SCIENCE AND TECHNOLOGY STATUS REPORT OF SRI LANKA - 2015

(Prepared based on the data collected from 31 Public S&T Institutions)

National Science and Technology Commission

Ministry of Science, Technology and Research

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National Science and Technology Commission

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Colombo 08, Sri Lanka

MESSAGE FROM THE HON. MINISTER OF SCIENCE, TECHNOLOGY AND RESEARCH

The Science and Technology Status Report of Sri Lanka is a document prepared by the National Science and Technology Commission (NASTEC), which is mandated by the Science and Technology Development Act No.11 of 1994 to prepare such a report and submit to the Government every year. This document highlights the status of human resources, funding, research projects carried out, new processes, technologies and products developed and number of research publications of national Science and Technology (S&T) institutions for the year 2015.

Based on the information collected, NASTEC has made several recommendations for further development of S&T in Sri Lanka and get maximum benefits from the research carried out by national S&T institutions for economic development of the country and social wellbeing of our people.

I thank NASTEC for their hard work towards successfully completing this task collecting data from large number of national S&T institutions and making useful recommendations. I also take this opportunity to thank the Chairpersons and CEOs of the national S&T institutions who provided information to make this endeavour a success.

Susil Premajayantha, M.P.
Minister of Science, Technology and Research
7th June 2017

FOREWORD

As per the Science and Technology Development Act No. 11 of 1994, the National Science and Technology Commission (NASTEC) is required to submit a review report annually to the government on the Science and Technology (S&T) activities carried out in the preceding year. This report provides information gathered in 2016 on the development of human resources, performance of 31 national S&T institutions, effectiveness of public spending on S&T and the use of S&T developments and services provided by national S&T institutions during the year 2015.

The data gathered revealed that overall researcher:non-researcher ratio is about 1:5. Further the research staff with a research degree such as PhD or MPhil is only about 18.6% of the total number of research staff. The survey also revealed that in the Agriculture and Engineering sectors, the number of recruits were less than the number left resulting in a net reduction in the S&T personnel in these fields. Based on the research carried out in these institutions, nearly 900 publications have been resulted in, of which about 60% of the abstracts were presented in national and international research conferences. About 9% are research papers published in reputed journals indexed in Science Citation Index. Ten national patents and one international patent have been obtained in 2015. Nearly 71000 members of the public were provided with many services including testing, calibration, training, consultancies etc. and about LKR 790 million had been generated by these services.

I am very thankful to the Chairpersons/Director Generals/Directors of the institutions who responded to our survey to enable us to prepare this national S&T report. I thank the Director and staff of NASTEC for the valuable service rendered towards preparing this document.

Senior Professor M.J.S.Wijeyaratne,
Chairman,
NASTEC
7th June 2017

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EXECUTIVE SUMMARY

National Science and Technology Commission (NASTEC) has identified 38 public sector institutions for reviewing their science and technology (S&T) status for the fiscal year 2015. Of these 38 institutions, 31 institutions participated in the current survey. The institutions were categorized into five sectors as Agriculture, Plantation, Engineering, Medical and 'Other' and each of these sectors had 12, 2, 2, 1 and 14 institutions respectively. Human resources, physical resources, finances and the productivity (output) of each sector were assessed on the basis of the responses to the questionnaire given to institutions.

In 2015, 7071 personnel were engaged in S&T activities in 31 S&T institutions that responded to the survey. Of them, 1121 were researchers (597 males and 524 females) and they were supported by 1593 support staff and 37 information officers and librarians. The highest number of research personnel were employed in the 'Other' sector followed by Agriculture, Plantation, Engineering and Medical sectors. Research personnel comprised only 16%, with a researcher:non-researcher ratio of 1:5. The highest percentage of researchers was present in the Science sector (41%) followed by Agriculture (32.7%), Engineering (18.8%), 'Other' (7.4%) and Veterinary (0.1%) sectors. In the Science sector, there were more female scientists than male scientists. The highest number of research staff was found in the 30-40 years age group followed by 40-50 years, above 50 years and under 30 years age groups. The numbers of researchers with PhD, MPhil and MSc Degrees were 13%, 6% and

38% respectively while 34% were BSc degree holders and 9% were Diploma holders. Those with research degrees, i.e., PhD and MPhil, accounted only for 19%.

When all institutions are considered, 100 scientists had been recruited and 73 scientists had left the S&T institutions in 2015. In 2015, 54% of the scientific staff had undergone some kind of training either through national or international workshops, seminars and conferences. A considerable number (81%) of scientific personnel in S&T institutions have participated in local trainings of 10 days or less duration.

The total amount of funds received for research activities in 2015 was nearly LKR 1218 million. Out of this, only LKR 938 million had been spent. Research funding was mainly from the Government sources. The responded S&T institutions have received LKR 1098 million (90% of the total funding) from the General Treasury for research in 2015, of which only about 78% has been spent. The 'Other' sector received the highest amount of funds, which is about LKR 606 million (50%). Agriculture and Medical sectors had received LKR 250.7 million (20.5%) and LKR 250 million (20.5%) respectively. The research funds received by the Plantation and the Engineering sectors had been 8% and 1% respectively. The highest amount of funds for science popularization workshops, seminars etc. had been given to the 'Other' sector, which is LKR 174.5 million. The Agriculture sector has received LKR 161.5 million while the Medical sector received LKR 0.9 million. LKR 1,406.5 million had been received for upgrading S&T institutions. Of the funds received from the General Treasury for upgrading in 2015, which was LKR 1300 million, only about 66.5% has been utilised. Upgrading includes construction of new buildings, maintenance and modification of existing

buildings, machinery and instruments, purchase of equipment and land development.

In 2015, generated revenue of S&T institutions by providing testing services, calibrating services, training, product and process certification, accreditation of labs/services, consultancies and other services was LKR 789 million. These services were provided to more than 71000 clients. The 'Other' sector generated the highest revenue of about LKR 706 million by serving around 40,000 clients. Engineering sector has served a relatively lesser number of clients, and had generated LKR 58 million. Agriculture sector generated LKR 25 million by providing services to 8400 clients. Plantation and Medical sectors have not generated any income in 2015. The 'Other' sector and Engineering sector generated their revenue mostly by providing testing services while Agriculture sector earned most of its revenue by providing 'other' services.

In 2015, S&T intuitions in all sectors have produced 37 new products, 58 new processes and 15 new technologies. Of these, the Agriculture sector has developed 49 processes, 9 technologies and 20 products. The Plantation sector has developed 3 processes, 2 products and 2 technologies. Engineering and Medical sectors have produced 7 and 1 new products respectively. The 'Other' sector had developed 6 processes, 4 technologies and 7 products. However, only 32 products and 9 processes have been commercialised. Of these products, 14 are from the Agriculture sector and 13 are from the 'Other' sector while 5 are from the Engineering sector. In 2015, 29 technologies developed by S&T institutions have been transferred. Of these, some appears to be those developed in earlier years.

In 2015, a total of 895 publications have been published by the researchers of S&T institutions in all sectors. The main form of publications, which accounted for 538, was abstracts of papers presented at research conferences and symposia. There were 84 research papers published in journals indexed in Science Citation Index (SCI) and 11 research papers published in journals indexed in SCI Expanded. There were 101 other publications which mainly consisted of articles in magazines, news bulletins and newspapers. The 'Other' sector published 65, 11 and 43 research papers in SCI journals, SCI Expanded journals and other refereed journals respectively. The Agriculture sector published 11 papers in SCI journals and 35 papers in other refereed journals while Plantation sector published 8 papers in SCI journals and 27 papers in other refereed journals. A total of 11 national and international patents were obtained and 1 national patent was pending registration in 2015. The number of patents received by all S&T institutions and the number of new technologies, processes and products commercialized as well as the number of technologies transferred and recommendations made are very low compared to the number of research publications produced.

1. INTRODUCTION

Science and Technology (S&T) are well known to be the catalysts that facilitate the development of a country. There is a strong relationship between scientific and technological advances and economic growth of a country. Further, appropriate use of S&T can improve health, education and living standards of people. High living standards are considered as an indicator of development of a country and therefore, science, technology and innovation which contribute to good health and high living standards are recognized as critical determinants of the development of a country. Hence, it is necessary to periodically review the progress of S&T institutions in order to ensure that the country is on the correct track in its development. In order to fulfil this objective, the National Science and Technology Commission of Sri Lanka (NASTEC) conducts a review on S&T status of Sri Lanka annually, using data obtained from various public sector S&T institutions.

The NASTEC was established under the provisions of the Science and Technology Development Act No. 11 of 1994 and came into operation in August 1998. The Commission is essentially a policy making body which has the responsibility of making recommendations to the Government on all aspects of scientific and technological development. The NASTEC is further mandated to review the S&T status of Sri Lanka in each year and submit a report to the Government. The review is focused on the measures adopted for the development of human resources, the performance of S&T institutions, public sector spending on S&T and the use of S&T by the public sector and private sector.

This report gives an overview on the current status of S&T in Sri Lanka. It provides information on human and physical resources in S&T institutions, their research activities, outcomes/achievements and financial expenditure for S&T and revenue generated by them. The NASTEC has identified 38 public sector S&T institutions to be considered in this S&T status review. The relevant information was collected through a questionnaire given to each institution. Of the 38 S&T institutions from which the information was requested, 31 have responded. These are listed in Table 1.1. The institutions which did not respond even after repeated reminders are listed in Table 1.2. Using the information provided by the institutions which responded to the survey, this report reviews the contribution of public sector S&T institutions towards the overall S&T status of the country, rather than reviewing the S&T status of individual institutions. These S&T institutions were categorized in to following five sectors.

1. Agriculture sector
2. Plantation sector
3. Engineering sector
4. Medical sector
5. Other sectors

The institutions categorized under the 'Other' sector render services and/or carry out research and development activities related to natural sciences, natural resources, environment, meteorology, industrial technology, nanotechnology, funding, infrastructure development, standardization and accreditation.

Table 1.1- Sector-wise categorization of S&T institutions reviewed

No.	Agriculture Sector	Plantation Sector	Engineering Sector	Medical Sector	Other sectors
1	Department of Agriculture (DOA)*	Coconut Research Institute (CRI)	Arthur C. Clarke Institute for Modern Technologies (ACCIMT)	Bandaranaike Memorial Ayurvedic Research Institute (BMARI)	Central Environmental Authority (CEA)
2	Department of Export Agriculture (DoEA)	Tea Research Institute (TRI)	National Engineering Research & Development Centre (NERDC)		Department of Meteorology (DoM)
3	Hector Kobbekaduwa Agrarian Research & Training Institute (HARTI)				Forest Department (FD)
4	Institute of Post-Harvest Technology (IPHT)				Gem & Jewellery Research & Training Institute (GJRTI)

5	Sri Lanka Council for Agricultural Research Policy (CARP)				Geological Survey and Mines Bureau (GSMB)
6					Industrial Technology Institute (ITI)
7					National Institute of Fundamental Studies (NIFS)
8					National Aquatic Resources Research & Development Agency (NARA)
9					National Building Research Organization (NBRO)
10					National Science Foundation (NSF)
11					Natural Resources Management Centre (NRMC)
12					Sri Lanka Accreditation

					Board for Conformity Assessment (SLAB)
13					Sri Lanka Institute of Nano Technology (SLINTEC)
14					Sri Lanka Standards Institute (SLSI)

*Department of Agriculture includes the following institutions: Fruit Research and Development Institute (FRDI), Farm Mechanization Research Centre (FMRC), Fruit Crop Research & Development Institute (FCRDI), Seed Certification & Plant Protection Centre (SCPPC), Seed & Planting Material Development Centre (SPMDC), Rice Research & Development Institute (RRDI), Plant Protection Service and Office of the Registrar of Pesticides.

Table 1.2- S&T institutions that did not provide information for the review

No.	Agriculture Sector	Plantation Sector	Medical Sector	Other sectors
1	Horticultural Crop Research and Development Institute (HORDI)	Rubber Research Institute (RRI)	Veterinary Research Institute (VRI)	Sri Lanka Atomic Energy Board (SLAEB)
2	Plant Genetic Resources Centre (PGRC)	Sugarcane Research Institute (SRI)	Medical Research Institute (MRI)	

2. STATUS OF HUMAN RESOURCES AND PHYSICAL RESOURCES IN S&T INSTITUTIONS

2.1 Categories of staff employed in S&T institutions

Development of a country depends on the development of S&T related infrastructure and appropriate utilization of human resources with advanced skills. Information on S&T human resource is useful to measure the current strength of a country's capacity to contribute to the global knowledge, research and development as well as to determine the future supply of scientific personnel. In the S&T status review, an overview of the human resources employed in the S&T institutions of the country has been presented. This section provides information on human resources in the 31 S&T Institutions which responded to the survey. Human resources employed in the S&T institutions were categorized into four groups, namely Scientific, Administrative, Accounting and Other Staff. The number of personnel in each of these categories is given in Table 2.1 and the relative distribution of these numbers is shown in Figure 2.1.

Table 2.1: Staff Strength – Distribution of staff employed in S&T institutions

Sector	Scientific Staff			Accounting Staff		Administrative Staff		Other Staff	Total
	Research Staff	Support Staff	Librarians, Information Officers	Accountants	Support Staff	Executives	Support Staff		
Agriculture	228	838	10	07	48	31	617	2369	4148
Plantation	113	126	03	03	12	11	39	254	561
Engineering	71	132	02	04	26	07	59	48	349
Medical	07	00	00	00	00	00	09	03	19
Other	702	497	22	26	122	84	272	269	1994
Total	**1121**	**1593**	**37**	**40**	**208**	**133**	**996**	**2943**	7071
	2751			**248**		**1129**		**2943**	

The survey revealed that 7071 personnel were employed in S&T activities in the 31 S&T institutions participated in the review in 2015. The highest percentage was recorded for 'Other' staff while the minimum representation was observed for the Accounting staff. The Scientific staff recorded the second highest percentage followed by Administrative staff. Librarians and information officers were categorized under the Scientific staff considering them as information scientists. The proportion of scientific staff of the total staff was 0.4. Of the Scientific staff majority (59%) were in support staff category (Figure 2.2). Only about 1% of the scientific staff were librarians and information officers.

Out of total 1121 research staff employed in all sectors, the highest number of 702 were employed in the 'Other' sector followed by Agriculture, Plantation and Engineering sectors respectively. The minimum number of research staff was engaged in the Medical sector (Table 2.1). Only 16% of the total staff were research personnel and therefore the researcher to non-researcher ratio was 1:5. This is mainly due to the Agriculture sector where researcher:non-

researcher ratio was 1:17. The overall researcher:research supporter ratio was 1:1.5. In the Agriculture sector this ratio was 1:4 while in the Engineering sector it was 1:2. In the Medical and 'Other' sectors this ratio was 1:<1 while in the Plantation sector it was 1:1 (Table 2.1).

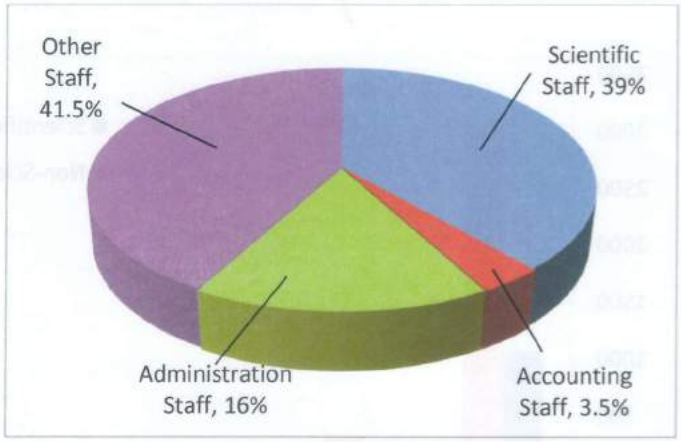


Figure 2.1: Composition of various categories of staff in S&T institutions

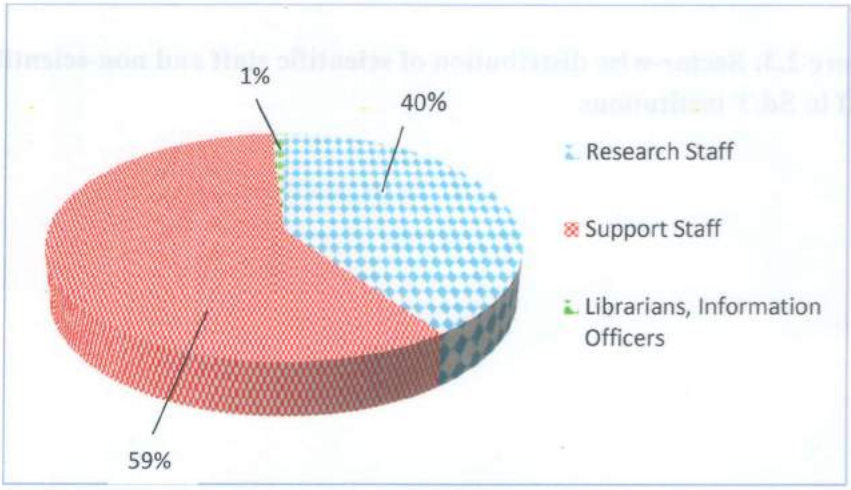
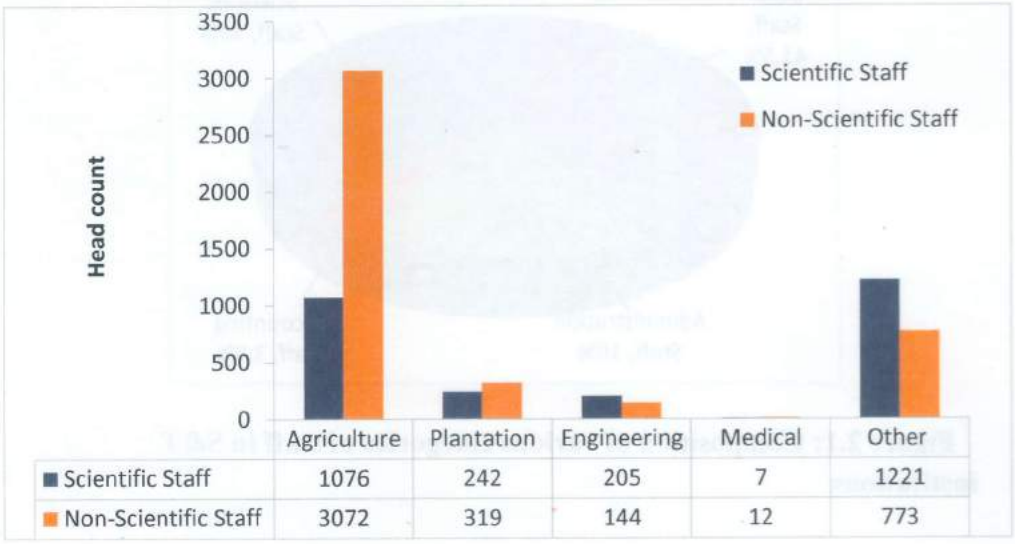


Figure 2.2: Composition of scientific staff in S&T institutions

When the numbers of scientific staff and non-scientific staff (accounting staff, administrative staff and other staff) are considered, it was observed that in Agriculture, Plantation and Medical sectors, the non-scientific staff outnumbered the scientific staff. In the Agriculture sector the number of non-scientific staff is about three times as that of scientific staff (Figure 2.3).



	Agriculture	Plantation	Engineering	Medical	Other
Scientific Staff	1076	242	205	7	1221
Non-Scientific Staff	3072	319	144	12	773

Figure 2.3: Sector-wise distribution of scientific staff and non-scientific staff in S&T institutions

Gender composition of research staff is shown in Figure 2.4. The overall gender composition is slightly imbalanced towards males (597 out of a total of 1121).

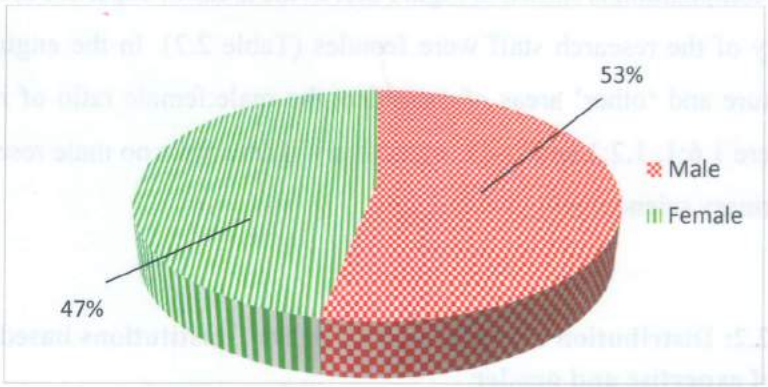


Figure 2.4: Gender composition of the research staff in S&T Institutions

2.2 Areas of expertise of research staff

Science, engineering, medical and health science, agriculture and veterinary science were the major S&T areas of expertise considered in this analysis. Research personnel who did not belong to any of these categories were included in the 'other' group. The numbers of researchers with different areas of expertise employed in each major sector together with their gender are given in Table 2.2. The highest percentage of researchers in S&T institutions of all sectors was observed in the expertise area of science (41%) followed by agriculture (32.7%), engineering (18.8%), 'other' (7.4%) and veterinary science (0.1%) (Figure 2.5). None of the researchers with expertise in medical and health science was reported in the 31 S&T institutions surveyed in 2015. The fields of expertise of the researchers of medical and health science were science (5 researchers) and agriculture (2 researchers). Only one medical

institution which was in indigenous medicine responded and MRI had not responded resulting in this observation.

The distribution of research personnel in the different fields together with the gender composition is shown in Figure 2.6. In the areas of expertise of science, majority of the research staff were females (Table 2.2). In the engineering, agriculture and 'other' areas of expertise, the male:female ratio of research staff were 1.6:1, 1.2:1 and 1.4:1 respectively. There were no male researchers in veterinary science field (Table 2.2).

Table 2.2: Distribution of research staff in S&T institutions based on areas of expertise and gender

Sector	Area of expertise												Total		
	Science		Engineering		Medical and Health Science		Agriculture		Veterinary Science		Other				
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M & F
Agriculture	09	07	03	02	00	00	105	97	00	00	03	02	120	108	228
Engineering	06	01	39	22	00	00	00	00	00	00	02	01	47	24	71
Plantation	15	20	00	00	00	00	54	24	00	00	00	00	69	44	113
Medical	00	05	00	00	00	00	02	00	00	00	00	00	02	05	07
Other	189	208	87	58	00	00	39	45	00	01	44	31	359	343	702
Total	**219**	**241**	**129**	**82**	**00**	**00**	**200**	**166**	**00**	**01**	**49**	**34**	**597**	**524**	**1121**
Total (M & F)	**460**		**211**		**0**		**366**		**1**		**83**		**1121**		

M-Male, F-Female

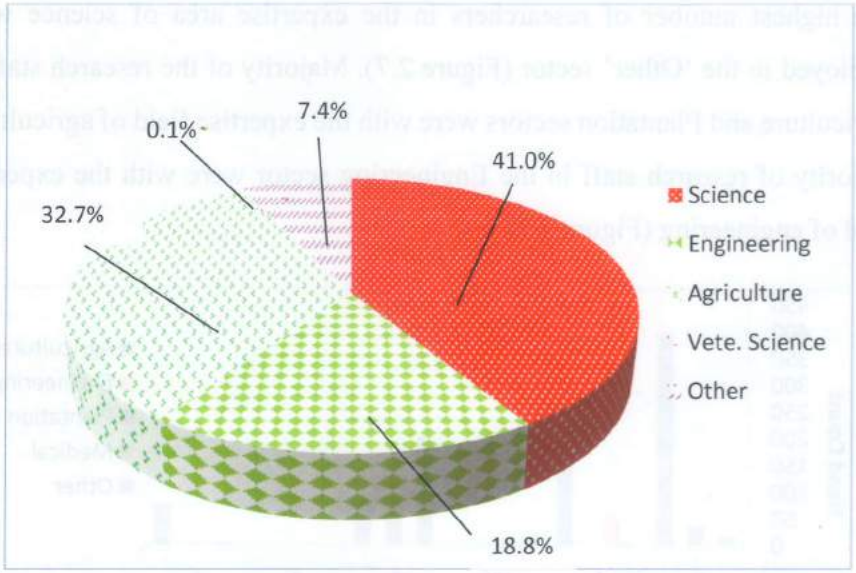


Figure 2.5: Composition of the research staff based on the areas of expertise in S&T institutions

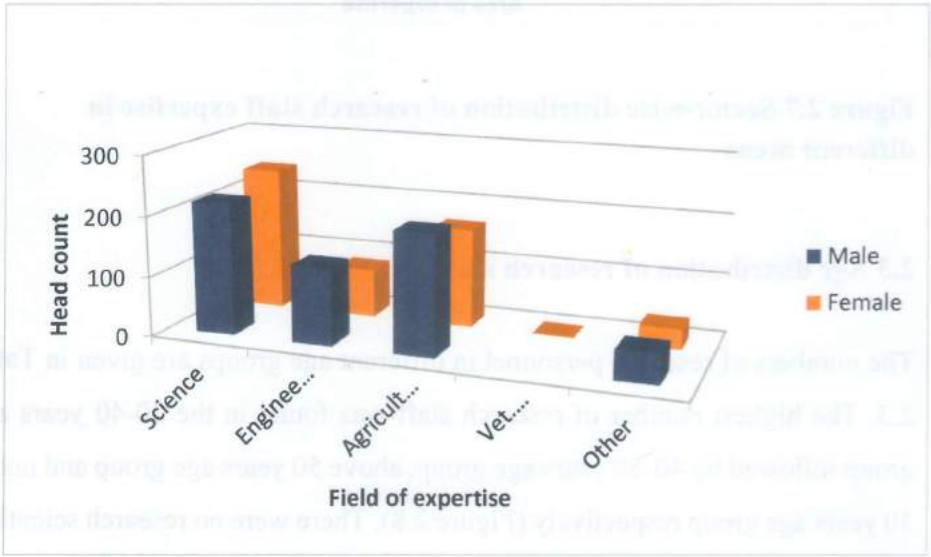


Figure 2.6: Research staff based on the field of expertise and gender

The highest number of researchers in the expertise area of science were employed in the 'Other' sector (Figure 2.7). Majority of the research staff in Agriculture and Plantation sectors were with the expertise field of agriculture. Majority of research staff in the Engineering sector were with the expertise field of engineering (Figure 2.7).

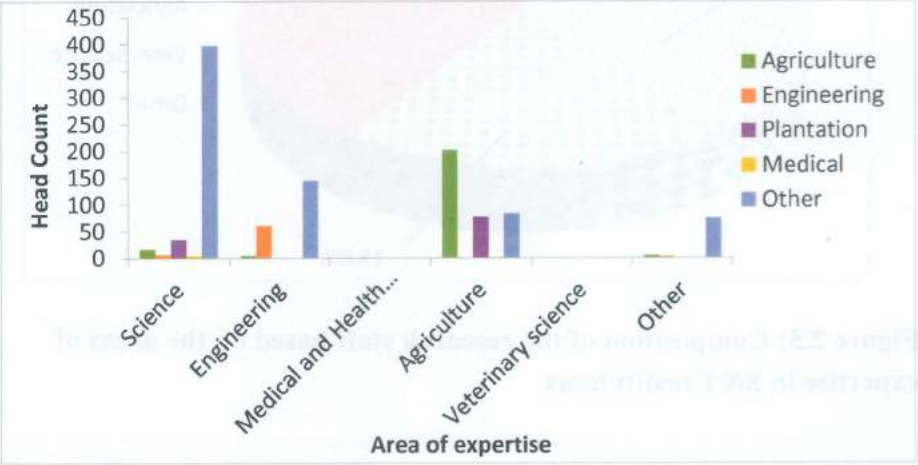


Figure 2.7 Sector-wise distribution of research staff expertise in different areas

2.3 Age distribution of research staff

The numbers of research personnel in different age groups are given in Table 2.3. The highest number of research staff was found in the 30-40 years age group followed by 40-50 years age group, above 50 years age group and under 30 years age group respectively (Figure 2.8). There were no research scientists under 30 years of age in the Agriculture and Medical sectors. Only in age group of 30-40 years, female researchers outnumbered the males. The number of female researchers in 30-40 years age group was higher than the number of male researchers in any age group. In the age group of >50 years, male

researchers were almost twice as of female researchers. In all age groups of the Engineering and Plantation sectors, male researchers outnumbered the female researchers. In the age groups below 40 years of the Agriculture, Medical and 'Other' sectors, female researchers outnumbered the male researchers. It appears that more and more young female researchers have been recruited to S&T institutions in the Agriculture, Medical and 'Other' sectors in recent past.

Table 2.3: Distribution of research staff in S&T institutions based on age group and gender

Sector	Age Group								Total		
	>50 Years		40-50 Years		30-40 Years		<30 Years				
	M	F	M	F	M	F	M	F	M	F	M&F
Agriculture	49	30	50	44	21	34	00	00	120	108	228
Engineering	06	04	23	07	09	07	09	06	47	24	71
Plantation	20	08	15	12	17	11	17	13	69	44	113
Medical	00	00	02	00	00	05	00	00	02	05	07
Other	74	36	92	92	122	138	71	77	359	343	702
Total	**149**	**78**	**182**	**155**	**169**	**195**	**97**	**96**	**597**	**524**	**1121**
	227		**337**		**364**		**193**		**1121**		

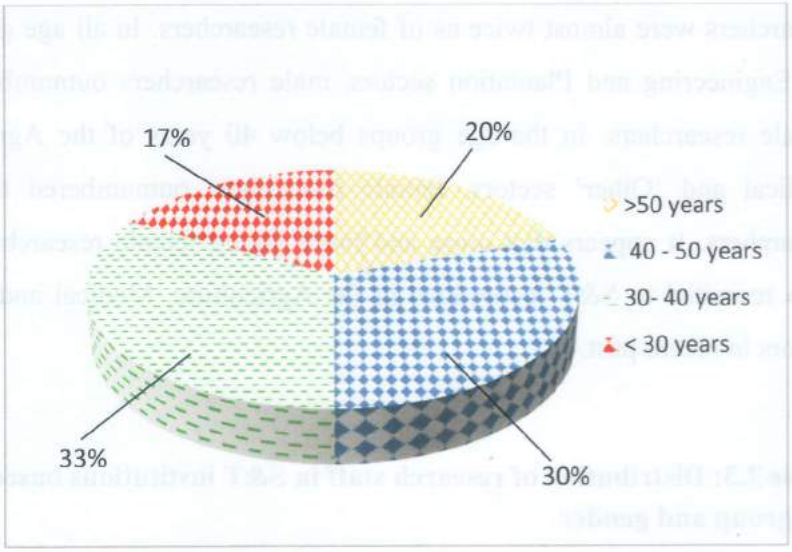


Figure 2.8: Composition of research staff based on age group

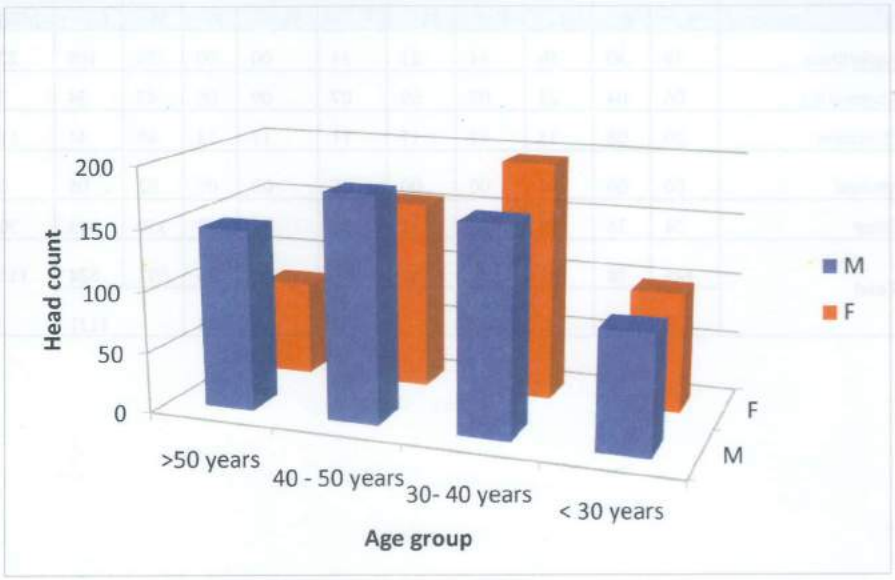


Figure 2.9: Research staff based on gender and age group

2.4 Highest educational qualifications of research staff

The number of research staff with different educational qualifications in each sector is given in Table 2.4. Figure 2.10 illustrates the overall composition of the research staff based on their highest educational qualification. More than 50% of the research staff possess postgraduate qualifications. These include 13% with PhD, 6% with MPhil and 38% with MSc Degrees while 34% were BSc degree holders and 9% were Diploma holders. These statistics indicate that majority of research staff possess MSc degree as their highest educational qualification while those with research degrees, i.e., PhD and MPhil, account only for 19%. It is necessary to encourage the research staff to get trained at the research degree level and when recruiting to the grades of research staff in future, emphasis may be given to those with research postgraduate degrees. The number of female researchers qualified with PhD, MPhil, BSc and Diploma was lower than the number of male researchers with the same qualifications. However, the number of female scientists with MSc degrees was higher than that of male researchers with the same qualification.

Table 2.4: Research staff based on highest educational qualification and gender

Sector	Highest Qualification										Total		
	PhD		MPhil		MSc/MA		BSc		Diploma				
	M	F	M	F	M	F	M	F	M	F	M	F	M&F
Agriculture	18	13	09	12	52	60	36	20	05	03	120	108	228
Engineering	01	00	02	00	16	07	22	09	06	08	47	24	71
Plantation	15	14	07	04	15	11	32	15	00	00	69	44	113
Medical	00	00	01	00	00	05	00	00	01	00	02	05	07
Other	51	31	19	12	123	142	113	130	53	28	359	343	702
Total	**85**	**58**	**38**	**28**	**206**	**225**	**203**	**174**	**65**	**39**	**597**	**524**	**1121**
Total (M&F)	**143**		**66**		**431**		**377**		**104**		**1121**		

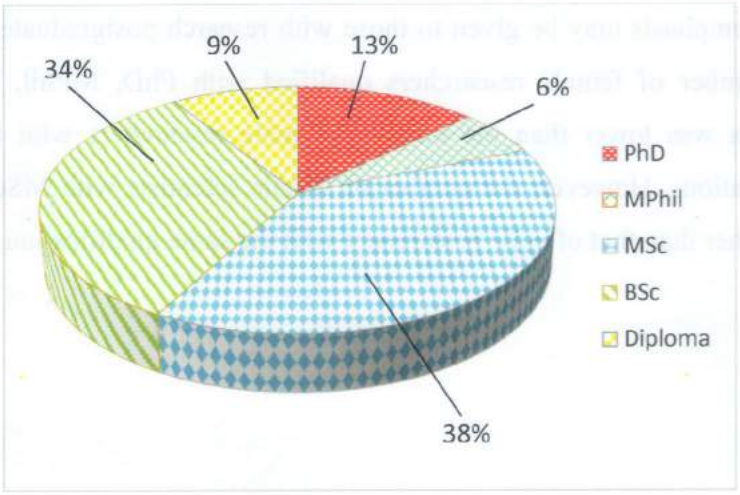


Figure 2.10: Research staff based on highest educational qualification

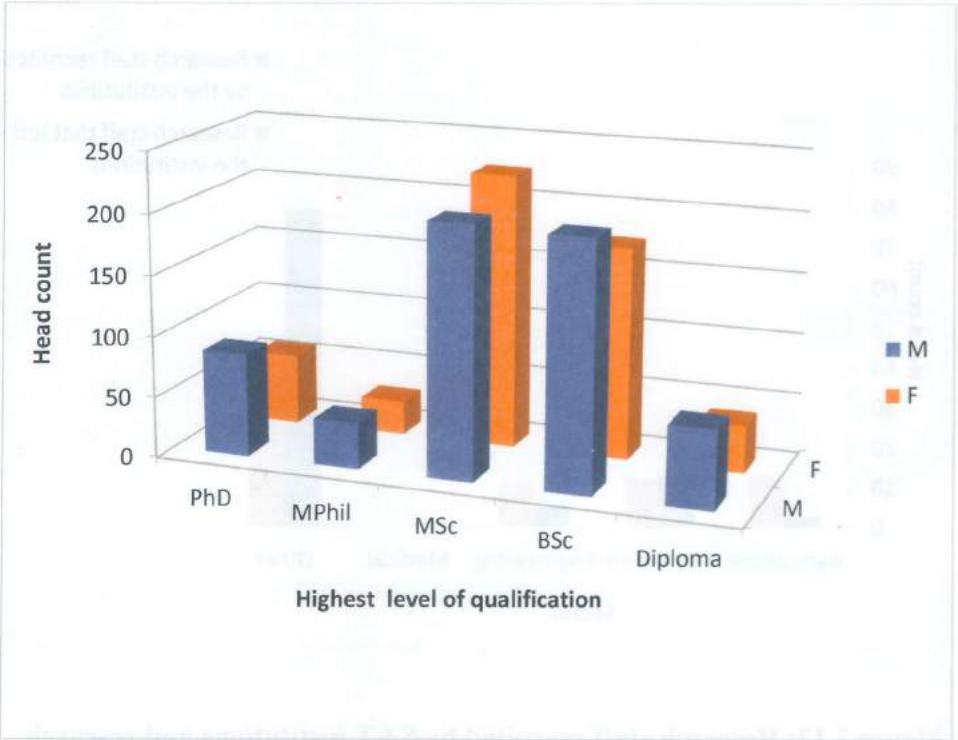


Figure 2.11: Research staff based on highest educational qualification and gender

2.5 Research staff recruited and left in 2015

The highest number of research personnel recruited in 2015 by S&T institutions was in the 'Other' sector (Figure 2.12). Similarly, the highest number of researchers who left the S&T institutes was also recorded in the 'Other' sector.

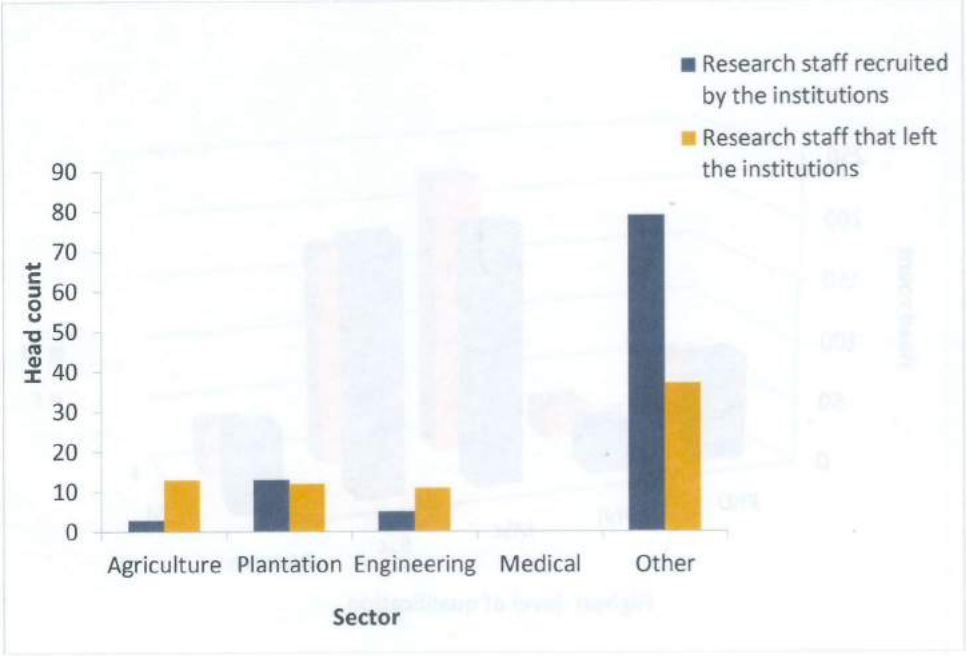


Figure 2.12: Research staff recruited by S&T institutions and research staff that left S&T institutions in different sectors

In the 'Other' and the Plantation sectors, the numbers of research staff recruited were higher than the numbers left the institutions due to resignations and retirements. However, the difference between the number recruited and the number left in the Plantation sector was relatively small. The number recruited in the 'Other' sector was twice as the number left. The net increases in the number of research staff in the 'Other' and Plantation sectors in 2015 were 42 and 1 respectively. In the Agriculture and Engineering sectors, 13 and 11 research personnel have left the institutions. However, only 3 research personnel were recruited to the Agriculture sector whilst 5 research personnel were recruited to the Engineering sector. Therefore, in the Agriculture and Engineering sectors there was a net reduction of 10 and 6 research personnel during the year 2015. This reflects that there is a high tendency of researchers

leaving the institutions especially in the Agriculture and Engineering sectors. Most of them have resigned for better employment opportunities. When all 31 institutions were considered, 73 scientists had left the S&T institutions while 100 researchers have been recruited in 2015.

2.6 Human Resource Development

In order to enhance competencies of the scientific staff, it is imperative to provide regular training for them. In 2015, 54% of the scientific staff had undergone some kind of training either through national and/or international training programmes, workshops, seminars and conferences. A considerable number, i.e., approximately 81% of the scientific staff have participated in local trainings of 10 days or less duration. Table 2.5 shows the details of participation of scientific staff in national and international training programmes, workshops, seminars and conferences.

The highest number of participation in foreign as well as local training was from the 'Other' sector followed by the Agriculture sector. Although there are only 205 members in the Scientific staff of the Engineering sector, number of foreign training programmes they have participated is almost double, being 379.

Table 2.5: Participation of the scientific staff in national and international training programmes, workshops, seminars, conferences etc.

Sector	Duration (Days)								Total	
	≤10		11-20		21-30		>30			
	L	F	L	F	L	F	L	F	L	F
Agriculture	374	38	00	16	05	27	07	10	386	91
Engineering	367	08	03	00	01	00	00	00	371	08
Plantation	27	09	00	00	00	01	00	00	27	10
Medical	00	00	00	00	00	00	00	05	00	05
Other	447	107	00	33	05	05	06	08	458	153
Total	**1215**	**162**	**03**	**49**	**11**	**33**	**13**	**23**	**1242**	**267**

L-Local, F-Foreign

2.7 Physical resources in S&T institutions

S&T institutions in the 'Other' sector have the highest number of laboratories followed by Agriculture, Engineering, Plantation and Medical sectors respectively (Table 2.6). Agriculture sector has the highest number of auditoriums/conference halls whereas 'Other' sector has the highest number of libraries.

Some of the institutions functioning under the Department of Agriculture have their websites connected to the main website of the Department of Agriculture. Some institutions have specific databases to maintain records of their services. All these institutions have a total of 1510 computers and laptops.

Since the total number of libraries is less than the total number of institutions participated in the survey, it appears that some S&T institutions do not have their own libraries.

Table 2.6: Number of laboratories, auditoriums/conference halls and libraries present in S&T institutions in different sectors

Sector	No. of Laboratories	No. of Auditoriums/Conference Halls	No. of Libraries
Agriculture	42	20	07
Engineering	14	06	02
Plantation	07	02	02
Medical	03	03	01
Other	108	17	13
Total	**174**	**48**	**25**

3. FUNDING OF S&T INSTITUTIONS

3.1 Funds for research activities

The major funding sources for research in S&T institutions during 2015 were the General Treasury, National Research Council (NRC), National Science Foundation (NSF), National Agricultural Research Plan (NARP) and 'other' sources which included private sector. Figure 3.1 and Table 3.1 show how research funds from different sources were distributed among different sectors. The total amount of funds received for research activities of all S&T institutions in 2015 was nearly LKR 1218 million. Out of this, only LKR 938 million had been spent. The direct contribution of the General Treasury for research in S&T institutions was LKR 1098 million, which is about 90% of the total amount. NSF, NRC, NARP and 'other' sources had funded 7.5% which is equivalent to LKR 90 million. Of this LKR 90 million, LKR 26.1 million has been provided by sources other than NSF, NRC and NARP. Remaining 2.5%, which is nearly LKR 30 million had been provided by foreign bodies. Thus funding from foreign sources had been very low. Since financial support for NSF, NRC and NARP is also provided by the General Treasury, it had been the main funding source for S&T institutions in the year 2015.

The 'Other' sector received the highest amount of funding, which is equivalent to about LKR 606 million (50%). The Agriculture sector had been provided LKR 250.7 million (20.5%) while the Medical sector had been provided LKR 250 million (20.5%). The research allocations received by the Plantation and

the Engineering sectors had been 8% and 1% respectively. It has to be noted that one institution in the Medical sector and 12 institutions in the Agriculture sector had been provided almost the same amount of funding for research activities (Figure 3.2).

None of the sectors has spent all the funds received for research (Figure 3.2). The total amount spent was only 77% of the amount received. Of the total amount of LKR 1098 million received from the General Treasury for research, only LKR 861 million, which was about 78% has been spent. The Plantation sector has spent the highest percentage of funds received from the General Treasury, which was 99.1% followed by the 'Other' sector (97%), Engineering sector (90.5%) and Agriculture sector (85.5%). The Medical sector has spent only 24.1% of the funds received for research from the General treasury (Table 3.1). Engineering and Medical sectors have not received any foreign funding or funding from 'other' sources such as NSF, NRC and NARP for research.

Agriculture sector has received the highest amount of foreign funds for research (LKR 22.6 million) followed by 'Other' sector (LKR 6.2 million) and Plantation sector (LKR 0.96 million). None of these sectors has spent the entire amount of foreign funds received by them. Agriculture sector has spent only 59% of foreign funds followed by Plantation sector which has spent only 52%. 'Other' sector has spent only 48% of the foreign funds received by them (Table 3.1). It may be possible that these funds are carried forward to be used in the following year.

The highest amount of funds from 'other' sources have been received by the 'Other' sector (LKR 34.4 million) followed by the Agriculture sector (LKR 28.1 million) and Plantation sector (LKR 27.3 million). Of these funds, S&T institiutions in 'Other' sector has spent more than 99% of the funds received

by them. The Agriculture and Plantation sectors have spent only 54% and 41% of funds received from 'other' sources (Table 3.1). It may be possible that these funds are carried forward to be used in the following year.

Table 3.1: Funds received by public sector S&T institutions for research activities by different funding sources (the amount spent as a % of the amount received is given in the amount spent column within brackets)

Sector	Funding source	Amount received (LKR Million)	Amount spent (LKR Million)	Total amount received (LKR Million)	Total amount spent (LKR Million)
Agriculture	General Treasury	200.0	171.0 (85.5%)	250.7	199.6 (79.6%)
	Foreign	22.6	13.4 (59.3%)		
	Other *	28.1	15.2 (54%)		
Plantation	General Treasury	69.7	69.1 (99.1%)	98.0	81.0 (82.7%)
	Foreign	0.96	0.5 (52%)		
	Other*	27.3	11.3 (41.3%)		
Engineering	General Treasury	12.85	11.63 (90.5)	12.9	11.6 (89.9%)
Medical	General Treasury	250.0	60.3 (24.1%)	250.0	60.3 (24.1%)
Other	General Treasury	565.5	548.5 (97%)	606.1	585.7 (96.6%)
	Foreign	6.2	3.0 (48.4%)		
	Other*	34.4	34.2 (99.4%)		
Total				**1217.7**	**938.2 (77%)**

*NSF, NRC, NARP and 'other' sources

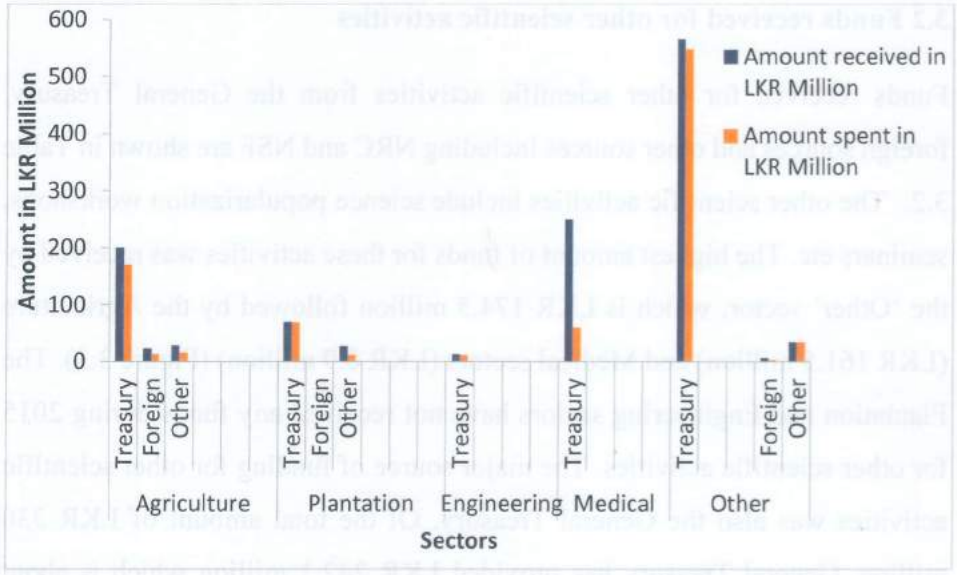


Figure 3.1: Funds received from different sources and spent by S&T institutions for research and development activities

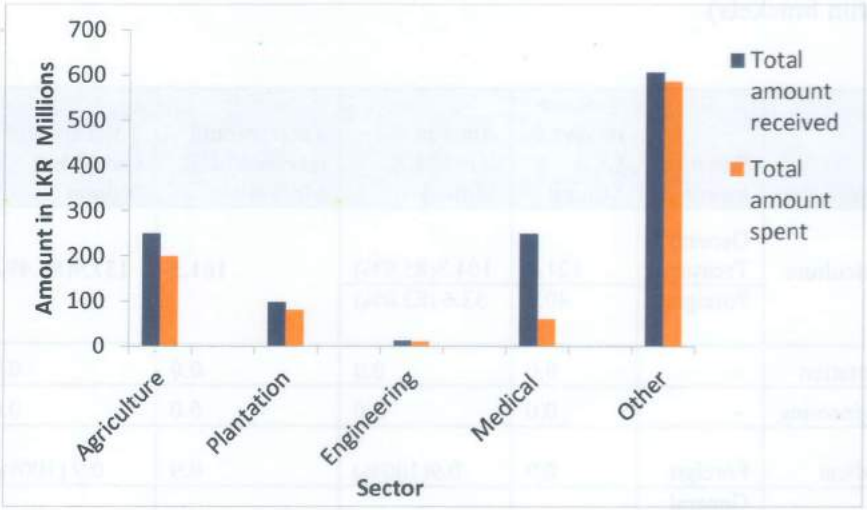


Figure 3.2: Total amount of funds received and spent by S&T institutions for research and development activities

3.2 Funds received for other scientific activities

Funds received for other scientific activities from the General Treasury, foreign sources and other sources including NRC and NSF are shown in Table 3.2. The other scientific activities include science popularization workshops, seminars etc. The highest amount of funds for these activities was received by the 'Other' sector, which is LKR 174.5 million followed by the Agriculture (LKR 161.5 million) and Medical sectors (LKR 0.9 million) (Figure 3.3). The Plantation and Engineering sectors have not received any funds during 2015 for other scientific activities. The major source of funding for other scientific activities was also the General Treasury. Of the total amount of LKR 336 million, General Treasury has provided LKR 242.1 million which is about 72%.

Table 3.2: Funds received by public sector S&T institutions for other scientific activities (Amount of funds spent as a % of funds received is given within brackets)

Sector	Funding source	Amount received/ LKR Million	Amount spent/LKR Million	Total amount received/LKR Million	Total amount spent/LKR Million
Agriculture	General Treasury	121.4	104.3(85.9%)	161.5	137.9(85.4%)
	Foreign	40.1	33.6 (83.8%)		
Plantation	-	0.0	0.0	0.0	0.0
Engineering	-	0.0	0.0	0.0	0.0
Medical	Foreign	0.9	0.9(100%)	0.9	0.9 (100%)
Other	General Treasury	120.7	131.7(109%)	174.5	182.7(104.7%)
	Foreign	28.3	27.9 (98.6%)		
	Other*	25.5	23.14(90.7%)		

*NRC, NSF and 'other' sources

Foreign funds for other scientific activities have been received by Agriculture, 'Other' and Medical sectors. These are LKR 40.1 million, 28.3 million and 0.9 million respectively (Figure 3.4). Of these, the Agriculture sector has spent 83.8% and 'Other' sector has spent nearly 99% of the funds received by them. Medical sector has spent all the funds received by them. The 'Other' sector has received funding for other scientific activities from 'other' sources also (Figure 3.4), of which 91% has been spent.

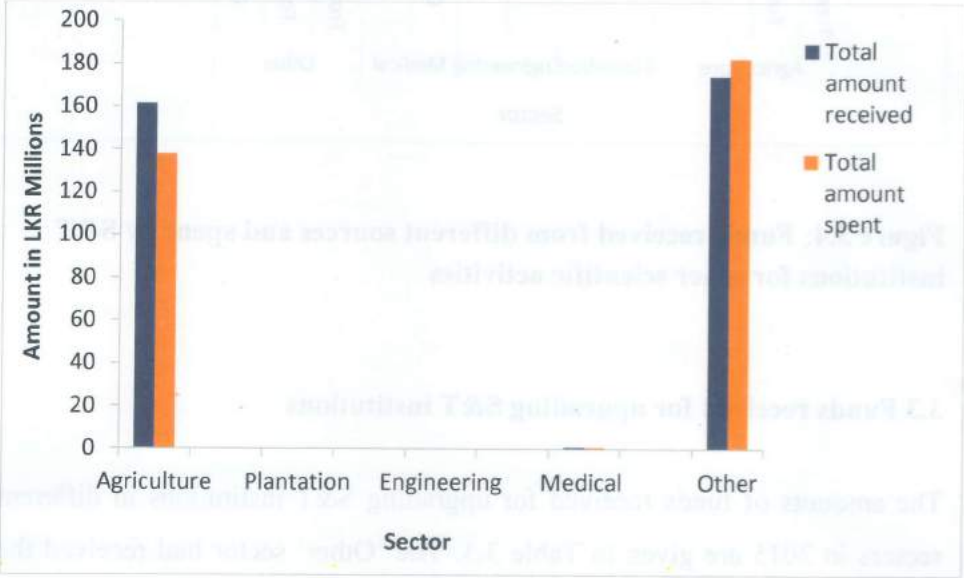


Figure 3.3: Total amount of funds received and funds spent by S&T institutions for other scientific activities

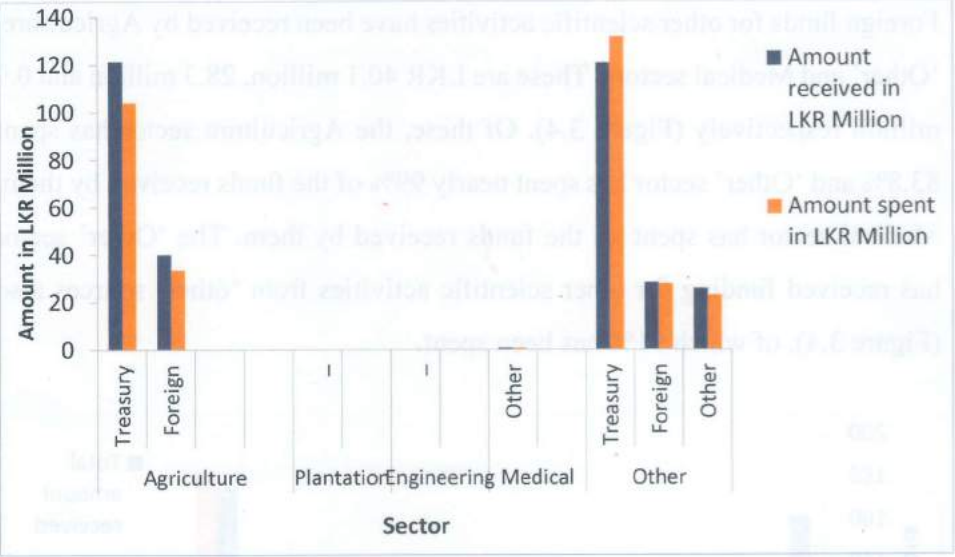


Figure 3.4: Funds received from different sources and spent by S&T institutions for other scientific activities

3.3 Funds received for upgrading S&T institutions

The amounts of funds received for upgrading S&T institutions in different sectors in 2015 are given in Table 3.3. The 'Other' sector had received the highest amount of funds, which is LKR 784.2 million followed by the Agriculture, Medical, Engineering and Plantation sectors respectively. The General Treasury has disbursed LKR 1300 million for upgrading S&T institutions in 2015. However, of these only about LKR 864.7 million, which is about 66.5% has been utilised. Plantation, Medical and Engineering sectors have received funds for upgrading institutions only from the General Treasury. Agriculture sector has received funds from 'other' sources also. In addition, this sector has utilised some of their generated income also for upgrading.

Table 3.3: Funds received from different sources by public sector S&T institutions for upgrading and the amounts spent (The values given within brackets are the amounts spent as a % of the amount received)

Sector	Funding source	Amount received/ LKR Million	Amount spent/ LKR Million	Total amount received/ LKR Million	Total amount spent/ LKR Million
Agriculture	General Treasury	308.1	229.1(74.7%)	328.2	238.8(72.8%)
	Institute Generated	7.0	5.7 (81.4%)		
	Other*	13.1	4.0 (30.5%)		
Plantation	General Treasury	43.1	34.2 (79.4%)	43.1	34.2 (79.4%)
Engineering	General Treasury	82.0	81.6 (99.5%)	82.0	81.6 (99.5%)
Medical	General Treasury	169.0	0.003 (0%)	169.0	0.003 (0%)
Other	General Treasury	697.4	519.8(74.5%)	784.2	586.9(74.8%)
	Foreign	32.9	28.2 (85.7%)		
	Other*	53.9	38.9 (72.2%)		

* NRC, NSF and 'other' sources

The 'Other' sector has received funding from foreign sources and 'other' sources for upgrading S&T institutions (Table 3.3). Engineering sector institutions have utilised almost all of the funds they have received from the General Treasury. In the Medical sector, of the total of LKR 169 million, only LKR 3000.00 has been utilised. Plantation sector has spent about 79% of the funds they have received from the General Treasury for upgrading while the Agriculture sector and 'Other' sector institutions have utilised around 75% each. Of the foreign funding received for upgrading S&T institutions, only

about 86% has been utilised. Of the funding received from 'other' sources for upgrading, Agriculture sector had utilised only about 31% and 'Other' sector had utilised only about 72% (Table 3.3).

4. ACHIEVEMENTS OF S&T INSTITUTIONS

4.1 Research projects

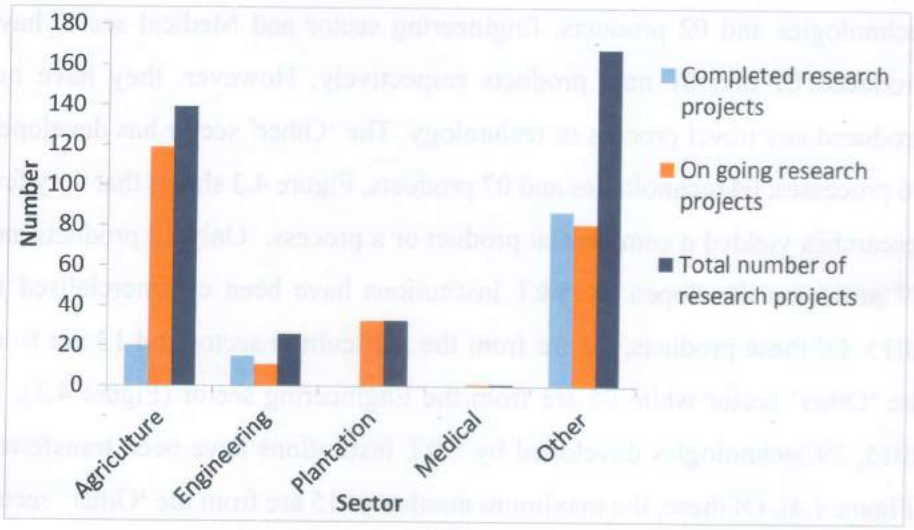


Figure 4.1: Research projects of S&T institutions

During 2015, a total of 367 research projects have been carried out by 30 S&T institutions responded for the survey. SLINTEC did not provide information on research projects and new products/processes/technologies developed in order to maintain confidentiality. Of these, 122 projects have been completed (Figure 4.1). The 'Other' sector has carried out the highest number of research projects followed by Agriculture, Plantation, Engineering and Medical sectors respectively. In the Medical sector, there was only one ongoing research project.

4.2 Research Output

In 2015, S&T intuitions in all sectors have produced 58 new processes, 15 new technologies and 37 new products (Figure 4.2). Among them, 49 processes, 09 technologies and 20 products have been developed by the Agriculture sector whereas the Plantation sector has developed 03 processes, 02 technologies and 02 products. Engineering sector and Medical sector have produced 07 and 01 new products respectively. However, they have not produced any novel process or technology. The 'Other' sector has developed 06 processes, 04 technologies and 07 products. Figure 4.3 shows that very few researches yielded a commercial product or a process. Only 32 products and 09 processes developed by S&T institutions have been commercialised in 2015. Of these products, 14 are from the Agriculture sector and 13 are from the 'Other' sector while 05 are from the Engineering sector (Figure 4.3). In 2015, 29 technologies developed by S&T institutions have been transferred (Figure 4.4). Of these, the maximum number of 15 are from the 'Other' sector followed by the Agriculture (10), Plantation (3) and Medical sectors (1). It appears that some of these new technologies that were transferred in 2015 have been developed in preceding years. In 2015, only 15 recommendations have been made by S&T institutions (Figure 4.4). There is a need for effective public private partnerships to transfer the knowledge and technology generated in research laboratories to industry in order to convert them to commercial products or processes.

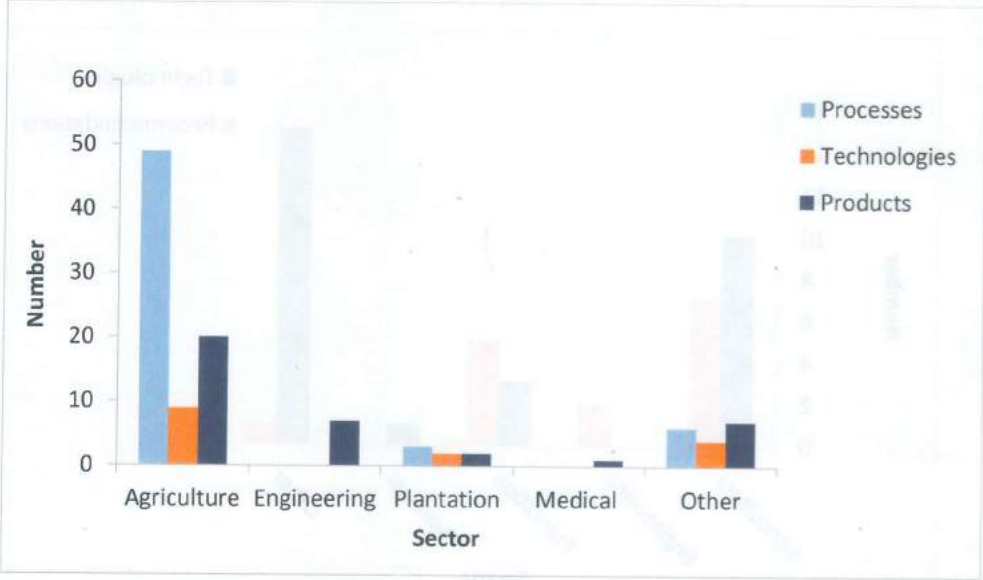


Figure 4.2: New processes, technologies and products developed by S&T institutions in different sectors

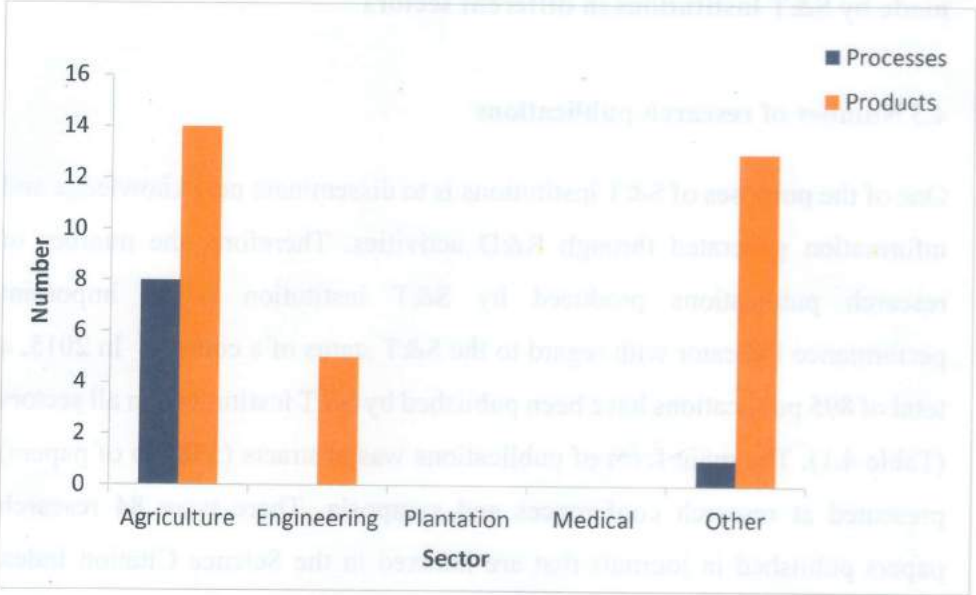


Figure 4.3: New processes, technologies and products commercialized by S&T institutions in different sectors

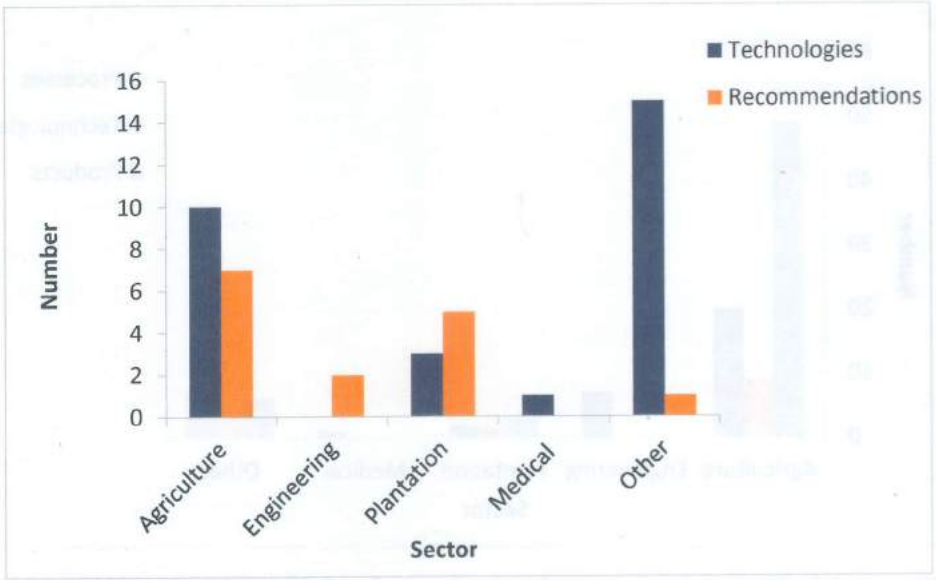


Figure 4.4: Number of technologies transferred & recommendations made by S&T institutions in different sectors

4.3 Number of research publications

One of the purposes of S&T institutions is to disseminate new knowledge and information generated through R&D activities. Therefore, the number of research publications produced by S&T institution is an important performance indicator with regard to the S&T status of a country. In 2015, a total of 895 publications have been published by S&T institutions in all sectors (Table 4.1). The main form of publications was abstracts (538 No of papers) presented at research conferences and symposia. There were 84 research papers published in journals that are indexed in the Science Citation Index (SCI) and 11 research papers have been published in journals indexed in SCI Expanded. There were 101 other publications which mainly consisted of articles in magazines, news bulletins and newspapers. The percentages of

different types of publications are shown in Figure 4.5. Sector-wise distribution of different types of publications is shown in Figure 4.6. The highest percentage of research papers, abstracts and chapters in books have been produced by the 'Other' sector while the highest number of books and the only monograph have been produced by the Agriculture sector. This large number of publications indicates that large amount of research is carried out in S&T institutions that end up as research publications.

However, as shown in figures 4.2, 4.3 and 4.4, development of marketable products and processes is very poor. This should be addressed urgently.

Table 4.1: Various categories of publications produced by S&T institutions

Sector	Number of publications								Total
	Journals indexed in SCI	SCI Journals indexed in SCI Expanded	Refereed Journals not indexed in SCI or SCI Expanded	Abstracts of papers presented at research conferences /symposia	Monographs	Books	Book Chapters	Other*	
Agriculture	11	00	35	74	01	31	00	38	190
Engineering	00	00	01	12	00	00	00	02	15
Plantation	08	00	27	37	00	03	03	09	87
Medical	00	00	00	111	00	02	00	00	113
Other	65	11	43	304	00	04	11	52	490
Total	**84**	**11**	**106**	**538**	**01**	**40**	**14**	**101**	**895**

*Other include articles in news bulletings, magazines, newsletters and newspapers.

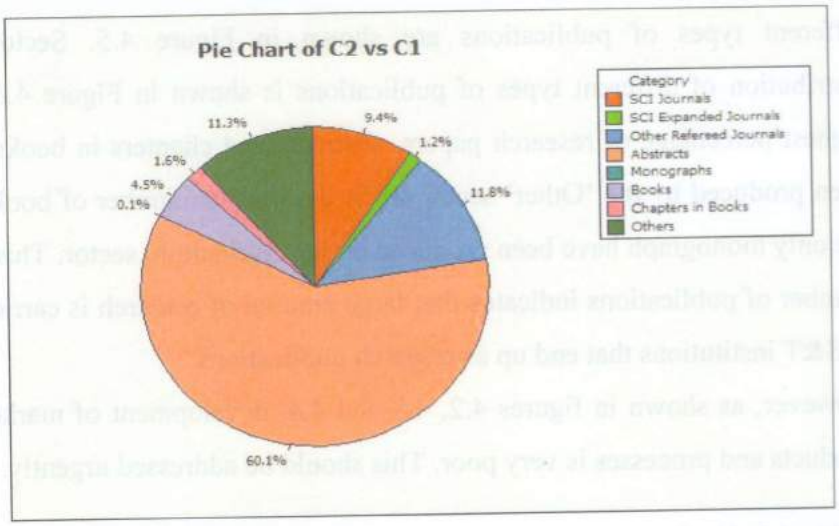


Figure 4.5: Composition of research publications produced by S & T institutions

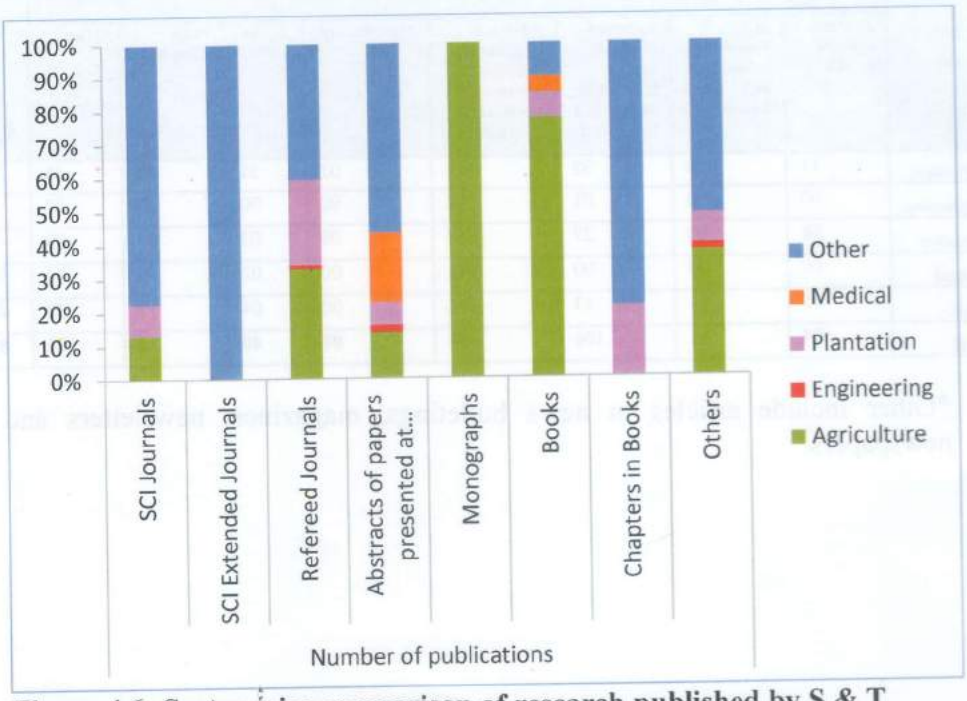


Figure 4.6: Sector-wise comparison of research published by S & T institutions

4.4 Number of patents

A total of 10 national patents were registered and one patent was pending for registration with the National Intellectual Property Office of Sri Lanka in 2015 (Table 4.2). However, none of the products which received national patents was commercialized. The 'Other' sector obtained the highest number of patents followed by the Agriculture sector. Only one institution from the 'Other' sector has received an international patent. The number of patents received is also very low compared to the number of research publications produced. Hence special attention should be paid to do more research leading to the development of products and processes which can be patented and marketed.

Table 4.2: Number of patents registered and pending in 2015

Sector	National Patents		International Patents		Total
	Number of National patents obtained	Number of National patents pending	Number of International patents obtained	Number of International patents pending	
Agriculture	02	00	00	00	02
Engineering	00	01	00	00	01
Plantation	00	00	00	00	00
Medical	00	00	00	00	00
Other	08	00	01	00	09
Total	**10**	**01**	**01**	**00**	**12**

4.5 Awards received by scientists or institution

In 2015, Research staff in Plantation sector had received 09 awards of which 07 are national and 02 are international. Agriculture sector has received 03 national awards, 02 by Research staff and 01 by the institution (RRDI). In the Medical sector, one international award has been received by the institution which has responded to the present survey. Research staff of the S&T institutions in the 'Other' sector had received 23 national awards and 3 international awards. However, the Engineering sector had not received any award in 2015.

5. SERVICES PROVIDED BY S&T INSTITUTIONS

Almost all S&T institutes are mandated to provide different services to the public which include testing, calibrating, training, product and process certification, accreditation of labs, consultancies, etc. Table 5.1 shows the number of clients served by each sector during 2015. Altogether, the 31 public sector S&T institutions participated at this survey have provided their services to more than 70908 persons (Table 5.1). The highest number of persons was served by the S&T institutions in 'other' sector followed by Agriculture, Plantation and Engineering sectors respectively. Majority of services provided were testing followed by training.

LKR 789 million has been generated by these 31 public sector S&T institutions in 2015 (Table 5.2). The highest amount of revenue (LKR 706 million) which was about 89.5% of the total amount, was generated by the 'Other' sector followed by the Engineering and Agriculture sectors respectively. S&T institutions in the Plantation and Medical sectors, which participated in the survey have not generated any revenue. The highest amount of revenue has been generated by providing testing services followed by product/process certification and other services which included registration of pesticides, pesticide companies and pest control services, conducting contract research, sales of publications etc. Each of these services has generated more than LKR 100 million. Consultancy services provided by S&T institutions have generated nearly LKR 65 million and around LKR 55 million has been generated by providing training.

Table 5.1: Number of clients served with different services by S&T institutions

Services provided	Number of Clients Served					Total
	Agriculture	Plantation	Engineering	Medical	Other	
Testing facilities	435	5126	1017	*	23081	29659*
Calibration	00	00	24	00	6457	6481
Training	19000	415	275	*	4242	23932*
Product/ Process certification	00	2808	00	00	00	2808
Accreditation of Services	00	00	08	00	00	08
Consultancies	529	10	362	*	106	1007*
Others	852	00	00	00	6161	7013
Total	**20816**	**8359**	**1686**	*	**40047**	**70908***

*Medical sector has provided testing facilities, training and consultancies during 2015. However the number of clients served was not provided to the current survey.

Table 5.2 Revenue generated by rendering different services by S&T institutions

Services provided	Revenue generated (in LKR 1000s)					Total
	Agriculture	Plantation	Engineering	Medical	Other	
Testing facilities	60	00	25,120	00	332,800	357,980
Calibration	00	00	150	00		150
Training	345	00	7,000	00	47,800	55,145
Product/ Process certification	4,310	00	00	00	141,500	145,810
Accreditation of Services	00	00	1,600	00	26,300	27,900
Consultancies	2,600	00	12,600	00	50,000	65,200
Others*	18,524	00	11,100	00	107,800	137,424
Total	**25,839**	**00**	**57,570**	**00**	**706,200**	**789,609**

*Others indicate registration of pesticide companies, pesticides and pest control services, conducting contract research, sales of publications etc.

6. RECOMMENDATIONS

1. Researcher:non-researcher ratio in the Agriculture sector is 1:17. Hence for every researcher there are 17 non-researchers in the public sector S&T institutions dealing with agriculture. Since the ratio of non scientists to scientists in the agriculture sector is large, the requirement of such a ratio should be re-evaluated to balance the scientific researcher component in the agriculture sector.

2. The highest number of personnel in the S&T sector are in the institutions dealing with agriculture. In the recent past, the percentage contribution from agriculture to national GDP has reduced. Therefore, it is necessary to take action to increase the contribution from this sector to national GDP. Novel research leading to development of new marketable value added products while ensuring food security is needed.

3. It is necessary to encourage research personnel to get trained at the research degrees level (i.e. PhD or MPhil level) and necessary facilities have to be provided for such training. Further, when recruiting research personnel in future, emphasis has to be given to those with research postgraduate degrees.

4. The numbers of research staff left the public S&T institutions in 2015 in the Agriculture and Engineering sectors was higher than the number recruited resulting in a net reduction in the numbers in these sectors. This is not a favorable trend. Most of the personnel have left for better employment opportunities. Therefore, it is necessary to take immediate action to retain research staff in the S&T institutions. This can be done in many ways including improving the working environment, appreciating and rewarding the achievers and providing financial and non-financial incentives.

5. Funding for STI activities is a critical aspect in the development process of any country. It can be seen that the Gross Domestic Expenditure on Research and Development (GERD) as a percentage of the Gross Domestic Product (GDP) has declined from 0.16 in 2010 to 0.11 in 2013. This is a very low level of national R&D investment as a percentage of GDP. Hence it is necessary to provide more funding for the S&T sector.

6. Even though the amount of funds received by S&T institutions for research and development is very low as a % of GDP when compared to other countries in the region, none of the S&T sectors was able to spend all the funds received from the General Treasury for research and upgrading of institutions. Therefore, it is neessary to spend all the funds received from the General treasury for a particular year, within that year itself for the development of S&T sector by the relevant institutions.

7. GERD and Business (or private) Expenditure on R&D (BERD) as a proportion of GDP are also considered as important criteria for determining the strength of a country's innovation system. Foreign funding for S&T has been very low during the year 2015. Sri Lanka therefore, should adopt a successful mechanism to attract private sector and foreign direct investment for research and development.

8. S&T institutions have identified several barriers faced in technology transfer such as lack of funds and facilities for technology transfer activities, insufficient number of trained staff to develop and transfer technologies and lack of publicity for novel technologies. It is necessary to overcome these issues faced by S&T institutions.

9. Private sector is to be advised to take action for contributing to national development by giving priority to have collaboration with appropriate public sector scientific institutes in order to come up with new innovations and products that are competitive in the world market. Considering private sector as the engine of growth, they need to be advised strongly by the Government to change their attitudes for the benefit of the country's future. Advising and directing them to look at long term goals which will be beneficial for the country instead of short term monetary gain only, are necessary.

10. It is necessary to set up a commercialization unit in every S&T institution and relevant trained personnel for this purpose should be recruited.

11. Sri Lanka has limited resources for purchasing high end sophisticated equipment in multiple numbers. Therefore, it is necessary to share the available resources among S&T institutions.

12. Although large amount of research is carried out in public S&T institutions, in the present era of envisaging rapid economic growth, all S&T institutions should pay special attention to develop more marketable inventions and innovations through research, which are acceptable even to the foreign market.

13. Expatriate scientists who are established in foreign countries need to be invited to set up laboratories in Sri Lanka and to use high calibre young scientists here to conduct research using local natural resources and develop high value products that can compete and marketed in the world market.

ANNEXURE I

Establishment Acts of S&T Institutions reviewed

	Institute	Act
01.	Arthur C Clarke Institute for Modern Technologies (ACCIMT)	Science and Technology Development Act No. 11 of 1994
02.	Bandaranayake Memorial Ayurvedic Research Institute	N/A
03.	Central Environmental Authority (CEA)	National Environmental Act No. 47 of 1980. National Environment (Amendment) Acts No. 56 of 1988 and No. 53 of 2000
04.	Coconut Research Institute (CRI)	Coconut Research Ordinance No. 24 of 1928
05.	Department of Agriculture	N/A
06.	Department of Export Agriculture	N/A
07.	Department of Meteorology	N/A
08.	Forest Department	N/A
09.	Gem and Jewellery Research and Training Institute	National Gem and Jewellery Authority Act
10.	Geological Survey and Mines Bureau (GSMB)	Mines and Minerals Act No. 33 of 1992
11.	Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI)	The institute was established in 1972 as a statutory board in collaboration with the UNDP/FAO, which functions under the Ministry of Agriculture
12.	Industrial Technology Institute (ITI)	Science and Technology Development Act No. 11 of 1994
13.	National Engineering Research and Development Center (NERDC)	State Industrial Corporations Act No. 49 of 1957

14.	National Aquatic Resources Research and Development Agency (NARA)	Fisheries and Aquatic Resources Act No. 54 of 1981
15.	National Building Research Organization (NBRO)	Established by a cabinet decision
16.	National Institute of Fundamental Studies (NIFS)	Act No. 55 of 1981
17.	National Science Foundation (NSF)	Science and Technology Development Act No. 11 of 1994
18.	Sri Lanka Accreditation Board for Conformity Assessment	Sri Lanka Accreditation Board for Conformity Assessment Act. No. 32 of 2005
19.	Sri Lanka Council for Agricultural Research Policy (CARP)	Coconut Research Ordinance No. 24 of 1928.
20.	Sri Lanka Institute of Nanotechnology (SLINTEC)	Established in 2008 as a public-private partnership between the Government of Sri Lanka and five private companies
21.	Sri Lanka Standard Institute (SLSI)	Bureau of Ceylon Standards Act No. 38 of 1964. The Institution functioned under the name of Bureau of Ceylon Standards until the Act was repealed and replaced by the Sri Lanka Standards Institution Act No. 6 of 1984
22.	Tea Research Institute (TRI)	Tea Research (Amendment) Act (No. 57 of 1961)
23.	The Institute of Post Harvest Technology (IPHT)	State Agricultural Corporations Act. No. 11 of 1972