CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The simplest meaning of research\(^1\) is re search or search again. Kothari (1999) describes it as the search for knowledge through objective and systematic method of finding a solution.

Unlike pure laboratory research or field application of laboratory results, the social science research\(^2\) is often confronted with the question of its scientific nature, its sample size, nature of hypothesis or the mode of analysis (Mouly & Sankaran, 1995). As a result, social science researchers have become increasingly careful to conduct systematic studies in their research taking both qualitative and quantitative methods into account. Though the origin of sociological statistics\(^3\) can be traced far back, it was not until the mid twentieth century the statistical methods were used extensively in wide variety of areas of social research.

Further, both strategy and planning are important for any research. Strategy means more than planning a study and more than decisions made as to its execution.

Strategy

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\(^1\) According to the Oxford Advanced Learners Dictionary, the term 'research' is “a careful study of a subject, especially in order to discover new facts or more information about it”.

\(^2\) Social science research is a systematic method of exploring, analyzing and conceptualizing social life into order to extend, correct or verify knowledge whether that knowledge aid in the construction of a theory or in the practice of an art (Young, 1996).

\(^3\) The systematic collection of sociological statistics originated in Germany towards the end of the eighteenth century. In its earliest form it was an attempt to access, for political purposes, the relative strengths of the German states by comparing such things as population, industrial and agricultural outputs. In England, statistics is a legacy of the Napoleonic wars. In order to raise the new taxes that the cost of war demanded, it was found necessary to begin that systematic collection of numerical data which would enable the government departments to base their expectation of revenues and expenditures with more precision than had hitherto been required. The age of form filling had begun and with it began the development of that branch of applied mathematics, which provides us with systematic methods of analyzing large numbers of numerical facts (Brooks and Dick, 1972).
refers also to personal values and standards of conduct during investigation. While
the investigator is intent on obtaining reliable, verifiable and measurable data he or
she must do it without embarrassment or harassment to the informants or agencies
from which data are secured or by which they are verified. Research planning on
the other hand is nothing but series of actions or steps necessary to effectively carry
out research and the desired sequencing of these steps. There are various steps
involved in a research process, which are not mutually exclusive; nor they are
distinct, they do not necessarily follow each other in any specific order and the
researcher has to be constantly anticipating at each step in the research process and
the requirements of the subsequent steps. However, the following flowchart
effectively illustrates the research process (Figure 3.1).

![Research Process Flowchart](image)

**Figure 3.1: Research Process Flowchart** (Source: Kothari, 1999).
3.2 Steps considered in formulating the topic and research problem

Initiation is the most crucial part of any inquiry. According to Northrop (1937) in his book "Philosophies of Science":

“One may have the most rigorous method of investigation, but, if a false or superficial beginning is made, rigor ater on will never retrieve the situation. It is like a ship leaving port for a distant destination. A very slightest erroneous deviation in taking one’s bearings at the beginning may result in entirely missing one’s mark at the end, regardless of the sturdiness of one’s craft or the excellence of one’s subsequent seamanship”

3.2.1 Selection of a topic

Often the same general topic can be approached either with an emphasis on contributing to the solution of a social problem or with an emphasis on contributing to theoretical knowledge; frequently, there is a combination of both kind of interest. The researcher’s personal interests and value judgments can be an important factor. Thus he or she may personally incline or to have a preference for a certain type of topic or may be averse or have a dislike for doing other types of topics due to the hardships involved (e.g. in doing a study of poverty, the researcher may have to work in unhealthy or unwholesome surroundings). At the same time, the personal values of the researcher should not be allowed to influence the outcomes of research.

The reason for my selection of the topic “the national agricultural research systems” is mainly due to the interest developed in me when working as the Co-ordinator to the Committee on agricultural research funding, at the National Science Foundation of Sri Lanka for the past twelve years. During this period I have learned and read a lot about national agricultural systems in other countries and have always wanted to study the subject as to what measures that one could consider to improve the same in my country. Naturally, the NARS in India attracted me much and the topic found to be quite interesting due to the reasons mentioned in the scope of this thesis.
3.2.2 Selection of a research problem
Moving from the selection of a topic to the selection of a research problem is essential since it will help the researcher to avoid (a) collecting data which will later prove to be useless or unnecessary, (b) using methods which will later prove to be inadequate or irrelevant and (c) wasting time and money in doing (a) & (b).

During the past twelve years, I have been closely associating with the agricultural science community in Sri Lanka through the research grants awarded to them by the National Science foundation. Listening to their problems, difficulties, positive and negative issues in the Sri Lankan system in regard to their research productivity, publications and so on made me get interested in the sociological aspects of the scientific community that paved the way to my research problem. Since rice is the staple food and top priority crop in Sri Lanka, to narrow down the research problem, the field of rice research was selected by me to work on for this PhD thesis.

The next important thing was the understanding of the problem thoroughly and rephrasing the same into meaningful terms from an analytical point of view. At the very outset, the complexity of the "National Agricultural Research Systems" in the two countries and the importance of S&T development in rice research were examined by the use of available literature (both concerning the concepts and theories and the empirical literature consisting of studies made earlier which are similar to the one proposed). The subject was further discussed with the two supervisors taking their advice. It was also discussed with the other faculty members and my colleagues. Finally, the limitations of, mainly time, funds and other resources were taken into consideration and the present research topic was agreed upon.
3.3 Formulating-working hypotheses

Working hypotheses are usually formulated after extensive survey of literature is over. They are tentative assumptions made in order to draw out and test their logical or empirical consequences. They arise as a result of a priori thinking about the subject, examination of the available data and material including related studies and the counsel of experts (Kothari, 1999). These assumptions are made on the basis of probabilities, shrewd guesses and profound hunches (Young, 1996).

According to Cohen and Nagal (1934), "1) the function of a hypothesis is to direct our search for the order among facts... 2) it is of considerable advantage of a systematic inquiry begun with a suggested explanation or solution of a difficulty which originated it. Such tentative explanations are suggested to us by something in the subject matter and our previous knowledge". ¹

Without a working hypothesis the explorer finds it very difficult, laborious and time consuming to make adequate discrimination in the complex interplay of factors before him. According to George Lundberg (1972), experienced social researcher and theorist: "The only difference between gathering data without an hypothesis and gathering them with one is, that in the latter case we deliberately recognize the limitations of our field of investigation so as to permit a greater concentration to attention on the particular aspects which, past experience leads us to believe, are significant for our purpose". ²

¹ The above quotation has been drawn from book by P.V. Young (1996).
² The above quotation was drawn from book by P.V. Young (1996).

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3.3.1 Hypotheses formulated to guide the research

Based on the questions arisen from the literature survey, the following hypotheses were formulated to be tested relevant to the three levels of this study as indicated in the Chapter 2.

**Level (1): National Agricultural Research Systems**

(H1)- Institutional and organizational linkages between different actors (in the NARS) are as important as R&D factors in infusing dynamism.

(H2)- Constitution of scientific communities and professionalisation are the important determining factors for characterizing the weak (under developed and not well established) or strong (effective, well established and developed) NARS in the national contexts.

(H3)- NARS in Sri Lanka is weak and less established compared to the same in India.

**Level 2: Rice science community**

(H4)- Rice research component in Indian NARS is more effective and strong compared to the same in Sri Lanka.

(H5)- Strong or weak rice research component in NARS is highly determined by the notion of scientific community and professionalisation.

**Level 3: Contribution and research productivity of rice scientists**

(H6)- Various organizational and institutional factors are more important in determining the research productivity of rice scientists than the national contexts.

(H7)- Publication of research is more likely to be taken as the criteria for evaluation of the productivity of rice scientists compared to other factors.

(H8)- Rewards and recognition determine the productivity of rice scientists compared to other factors.
The above hypotheses were tested in order to make recommendations in the light of the outcome of the project.

3.4 The research methodology adopted

As regards research methodology of this PhD project, two case studies\footnote{The case study is but one of several ways of doing social science research. Other ways include experiments, surveys, histories and the analysis of archival information (as in economic studies). Each strategy has peculiar advantages and disadvantages, depending upon three conditions: (a) type of research question, (b) the control the investigator has over actual behavioral events, and (c) the focused on contemporary as opposed to historical phenomena. In brief, the case study allows an investigation to retain the holistic and meaningful characteristics of real-life events such as individual life cycles, organizational and managerial processes, neighbourhood change, international relations and the maturation of the industries (Yin, 1994). The essence of a case study or in other words, the central tendency among all types of case study, is that it tries to illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what result, see Schramm (1971).} for India and Sri Lanka were conducted to throw light on historical development of NARS in general and the S&T development in rice production in particular. The study of sociological aspects of rice scientists combined with the science policy issues was also included in the entire analytical framework.

The case study research methodology adopted in this project, was according to the guidelines given in the book, *Case study research - Design and methods* by Robert.K.Yin (1994). According to Yin, the case studies, as a research strategy, are used in many situations such as policy, political science, public administration research, and community psychology and sociology, organizational and management studies, city and regional planning research, the conduct of dissertations and thesis in the social sciences etc.

The evidence or collection of data may come from six sources: documents, archival records, structured questionnaire and interviews, direct observations, participant-observations and physical artifacts. One should note that no single source has a complete advantage over the others. In fact, the various sources are
highly complementary and a good case study will therefore want to use as many sources as possible or in other words multiple sources of evidence\(^1\) (Yin, 1994).

**Documentation**

Documentary information is relevant to every case study topic. This type of information can take many forms and should be the object of data collection plans. The variety of documents could be books, journals, letters, memoranda, reports, announcements, minutes of meetings, statements, proposals, newspaper clippings, and other articles appearing in the mass media. Documents can corroborate and augment evidence, specific details from other sources, and inferences. Because of their overall value, documents play an explicit role in any data collection in doing case studies. Systematic searches for relevant documents are important in any data collection plan.

**Archival records**

For many case studies, archival records such as service records, organizational records, maps and charts of the geographic characteristics of a place, list of names and other relevant commodities, survey data collected about a 'site', personal records etc., will be important. However, unlike documentary evidence, the usefulness of these archival records will vary from case study to case study. For some studies, the records can be so important that they can become the object of extensive retrieval and analysis, i.e. historical studies. In other studies, they may be of only passing relevance.

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\(^1\) One example of a case study that used multiple source of evidence is a book by Gross *et al.*, *Implementing Organization Innovations* (1971), covering events in a single school. The case study included a structured survey of a larger number of teachers, open-ended interviews with a smaller number of key persons, and observational protocol for measuring the time that students spent on various tasks, and a review of organizational documents. Both the survey and the observational procedures led to quantitative information about attitudes and behaviour in the school, whereas the open-ended interviews and documentary evidence led to qualitative information. All sources of evidence were reviewed and analyzed together, so that the case study's findings were based on the convergence of information from different sources, not qualitative and quantitative data alone.
Structured questionnaire/direct interviews

One of the most important sources of case study information is the structured questionnaire and interviews. These may take several forms. Most commonly, for case studies, the direct interviews\(^1\) are of open-ended nature, in which the investigator can ask respondents for the facts of a matter as well as for the respondents' opinions about events. In some situation, one may even ask the respondent to propose his or her own insights into certain occurrences and may use such propositions as basis for further inquiry.

A structured questionnaire survey could be designed as part of a case study. This situation would be relevant, for instance, if the researcher were doing a case study of a neighbourhood, institution or an organization, so the residents or the employees would be part of the case study. This type of survey would involve the sampling procedures and it would subsequently be analyzed in a similar manner.

Direct observations

By making a field visit to the case study 'site', the researcher can create an opportunity for direct observation and get first hand experience with scientists working in the laboratories through informal discussions and recording their views. Assuming that the phenomena of interest have not been purely historical, some relevant behaviors or environmental conditions will be available for observations. Such observations serve as yet another source of evidence, especially in comparative perspectives in a case study involving cross-national exploration.

Less formally, direct observations might be made throughout a field visit, including those occasions during which other evidence, such as that from

\(^1\) In social science research methodology, the 'interview' is a research interview, design for the purpose of improving knowledge. It is a special type of conversational interaction, which has special features that need to be understood. It has to be planned and prepared for like other forms of research activity but what is planned is a half-script or quarter script interview: Its questions are only partially prepared in advance (semi-structured) and will therefore be largely improvised by the researcher as interviewer. But the interview as a whole is a joint production by the researcher and the interview. see, Wengraf (2001).
interviews, is being collected. For instance, the condition of buildings or workspaces will indicate something about the climate or impoverishment of an organization; similarly, the location or the furnishings of a respondent’s office may be one indicator of the status of the respondent within an organization.

Observation evidence is often useful in providing additional information about the topic being studied. If a case study is about, for instance, a new technology, the observations of the technology at work are invaluable aids to any further understanding of the limits or problems with the technology.

**Participant-observation**

This is a special mode of observation in which the researcher is not merely a passive observer. Instead, he or she may assume a variety of roles within a case study situation and may actually participate in the events being studied. In urban neighbourhoods, for instance, these roles may change from having casual social interactions with various residents to undertaking specific functional activities within the neighbourhood (see Yin, 1982a). Here, the researcher is expected to be a participant in the particular environment and he may have to live there for a minimum period of three months. This technique has been most frequently used in anthropological research studies.

**Physical artifacts**

A final source of evidence is a physical or cultural artifact, a technological device, a tool or instrument, a work of art, or some physical evidence. Such artifacts may be studied in the institution where they are developed as a part of field visit to find out how feasible they are for practical use.

Therefore, depending on the field, area and the topic of the research project, and the time availability for completion of the project, the researcher can decide on what type of sources of information to be used in the methodology. However, one
analysis of case study methods found that those case studies using multiple source of information or evidence were rated more highly, in terms of their overall quality, than those relied only on single source of information (see Yin, Bateman and Moore, 1983).

**Data collection methods used in this study**

Considering all the methods described above, it was decided to use the following information sources to collect data for this study.

i) documentation for building up literature review

ii) archival records for historical development*(used only to a limited extent)

iii) structured questionnaire survey

iv) open-ended direct interviews

iv) direct observation**((By field trips to rice research institutes to get first hand experience with scientists working in the laboratories)

3.5 Designing of the questionnaire

Questionnaire designing is the most significant part in conducting a survey. The most important part of the actual design of question is, for who is to be answered by and how the researcher then intends to interpret it. The contents of the questionnaire directly influence the final result. Therefore, a well-prepared questionnaire is part and parcel to obtain more accurate results. The following steps were carefully considered before designing the questionnaire.

**Step 1: Planning questionnaire research**

- Consider the advantages and disadvantages of using a questionnaire.
- Prepare written objectives for the questionnaire
- Review the objectives of the questionnaire to others
- Review the literature related to the objectives of the questionnaire
- Determine the feasibility of administering the questionnaire in regard to the population of interest
- Prepare a time frame
Step 2: Preparing a questionnaire for administration

- Prepare the same questionnaire in a different form for easy administration purposes of the researcher.

The questionnaire (Appendix-3.1) was designed to obtain following information.

<table>
<thead>
<tr>
<th>Question No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- (i-vi)</td>
<td>Personal information</td>
</tr>
<tr>
<td>2</td>
<td>Educational qualifications</td>
</tr>
<tr>
<td>3- (i-vii)</td>
<td>Goal orientation of research</td>
</tr>
<tr>
<td>4</td>
<td>Time allocation for R&amp;D</td>
</tr>
<tr>
<td>5- (i-vii)</td>
<td>Rewards and recognition in the institute</td>
</tr>
<tr>
<td>6- (i-x)</td>
<td>Research climate</td>
</tr>
<tr>
<td>7- (i-iii)</td>
<td>Linkages of structure</td>
</tr>
<tr>
<td>8</td>
<td>Research collaboration</td>
</tr>
<tr>
<td>9- (i-iv)</td>
<td>Research productivity</td>
</tr>
<tr>
<td>10</td>
<td>Participation at seminars/workshops</td>
</tr>
<tr>
<td>11</td>
<td>Eminent scientists and best journals for publication</td>
</tr>
</tbody>
</table>

The draft questionnaire was reviewed by scientists at different capacities and was pre-tested with some of the research officers in the NARS of India and Sri Lanka. This helped to identify some factors, which were not considered before. Their comments were incorporated when the final questionnaire was prepared. The questionnaire was further examined by an Applied Statistician in the Department of Statistics and Computer Science; University of Colombo, Sri Lanka for feasibility of statistical analysis and further revised.

3.5.1 Importance of the selected questions

3.5.1a Structured Questionnaire

Questions 1 and 2 were asked as an identification problem. Each item under questions 1 and 2 were aimed at obtaining the personal information and the academic background of the scientists. Since the study was concentrated on the contribution of scientists to rice research,
the item number (iv): years of R&D experience and the item number (v): year of joining the institute, under the question number 1 were asked to calculate their research productivity.

The rest of the questions from the number 3-12 were aimed to identify the sociological aspects of rice scientists. Since it was important to know the attitudes of the scientists in regard to their goal orientations of research, various aspects relevant to goal orientations were asked under the question number 3.

*Time allocation* of scientists for R&D is another important aspect for the overall development of the science and technology of a particular country and thus, the question number 4 was formulated.

It is equally important to address the issues concerning the morale of the scientists as a community. There are certain issues relevant to this subject that will give them the opportunity to organize as a strong community. The idea behind the inclusion of the question number 5: *Rewards and Recognition* was to identify such issues.

*Research climate* in the institute where the scientists work strongly affect their work and the research productivity, since it is a known factor that the scientists are a sensitive group of human beings. Thus, the research climate around the scientists could be a sociologically important factor and the data on which can be used for analysis of contribution to research by scientists or to study the research productivity of scientists. Therefore, the question number 6 was formulated.

Question 7 and 8 were formulated to find out to what extent the rice scientists have organized at the national level as a community in regard to rice research in the two countries. *Structural linkages* among other institutes and the universities and also, the *national level collaboration of rice research* projects will explain this issue to some extent.
It was decided to consider the research productivity of rice scientists as a partial measure to evaluate their contribution to rice research. The question 9 was formulated to get the information on the research productivity by means of their research publications, patents obtained and awards received and so on.

Acquisition of new knowledge is another important factor for the HRD of the scientific community that will help them to work on a par with the advanced research culture in anywhere in the world. Frequency of participation at seminars, meetings and workshops at local and international level, therefore, is of much value. The question 10 was included to get information on this issue.

Finally, it was decided to learn about the eminent rice scientists and the popular local and international journals for publication of rice research so as to gather more information on the rice scientists as a recognized community and their contribution to rice research. The questions 11 and 12 were aimed at this.

It must also be mentioned that the questionnaire was limited to twelve simple questions and designed as a close-ended structured questionnaire so as to make it easy to the scientists to respond positively. Further, an appropriately drafted covering letter stating the rationale for selecting this particular title and the objectives of the project was also attached with the questionnaire, personally addressing to each scientist (Appendix 3.2).

3.5.1b Questions used for the direct interviews
The direct interviews were held mainly to aim at the issues or questions that were arisen during and after the literature survey of this study relevant to the NARS of the two countries. The particular questions (Appendix 3.3) were formulated focusing on the administrative, policy and sociological perspectives of the

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1 Many scientists in the two institutes in India and Sri Lanka, who were included in the sample for the structured questionnaire survey, commented saying, 'You have drafted the covering letter in such a nice way that we simply could not refuse to respond'.
agricultural research, based on which the NARS of the two countries have been established. Not all the questions were asked from all the persons interviewed, but depending on their area of specialty and experience in the different sectors, the suitable questions were selected for each case. Emphasis was made as much as possible to get the interviewee into in-depth discussions on the important issues.

3.6 Selection of the research site

It is also important to justify for or rationalization of the choice of the research sites. Sri Lanka has one rice research institute namely the Rice Research and Development Institute (RR&DI) at Batalagoda, Ibbagamuwa. In the case of India, there are two rice research institutes namely, the Central Rice Research Institute (CRRI) at Cuttack, Orissa and the Rice Research Directorate (DRR) at Rajendranagar, Hyderabad. Out of the two, the CRRI is the older institute, which was established in 1946 during the same period similar to RR&DI in Sri Lanka, which was established in 1952. The DRR on the other hand, established as a national project in 1965 and then was upgraded in 1988. Also, compared to DRR, the CRRI and RRDI share similarities being located in the isolated research environments, a little away from the main town area. Since I had visited the DRR previously in 1999, I felt that for comparison, the selection of the CRRI as the Indian institute was more meaningful for me to study the growth and development of rice research within the framework of NARS.

3.7 Sampling of Data

Given below were the facts considered before selecting a sample of respondents.

- Identify the accessible population.
- Avoid use of samples of convenience

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\[1\] According to Wengraf (2001), to get into something 'in depth' is to get a more detailed knowledge about it and to get a deep understanding of how little the researcher knows about it. See, Rorty (2000) for recasting of the concept of 'depth' into one of 'width'.
- Use of Simple random sampling is desirable
- Determine correct sample size for getting precise results
- Use of a larger sample does not compensate for a bias or reliability

Also considering the time constraints, funds and resources available, the following sample size was selected for this study.

In the case of CRRI (India), a list of the 93 scientists was prepared according to the alphabetical order and every other scientist in the list was counted as the sample, which were 46. Out of the 46 scientists, 3 were away on leave from the institute (during my stay at the institute) for a substantial period either for training or higher studies. In the case of RRDI (Sri Lanka), only one scientist out of the 22 scientists was on long-term study leave during my questionnaire survey.

3.8 Collection of Data

| • Direct Interviews | - A sample of 25 scientists from each country was selected. As for India, they represented ICAR, IARI, CRRI, DRR, NAARM, NCAP, NISTADS, ICGB, NCPGR, SAUs etc.. As for Sri Lanka, they represented CARP, DOA, DEA, RRDI, PGIA, HKARTI, TRI, RRI, IPHT and faculties of agriculture etc. |
| • Structured Questionnaire | - CRRI (India) - the number of scientists, who were actively involved in R&D, at the time of the questionnaire survey, was 93. A 50% sample was taken. RRDI (Sri Lanka) – had only 22 scientists, who were actively involved in R&D, at the time of the questionnaire survey. Therefore, the total population was considered. |

What is the exact size of the Indian sample? \( 46 - 3 = 43 \)

Give a table indicating organizational affiliation of each of the scientists in the sample.
Both primary and secondary data were collected under this project by qualitative and quantitative means.

<table>
<thead>
<tr>
<th>Qualitative data</th>
<th>From the literature, interviews with key informants, structured questionnaire, records available and direct observation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative data</td>
<td>From the available statistical records and the structured questionnaire.</td>
</tr>
</tbody>
</table>

Primary data were collected from the direct interviews, structured questionnaire and direct observation for the year 2002.

Secondary data were collected from archival records, books, annual reports of the institutes, journals, magazines, newspaper clippings, data bases and web sites in the internet covering the period 1850s - 2002.

The details of the study conducted to collect data under each information source are presented below.

(i) Documentation for building up literature review

({Books, journals, magazines, reports, minutes of meetings, statements, newspaper clippings, records, data bases, CD-ROM searches, relevant websites in the internet etc. was used}).

(ii) Archival records for historical development.

{It was noted that in the case of India, the historical development of NARS has well been documented. But for Sri Lanka it was necessary to visit the Sri Lanka Archives to get certain clarifications and more information on the issues that had already been reviewed in the previous studies with reference to historical development of the NARS in the country}.
(iii) **Structured questionnaire survey**

{A structured questionnaire was distributed among the scientists in the Central Rice Research Institute (CRRI) in Cuttack, India and the Rice Research and Development Institute (RRDI) in Batalagoda, Sri Lanka. Field visits to these two institutes were made by me to meet the scientists. Copies of the questionnaire were distributed among them and I collected the information personally during my stay in the two institutes (Three weeks stay at the CRRI and one week stay at the RR&DI). The questionnaire filled by the respondents was coded and entered into computer software packages for storage. The results obtained from the analysis of the questionnaire survey are presented and discussed in the Chapter 7}.

(iv) **Open-ended interviews**

{The open-ended direct interviews were done with key informants such as very senior research scientists, academics and scientific administrators in the NARS of both India and Sri Lanka (see Appendix 3.4 and 3.5). The outcomes of these interviews are discussed in the Chapters 5, 6 and 7}.

(v) **Direct observation**

{The relevant information on the NARS, rice technologies and scientific community in rice research through direct observation was also collected personally by me during the field visits to the two institutes under case study. These were supplemented with my own personal experience in dealing with the agricultural research sector for nearly fifteen years and the issues are discussed in the Chapters 5, 6 and 7}.
3.9 Analysis of data

Data analysis of case studies consists of examining, categorizing, tabulating, or otherwise combining the evidence to address the initial propositions of the study. Patton (1987) discusses different types of combining or convergence of evidence, and encourages you to use multiple sources of information according to the following type, known as convergence or non-convergence of multiple sources of evidence (Figure 3.2 and Figure 3.3).

![Diagram showing convergence of multiple sources of evidence](source: Cosmos Corporation)

**Figure 3.2 Convergence of multiple sources of evidence (Single study)**
Yin (1994) suggests that a researcher is free to consider either one of the above, depending on the research title, initial proposition of the study and the experience capacity of the researcher.

After careful consideration of the proposition of the plan, it was decided to converge the multiple sources of evidence or data to arrive at conclusion of this study.

To achieve some of the objectives stated in the project, first a descriptive statistical analysis was performed on all qualitative and quantitative variables included in the structured questionnaire. Descriptive methods are usually used to identify the initial patterns of the data. Simple tabulation of data with percentage values along with the mean values was used for comparison of the rice scientists in the two countries. In regard to some variables Pi-charts and bar graphs were also used for visual improvements of the analysis. Then further analysis was done using formal statistical methods such as t-tests for significance of variance and Spearman’s rank correlation, to see whether there is any agreement between the scientists in the two countries in regard to some important factors. The statistical packages SAS and SPSS were used for this analysis. Some graphs were created by the MS Excel package.
The qualitative data gathered through the open-ended direct interviews were also carefully analyzed. For this purpose, the responses relevant to each question by various respondents were taken into consideration before arriving at conclusions.