

QUALITY ASSURANCE IN RESEARCH IN THE UNIVERSITY FACULTIES AND OTHER RESEARCH INSTITUTES



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National Science Foundation



and
Quality Assurance and Accreditation Council
of the UGC

**QUALITY ASSURANCE IN RESEARCH
IN THE UNIVERSITY FACULTIES
AND THE RESEARCH INSTITUTES**

(A framework to improve the quality of research in terms of inputs,
processes, outputs and outcomes)

Prepared by the
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and
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**Quality Assurance and Accreditation Council
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GUIDELINES FOR A QUALITY ASSURANCE SYSTEM FOR RESEARCH IN UNIVERSITIES AND RESEARCH INSTITUTES

Preamble

Research provides the most fertile environment for training people and generating new ideas. The universities and research institutes promote an organizational culture for research, using public funds. This brings in a responsibility of accountability, and need for adherence to high standards of conduct in research.

Research involves organized generation of new knowledge based on carefully planned, and systematically executed activities together with exercise of the mind. It envisages a rigorous approach to practice in terms of design, procedures, analysis and interpretation of data. The generation and analysis of the new information leads to innovations. The process of generation and analysis of new information necessarily require mechanisms to assure quality during practice. There are well designed quality assurance systems operational today in the testing and research areas to ensure integrity of the results. In a well organized research system attention is paid to a clear organizational structure with well defined functions of individuals, the competence of persons carrying out research, compliance with safety and ethical considerations, maintenance of high professional standards, careful planning of research, documented operations, and document control procedures while maintaining the flexibility and independence necessary for the researcher to move into and handle new situations. The latter is essential in keeping the doors open for an innovative approach in research.

Considering the guidance necessary currently for improving quality of research, the NSF together with the Quality Assurance and Accreditation Council of UGC identified the following three major areas to be addressed initially, with a view to expand the quality assurance in research systematically.

1. Quality of research proposals and grant applications
2. Research process
3. Dissemination and utilization of research findings and cost benefits of research

Of the three areas the first and the third generally get reviewed externally by the peers in recommending the grant applications for funding and in accepting publications. The second aspect of assuring quality of the research process requires internal attention to minimize the risk of research output becoming compromised by poor research practices. This necessarily brings in a quality management structure for research, which could form a part of the commitment of the top management of the research organizations to ensure strengthening of the research process. The activity could be thus linked with the functioning of research committees at different levels of management in the Universities and Research Institutes (Annex 1). Transparency on the research process is increasingly becoming an important requirement identified by the research funding bodies. The three

areas are described below and a mechanism to assess the extent of practice and success in the three areas is given in Annex 2.

1. Quality of Research proposals / Grant applications

Many scientists owe their greatness to their wisdom of choosing the research problems and development of a hypothesis through inductive logic. The background leading to identification of a research problem, and the selection of formulated methods and their principles are documented in research proposals/ grant applications providing the opportunity for the reviewers to critically examine the merit of the proposed work. This helps both in enhancing the quality of research and success in research leading discoveries. The researchers need to follow the guidelines available for preparation of applications strictly and identify themselves the approach for an effective outcome and its application to the society. This aspect would be handled mostly by the organizations providing research grants or committees within the institutions addressing policy guidelines and targeted outputs.

2. The Research Process (Laboratory work/ field work/ data gathering/ data analysis etc.)

The practice of research at all levels carries inherently with it a certain amount of chaotic activities, sometimes jumping outside the planned sequence, frequent back-tracking and repetition steps at times, leading to frustrations among researchers. While these events are considered essential at times, leading to new areas of thinking and innovations, too much of chaotic activities and the problems faced by researchers in interpretation of data or lack of adequate information at the end phase of research could best be avoided by following a well organized series of activities. This needs application of quality assurance techniques. The quality assurance is a combined effort of the researchers and the research management system in the respective organizations. It is a two way process that keeps research at high standard. The expected activities cannot be left in the hands of one of the two parties. Such situations naturally lead to deterioration of research standards. The responsibilities and related activities in a progressive research system could be identified as follows.

Management responsibilities

- a) The senior managers in the Universities (Research Committees, Senate, Council) and Research Institutes (Research Committees, Research Directors, Governing Board) are responsible in providing adequate funds, an environment conducive to research, and a well defined long term research policy. The governing bodies need to address means for encouraging teamwork, development of appropriate research skills, maintenance of professionalism and adherence to ethical guidelines leading to creation of a sound research culture through appropriate policies.

- b) Unacceptable quality problems in research are caused mostly from inadequate attention to accepted standards in research, deliberate violations of accepted standards of research, human inadequacies in design, conduct, observations and interpretations in research, and limitations in funds. The research management bodies of the Universities and Institutes need to establish mechanisms to identify and address these issues at early stages of research projects. The weaknesses in these areas could best be addressed by setting up procedures and mechanisms for preventive actions and corrective actions during on-going processes of research. The actions should arise from within the researchers through regular observations and discussions among themselves as a complementary activity.
- c) The complementary activities may take the form of weekly informal discussions, regular research presentations and discussions within the research community, and with researchers from outside with a view to address issues of research quality, right from the beginning of the research process.
- d) Current practices in research essentially demand a multidisciplinary approach and it is extremely difficult for an individual researcher to maintain adequate competency in a wide spectrum of disciplines, especially in generating data using sophisticated equipment and in meaningful interpretation of data.

The human factor is the most important element in formulation and execution of research. The qualifications, experience and the competencies of the scientists need to be addressed and teams need to be built where necessary to enhance research quality, eliminating issues arising from human inadequacies.

- e) Research essentially involves in moving into new areas of knowledge, hitherto unexplored by others. This leaves much room to get misdirected among heaps of information or get diverted into specific subject areas due to personnel interests. The scientific discussions interaction with the research administration and self assessments help much in remaining aimed at the original targets of research.
- f) Researchers need to maintain high professional standards of honesty, openness, accountability and move away from conflicts of interest. Issues on plagiarism, infringement of intellectual property rights, fabrication of results, due recognition of contributions of coworkers, nondisclosure of published information are some of the activities that damages the researcher, the Institute and the research process. The research management systems need to identify mechanisms to prevent the researchers drifting away from professional standards.

A research management systems need to address above aspects to assure quality of research.

Technical requirements

The research results are generated through well planned interactions among, human environmental, equipment, procedural and many other factors. Sound technical interactions thus become an important component in assuring research quality. Some of the more important technical areas needing attention are discussed below.

a) Environmental control:

Many sophisticated equipment are used today to generate research data. Most of the equipment are highly sensitive to changes in environment, pollution and contaminant in the environment. Uncontrolled interactions of the environment with the equipment could lead to erroneous results. The problems arising during testing from fluctuations in temperature, relative humidity, vibrations, electromagnetic radiation, chemical and microbiological quality of air and their effects on results need to be understood in research. Appropriate control measures and maintenance of acceptable and recommended environmental standards is essential in the research laboratories and in locations where measuring equipment are used.

b) Measurement traceability:

The generation of data in research applies a variety of methods using equipment, reference materials, computer software, and test kits. Most of these “instruments” could serve as ‘Black boxes’ where an output is generated related to the inputs. The researcher needs to understand the input-output relationships and significance of generated information in relation to the research process. The information generated by the instruments need to be linked to the standard measurement units (mass, volume, temperature *etc*) so that the results become internationally comparable. The researchers need to address the following mechanisms to ensure the validity of the generated data and their international acceptability.

- i. Balances: Regular calibration of the balances by the national metrological body to ensure the accuracy of the readings. Daily check-weight on balances (other than internal calibration) to ensure the precision of data.
- ii. Volumetric apparatus: Measurement of weight of a volume delivered by the volumetric apparatus to ensure uniformity of results. (In purchasing glassware for research Class A glassware should be used)
- iii. Thermometers: Regular calibration by the national metrological body.
- iv. pH meters: Calibration using two buffers and checking a third buffer on a daily basis
- v. Sophisticated electronic measuring instruments: Preparation of the calibration curves on a regular basis and using readings only within the

recommended sectors of the calibration curve. Checking the results using standard reference materials, after each 5-7 test samples.

- vi. Computer software: Regular checking on results using a standard set of data.
- vii. Test kits: Ensuring that the kits are validated by the producers or testing organizations for the specific matrix to be analyzed using the kits.
- viii. Microbiological testing: Using ATCC microbiological standard cultures on regular basis to ensure the correctness of observations.

c) Sampling and sample handling:

Samples tested in research are expected to represent truly the conditions in the lot under examination. Well defined sampling and sample handling procedures are essential to ensure the validity of results from such exercises. Some of the biological materials in solid matrices show extremely inhomogeneous distribution of analytes. Research on such materials should be carried out based on well designed, statistically valid sampling plans with adequate number of samples tested to generate meaningful results.

It is also essential to adhere to sampling techniques that would prevent environmental pollution or contamination, meet time limitations between sampling and sample analysis, and temperature conditions during transport and storage of samples to ensure validity of results. All measures need to be taken to prevent environmental pollution due to disposal of samples, especially the contamination of water.

d) Document Control and Documentation

Document control involves acceptance of a set of documented, internationally acceptable, work procedures, test methods and record keeping procedures by consensus in an organization. Once the procedures and documents are accepted they are marked as controlled documents and followed strictly. Any modifications to such procedures are done only with consensus among the researchers and research management system. Application of the above concept to research is done mostly in relation to,

- i. Test methods to be used
- ii. Record keeping
- iii. Storage of records

Other examples of documentary evidence expected in research are given in Annex 1

Test methods: Researchers tend to obtain test methods from a variety of sources and at times modify the methods to suit the working conditions. A test method becomes internationally acceptable only if it is validated using rigorous procedures. Once validated the test method should be applied as it is, with no modifications whatsoever. Even with a

validated test method the analyst need to show competence through practice of the method and use of reference materials. In a document control system the test methods, sampling methods and sample handling should be documented and accepted before application.

Record keeping: It is said earlier that the research envisage certain degree of back-tracking and repetitions to ensure the validity of activities. This envisages examining the primary data repetitively with a view to alter the limitations of work, and take corrective and preventive actions where necessary. During analysis and interpretation of data re-examination of primary data becomes useful. Researchers must keep clear and accurate records of the methods, practices, results, thoughts, comments and conclusions on a daily basis. This information becomes necessary in addressing issues that may arise after publication and intellectual property right issues. Examination of regular record keeping by a senior researcher in the group would help much in quality assurance. Temperature, time relative humidity records of the environment and of equipment maintained on a daily basis or when in use, contributes much in interpretation of results, especially in identifying non-conformities during practice of research.

Storage of records: In many science areas the records are expected to be kept in storage for 5-10 years. Research data belongs to the organization or the funding bodies and it is the duty of the researchers to store the records in a fitting manner, to be used later if required. Stored data also becomes useful when new tools to analyze the data become available with progress in Science.

3. Dissemination and utilization of research findings and cost benefits of research

Generation and dissemination of new knowledge is a major function of the Universities and the research institutes. The ultimate quality of research is reflected in the quality of publications, among several other outcomes. Publication of research in cited journals and other peer reviewed journals are taken as good indicators of quality research. Selection of the appropriate communication network for research, with the view to obtain highest exposure to the scientific community engaged in one's research area lies in the hands of the researchers.

In publishing research the issue of authorship is important. The authors of a publication should only be the persons who contributed substantially to planning, execution, interpretation of research and writing. All authors are equally responsible for the contents in the publications and should possess capability to explain or defend the contents. Similarly no researcher should include the name of a person as author without his/her consent. Others who assisted in the research in different ways are expected to be acknowledged by the authors.

All research findings belong to the mankind and should be available for utilization by interested parties. The research becomes meaningful only if it could be used by the society and its cost benefits established through application. Researchers need to make all attempts to address this aspect as a social commitment.

This document identifies the criteria given below in recognizing high quality research.

- a) Publications in cited journals or equivalents only
- b) Patents that have been commercialized successfully
- c) Innovations that have led to new practices, new equipment *etc* and currently in commercial use
- d) Creations that have gained high recognition socially.
- e) Research that has lead to increased productivity / yields, and in wide practice in the broad agriculture and industrial sectors.
- f) New theories that have gained international recognition.
- g) Applications of scientific results that have lead to economic or social benefits at national level.
- h) Capacity building at the level of PhD

The researchers are expected to target high quality in research and get exposed to peer-review through journals of high international standing.

The guidance provided in this document, the responsibilities and commitments identified for establishing an effective research management system (Annex 1), and the framework for assessment of quality research at the level of faculties or Institutes (Annex 2) are proposed as a mechanism to achieve quality assurance in research, resulting in improved research standards. The documentation expected to be maintained to ensure a high level of transparency is listed in Annex 3.

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RESEARCH MANAGEMENT SYSTEM FOR THE UNIVERSITIES IN SRI LANKA

Preamble

The research in the universities operates as a part of education with participation of academic staff members, and the students (postgraduate and undergraduate), with the technical officers playing an important supportive role. In general, the subject areas for research are decided by the academics in-keeping with the research priorities in the Faculty or based on personal academic interests, with concern on national needs. Research may also take a complete academic outlook as a means of generating new knowledge. University research has emphasis on research training at the level of first degree and in postgraduate studies, culminating at the highest level of PhD degrees. Independent research by academics also may take the form of postdoctoral studies.

Academics are freed to decide on research based on their interests, secure grants from outside bodies and utilize the grants for predetermined and identified purposes in research. In most situations the finances are handled by the accounts branch of the universities adhering to documented purposes in the research grant applications and agreements with funding bodies. Some researchers may operate their funds from the grant awarding institutions.

The researchers are directly responsible for their expenditure, publications, patenting and dissemination of information to the grant awarding bodies. Award of a research grant also imply or brings in to agreement (written or otherwise) that the University contributes, takes the responsibility, and get the benefits of the research generated using the funds awarded under the grants.

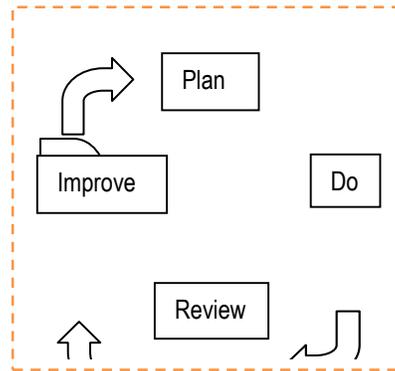
The research studies carried out in the universities, irrespective of the source of funds, are supported by infrastructure facilities provided by the universities, published under the address of the universities, and bring in direct benefits as a part of teaching / research training activity of the universities. A quality assurance system for research would contribute much to improve the standards of research and assist the academics and students to exhibit high level of competency. This proposal by the NSF/UGC identifying mechanisms of assessing quality envisage assessing three areas identified in the parent document. In order to make the research process more effective this document proposes a strong research management structure, in-line with the existing activities identifying functions of the management team.

The management team/s is basically expected to address issues leading to improved performance in research addressing the following four basic questions.

1. What are you (research scientists) trying to do?
2. How are you doing it?

3. How do you know that you are achieving the objectives?
4. How will you improve by bringing in changes to your plans, and actions?

The answers to the four questions are expected to generate a cycle of planning, activity, reviewing and continuous improvement.



The proposed research management structure in the universities is expected to operate on the concept given above with the specific functions identified for functioning of research committees at the level of the University Senate and the Faculty / Postgraduate Institute. The role of executives and the functions proposed for a research management structure in the universities are given below.

Responsibilities of the Research Management System

Promotion and support for research:

Council: Develop overall policy on research, research support systems and research management systems for the University.

Vice Chancellor and Director, Research & Development: Implement research policy through appropriate mechanisms to encourage research and maintain high quality standards with transparency.

Senate: Ensure high academic standards are maintained in research and the research scientists and research are recognized in the form of awards *etc.*

Senate Research Committee: Implement measures necessary to provide support services and maintain overall quality of research conducted in the University, including compliance with national research needs and management policies of the University.

Deans and the Faculty Research Committees: Ensure maintenance of quality of research at the Faculty level.

Duties of the Research Committees

University Senate Research Committee

The University Senate as the supreme academic body is responsible for ensuring that the arrangements are in place to:

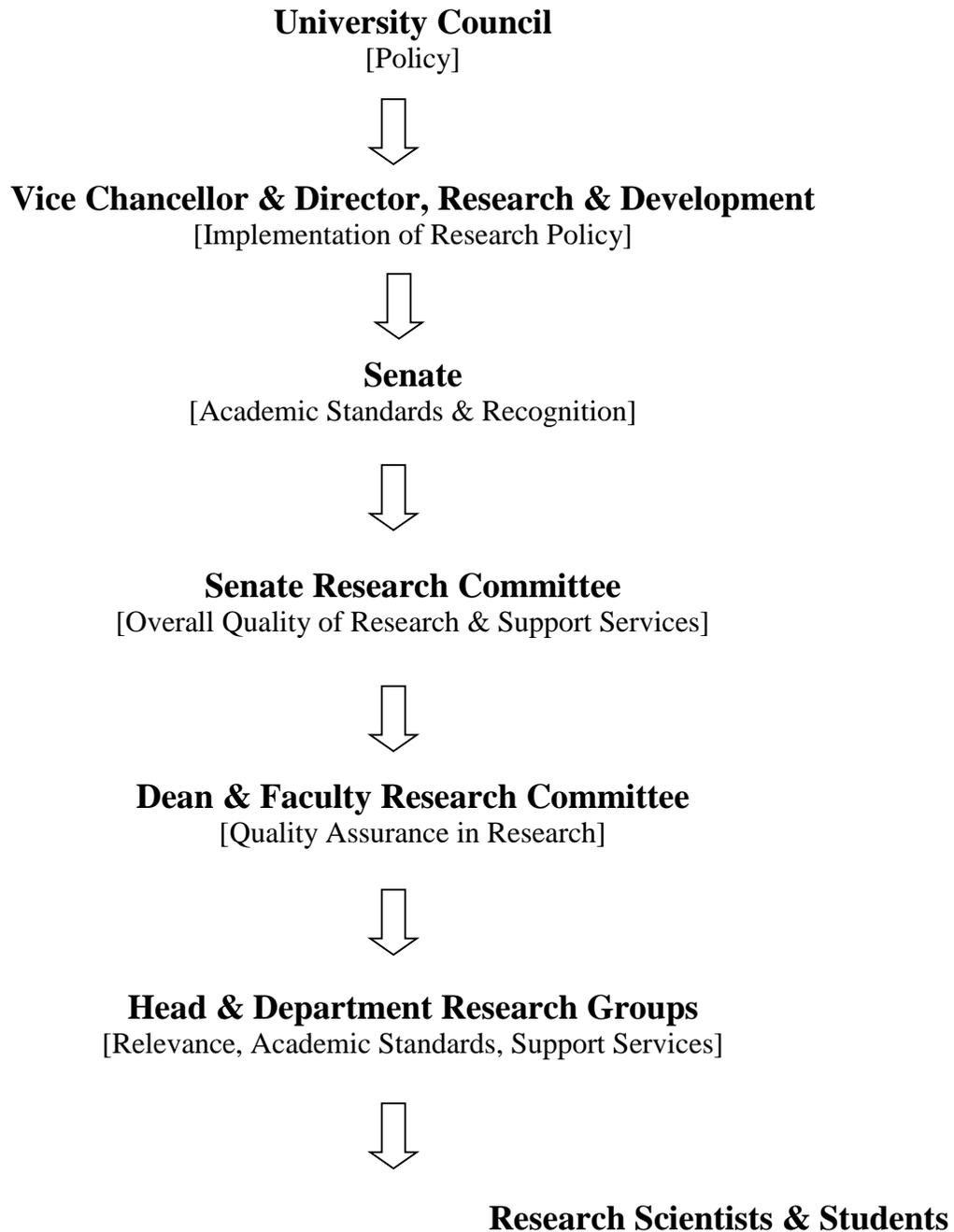
- a) Stimulate research, encouraging critical self evaluation, and maintain high quality standards in performance.
- b) Provide a dynamic environment through encouragement of research, serving as a mediator with the University Council and the academics.
- c) Provide guidance, evaluations and mechanisms for improvement of research through the Senate Research Committee chaired by the Vice Chancellor.
- d) Serve as an apex body to coordinate the activities of Faculty Research Committees.
- e) Ensure the funds allocated by the University are used to generate research of high standard.
- f) Prepare an annual report to be published in the University Statistics Publication.
- g) Conduct an annual review meeting chaired by the Vice Chancellor to discuss the University research as an enterprise.

Faculty / Postgraduate Institute Research Committees

The Faculty / PGI Research Committees form the direct liaison between the research scientists and the Faculty on one side, and form the link with the Senate Research Committee on the other side. The committee would be expected to:

- a) Promote through monitoring the application of academic standards to all modes and sites of research.
- b) Arrange for regular peer review of quality assurance in the research process.
- c) Provide an environment for development of research culture at the Faculty level.
- d) Provide a platform for discussing the new knowledge generated through research.
- e) Encourage the use of information generated by research for teaching.
- f) Evaluate the quality of research proposals submitted for funding to University and recommend.
- g) Review the publications prior to submission assisting in improvement.
- h) Use performance indicators to evaluate research.
- i) Prepare an annual report through the Faculty to the Senate Research Committee.

**ORGANIZATIONAL STRUCTURE FOR
RESEARCH MANAGEMENT STURCTURE IN THE UNIVERSITIES**



CHECK LIST FOR EVALUATION OF RESEARCH QUALITY IN THE FACULTIES (University) or INSTITUTES (Research)

[Evaluators together with research scientists are expected to mark the status of activities for the last 3 year period in the form given below. From the sections that are applicable to a given situation, it is proposed to recognize percent achievement and use it as a means to assign a star grading system for research quality in the faculties or Research Institutes. This rating would form a basis for funding of research by the funding bodies and from within the university]

0 = This criterion is not met at all 2 = This criterion is met partly
 1 = This criterion is met slightly 3 = This criterion is met fully
 NA = This criterion is not applicable

No	Criteria for assessment	0	1	2	3	NA	Comments
1	QUALITY OF PROPOSALS & GRANT APPLICATIONS						
1.1	Unit has secured funds from outside during last 3 years						
1.2	All the funds received have been utilized for research during the last 3 years						
1.3	Funds made available to the unit by the treasury have been utilized completely during last 3 years						
1.4	Unit has entered in to agreements with the industry to generate research in specific projects						
2	RESEARCH PROCESS						
	MANAGEMENT RESPONSIBILITIES						
2.1	The laboratory is managed in such a way that it operates independently, and it is free from external influences on handling research data.						
2.2	The senior management is committed to maintain a quality management system and agreed to provide resources for it.						
2.3	There is an organogram identifying the line of responsibilities in relation to research in the Unit.						
2.4	The research and technical staff members are committed to meet requirements of the quality system all times.						
2.5	The responsibilities of persons in the research system and the quality management activities are well defined.						
2.6	Persons taking up research are adequately qualified to work in the respective research areas.						
2.7	Teamwork is encouraged by the management.						
2.8	Regular research discussions with participation of management are held to bring in improvements.						
2.9	Measures are in place and implemented to maintain ethical standards in conducting and publishing research.						
	TECHNICAL REQUIREMENTS						
	(a) Environment control						

2.9	The laboratory maintains the environmental standards required to operate the equipment (temperature, relative humidity, chemical & microbiological quality of air) and generate reliable test results.						
2.10	Daily records of the environmental monitoring are maintained.						
	(b) Measurement traceability						
2.11	The equipment used to measure mass, volume and temperature in the laboratories is calibrated on a planned schedule to ensure the traceability of results to international system.						
2.12	Intermediate checks are performed frequently to understand the accuracy of performance of mass, volume and temperature measuring equipment.						
2.13	Where sophisticated equipment is used to generate qualitative and quantitative data, the performance of the equipment are checked on a daily basis using standard reference materials along with samples.						
2.14	Where sophisticated equipment is used to generate quantitative data, the calibration curves are prepared and test results obtained only within the calibrated points.						
2.15	Reference substances and cultures are used to ensure the validity of test results.						
2.16	The chemicals used for testing purposes are of appropriate grade and purity with quality assurance information obtained from the suppliers.						
2.17	The microbiological reagents, enzymes and other biological material are of certified quality for biological activity by the suppliers.						
2.18	Where test kits are used to generate research data, the kits are validated for the matrix under investigation.						
2.19	Where computer software is used to calculate and interpret results, the software is checked regularly using standard sets of data.						
	(c) Sampling and sample handling						
2.20	Well defined sampling plans, taking the inhomogeneities of distribution of the analytes, are used in collecting samples for testing.						
2.21	The samples are packed, transported, stored and tested within specified durations to retain the integrity of samples.						
2.22	The sampling methods are documented in the laboratory prior to practice.						
2.23	Documentary evidence pertaining to proper practice of the sampling methods is available in the laboratory.						
	(d) Document control and documentation						
2.24	The test methods used are validated internationally.						
2.25	The test methods used are checked for their suitability for the purpose using spiked samples and repeatability.						
2.26	The interactions by other components in the matrix during performance of the tests are well understood.						

Item	Notes
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2.27	If any changes in the validated and published test methods are done, the modifications are validated before application.						
2.28	The test methods and the protocols used are documented in the laboratory prior to use.						
2.29	The environment control conditions required in performing the tests are maintained and records of them are available.						
2.30	All primary data generated during research are legibly written and available for a predetermined period in the laboratory.						
2.31	Where results generated in other laboratories are used, there are mechanisms to ensure that the steps mentioned in this document are practiced by them.						
2.32	Where a researcher move into another position, the data are handed over to the institute.						
2.33	Outcome of all discussions related to research in progress are documented.						
2.34	The Unit carryout an annual quality review to identify improvements, implement preventive actions and assess the outcome of corrective actions.						
2.35	The Unit operates an approved publication policy with authorization procedures.						
2.36	Records of discussions and outcome on publication policy and publications are documented.						
3	Dissemination and utilization of research findings						
3.1	Unit has published research in cited journals during last 3 years.						
3.2	Unit has published research in other journals during the last 3 years.						
3.3	Unit has obtained patents during the last 3 years						
3.4	Patents generated in the unit have been commercialized during the last 3 years.						
3.5	Innovations that have led to new practices, new equipment <i>etc.</i> , are currently in commercial use.						
3.6	Creations of the unit have gained high recognition socially.						
3.7	Research has led to increased productivity / yields and in wide practice in the broad areas of agriculture/ industry.						
3.8	Research has found solutions to health related problems of humans and animals.						
3.9	New theories have gained international recognition						
3.10	Applications of scientific results have led to economic or social benefits at national level.						
3.11	Unit has contributed to capacity building by research leading to PhD.						
3.12	Awards of recognition have been received by the Unit or researchers at national / international level						
	TOTAL applicable points						
	TOTAL obtained points						
	Percentage						
1	The unit to be assessed would be the Faculties in the Universities or the Research Institutes.						

2	The units may be graded in the following way 50% of points out of total applicable to a given situation ** 65% of points out of total applicable to a given situation *** 80% of points out of total applicable to a given situation ****
3	The points will be calculated for the three areas separately, and the Unit should score more than 40% in each of the areas to be considered for star grading system

Examples of documentary evidence expected related to quality issues in research
(modified from publication of University of Reading, 2006)

	Quality issue	Evidence
1.	Responsibilities	Organizational structure indicating line of management responsibilities
2.	Professional standards	Memberships of relevant professional bodies and adherence to their guidelines
3.	Project planning	Approved research plan with milestones Statistically validated research plan and procedures for data analysis
4.	Competence and training	Curriculum vitae, training records
5.	Health and safety	Institute safety policy Documentation of specific precautionary measures
6.	Facilities and equipment	Maintenance and calibration records of equipment Use of standard reference material Application of environment control measures and good laboratory practices (GLP)
7.	Documentation of procedures and methods	Approved validated methods and protocols Evidence of competency in practice of selected methods Document control procedures
8.	Research work and records	Laboratory note books or indexed computer data files Records of communication with other researchers, collaborators <i>etc.</i> Archiving of documents
9.	Handling of samples and materials	Procedure for receiving samples, labeling and tracking them. Storage log books
10.	Quality control	Internal quality review procedures and minutes
11.	Publication of research	Approved publication policy with authorization procedures, where applicable.