage
1	1	Journal of Soil Science Society of America	USA	167	13.52	167	13.52
2	2	Journal of Indian Society of Soil Science	India	122	9.88	289	23.4

3	3	Soil Science	USA	111	8.99	400	32.39
4	4	Indian Journal of Agronomy	India	36	2.91	436	35.3
5	5	Soil and Fertilizer	UK	32	2.59	468	37.89
6	5	Agronomy Journal	USA	32	2.59	500	40.48
7	6	Journal of Potassium Research	India	29	2.35	529	42.83
8	6	Indian Journal of Agricultural Science	India	29	2.35	558	45.18
9	7	Journal of Tropical Agriculture	India	27	2.19	585	47.37
10	7	Madras Agricultural Journal	India	27	2.19	612	49.56
11	8	Oleagineux	France	22	1.78	634	51.34
12	9	Plant and Soil	Netherlands	21	1.7	655	53.04
13	9	Fertilizer News	India	21	1.7	676	54.74
14	10	Journal of Soil Science	UK	18	1.46	694	56.2
15	11	Advances in Agronomy	USA	16	1.29	710	57.49
16	12	Plant Physiology	USA	15	1.21	725	58.7
17	12	Communication in Soil Science and Plant Analysis	USA	15	1.21	740	59.91
18	13	Journal of American Society of Agronomy	USA	12	0.97	752	60.88
19	14	Soil Science and Plant Nutrition	Japan	11	0.89	763	61.77
				763	61.77		

4.3 Scatter of Cited Papers Among Journals

It is the Bradford's Law that describes a quantitative relation about the scatter of papers among the journals in which they are published. The Law states that "If scientific journals are arranged in the order of decreasing productivity of articles on a given subject, they may be divided into a nucleus of periodicals more particularly devoted to subject and several groups or zones containing the same number of articles as the nucleus, where the zones will be $1:n^2\dots$ ". An attempt was made to test the applicability of this Law, for the papers cited in the theses on soil science. The total number of papers cited was divided equally and the number of journals contributing the papers in each division was estimated by the quantitative method of interpolation and the ratio was worked out in the exponential form as shown in table 5.

Table 5: Distribution of source journals carrying equal number of cited papers

While dividing into three zones, the ratio of source journals is found to be $1:n:n^{2.25}$ with the value of $n = 6.74$. When the number of zones is taken as 4, the ratio is obtained as $1:n:n^2:n^{3.14}$ where $n = 3.71$. Even though none of the ratios is exactly the same as the one proposed by Bradford, regularity in the distribution is observed in the case of distribution. A study based on the complete population may yield a better agreement.

4.4 Country of Origin of the Top Ranking Journals

The first rank in terms of frequency of citations goes to the Journal of the Soil Science Society of America, which was earlier (up to 1976) titled as Proceedings of the Soil Science Society of America. Out of the 763 citations to the top ranking journals, 368 (48.23%) are to American journals and 291 (38.13%) are to Indian journals. Seven journals each contribute to these citations. Among the other five journals two are from U K, and one each from France, Netherlands and Japan. The significantly high preference given to U S journals is evident from this observation.

Table 6: Country-wise Distribution of Journals in Ranked List

Country of origin	Number of journals	No of citations	Percentage of citations
USA	7	368	48.2
India	7	291	38.14
United Kingdom	2	50	6.55
France	1	22	2.9
Netherlands	1	21	2.75
Japan	1	11	1.37
	19	763	100

4.5 Chronological Distribution of Citations

The chronological distribution of the cited items was examined taking the year of publication of the items. It is seen that publications of 1800 still continue to be cited in the theses on soil science. Publications up to 1930 have received 55 (3.07%) citations. The availability of age old basic documents in soil science which have considerable relevance even in the modern era is evident from the citation practice in theses. For further analysis the year of publication of the cited items is grouped into ten year intervals (fig. 2). For publications from 1931 onwards there is a continuous increase in the frequency of citation and from 1990s there is a decline. Publications of 1980s have received the highest number (23.41%) of citations. Works after 1980s account for more than half of the total citations.

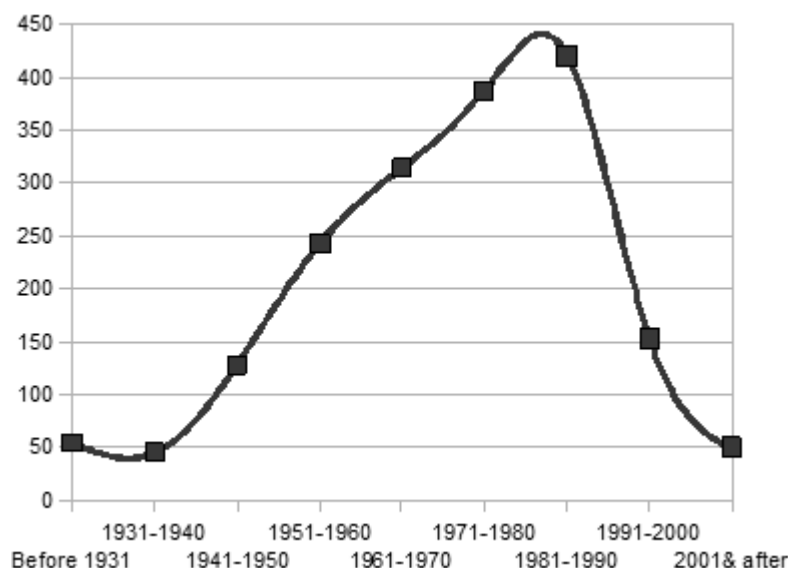


Figure 2: Chronological Distribution of Cited Items

4.6 Obsolescence of Soil science literature and Median Citation Age

The obsolescence of literature refers to the phenomenon of decline in the utility of literature with reference to age. It is a fact that a learned paper will get cited by others during a few years immediately after its publication and after reaching a maximum the number will go on declining. This is applicable to majority of publications. But there are very few ones which have to be considered classics in the subject area that will continue to be cited consistently for a long time. The rate of obsolescence is found to vary with respect to subject, those of more theoretical nature have relatively low obsolescence rate and vice versa. To identify the rate of obsolescence of literature in soil science, the age of cited items, as on the year of the theses was calculated and subjected to analysis.

Ten percent of the cited items are up to two years old (table 7). For very few references the year coincides with the year of the thesis. For 53.84% of the references, the age is 12 years or less. In analogy with the radioactive decay in nuclear chemistry, a concept 'half life' has been coined in bibliometrics to indicate the obsolescence rate of literature. Considering the fact that it is not possible to estimate the period that a document would require to get half of the total citations it is going to get, an alternative is proposed as a working definition. Accordingly it is defined as the period taken for getting half of the total citations already received. On this line, the half life of the literature in a subject is estimated as the minimum age of half of the active literature in the subject. This in fact is better indicated by the term 'median citation age' rather than half life. In tune with the statistical measure of central tendency 'median' which is defined as that value in a series which divides the whole series into two equal halves, 'median citation age' can be defined as age that divides the total number of active documents as indicated by citations in the current papers arranged in the order of their age, into two equal halves. In the present study, the median citation age is estimated as a measure of obsolescence rate of literature in soil science.

As far as the references in the complete sample are concerned the median citation age is found to be 11.13 years. In an earlier work Subbaiah (1989) has estimated the half life of agricultural literature as 11.5. The values computed for the theses in each of five years in the sample are given in table 8.

Table 7: Age of Cited Items

Year	Age of citations							Total citations
	Up to 2	3 to 12	13 to 22	23 to 32	33 to 42	43 to 52	53 plus	
1963	16	122	82	36	37	nil	nil	293
1973	36	139	73	26	7	8	2	291
1983	14	92	24	5	2	nil	nil	137
1993	63	342	246	123	39	22	4	839
2003	52	90	62	12	12	3	3	234
Total	181	785	487	202	97	33	9	1794
Percentage	10.09	43.75	27.15	11.26	5.41	1.84	0.5	100

Table 8: Year-wise Distribution of Median Citation Age

Year	Median citation age
1963	13.1
1973	9.91
1983	7.98
1993	12.61
2003	9.33

5. Major findings

1. Analysis of citations appended to a sample of 18 theses shows that 68% are from journals, 8.5% from books, 6% from theses, 4.35% from government documents, 4% from conference proceedings and 7% from other types of sources. In the case of books and journals, foreign publications account for the majority of citations. The importance of learned journals in scientific communication and their continued use in scientific and technical research are well supported from this study.
2. Among the citations single and multiple author contributions are in the ratio 7:13. Most of the single author publications seen cited are monographs. Among the multiple author publications around 60 % are two author contributions. The maximum number of authors in the cited items is found to be 6. The average number of authors per cited item comes to 2.12. These observations support the prevalence of team work in scientific research, in the context of soil science research also.
3. Citations to learned journals, which account for 68% of the total, are distributed among 270 titles. Nineteen journals were found to be cited more than 10 times. A Ranked list of these journals is given in table 4. The first rank goes to the Journal of the Soil Science Society of America. The second position is credited to the Indian journal: Journal of the Indian Society of Soil Science, with a margin of 45 citations.
4. Among the 270 journals cited, 169 titles are cited only once. The three journals, Journal of the Soil Science Society of America, Journal of the Indian Society of Soil Science, and Soil Science have been cited 167, 122 and 111 times respectively. Per capita citations to the other journals are 36 and less. While examining the mathematical distribution of the cited journals based on the productivity, it is observed that when categorised into three zones of equal productivity, the number of journals is in the ratio $1:n:n^{2.25}$ with the value of $n = 6.74$. Trying the number of zones as 4, the ratio is found to be $1: n: n^2: n^{3.14}$ where $n = 3.71$. The fraction in the exponents can be attributed to the limitation of the sample.
5. An analysis of the core journals in soil science, which have been cited more than 10 times reveals that more than 48% are from American journals and 38.14% from Indian journals. British and French journals account for 6.55 % and 2.9% respectively. Preference to learned sources of foreign origin for information support to soil science research is evident from this observation.
6. An analysis of the year of publication of the cited items shows that the 1980s form modal value. As regards the age of cited documents, 10% are of two years or less old. Age of 44% of the literature cited is in the range of 3 to 12 years. Altogether 89% of the citations are less than or equal to 52 years old. Only 0.5% of the citations are more than 53 years old. A few publications of even the 1800s are still being cited.
7. The median citation age, which is an objective measure of obsolescence rate, is found to be 11.13 years in soil science. A decade-wise analysis shows that it varies from 7.98 to 13.1. Earlier studies in agriculture have estimated the value as 11.5.

6. Conclusion

Scientific research is a cumulative in nature. Libraries and information centres have to act as a catalyst in the development of knowledge by rendering information support to the patrons. The information support which the researchers in soil science have utilized during their research carried out as part of the M Sc degree programme has been subjected to analysis in the present study. Though the findings are based on a sample, they can be generalized and made applicable to the field of agriculture in general.

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About Authors

Dr. Sarala Raman, Formerly Assistant Librarian (Sr. Scale), College of Agriculture, Vellayani Thiruvananthapuram

Mr. M Varghese, Associate Professor, Department of Library & Information Science, University of Kerala, Thiruvananthapuram