WOLLO UNIVERSITY

COLLEGE OF AGRICULTURE

DEPARTMENT OF PLANT SCIENCES

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FOR

THE COURSE:

RESEARCH METHODS IN PLANT SCIENCES

COURSE CODE: PLSC 2061

PREPARED BY: ALI SEID

MARCH, 2020

Course Guide Book	**Wollo University** **College of Agriculture**			
Program	Plant Science			
Degree Program	BSc in Plant Science			
Module Name	Research Methods and Tools			
Module No.	10			
Total ECTS of the Module	20			
Course Title	Research Methods in Plant Sciences			
Course Code	Plsc 2061			
Module Chair	Ali Seid Office location: Department of Plant science Phone: E-mail:aliseidmohammed@gmail.com			
Instructor/Tutor	Ali Seid Office location: Department of Plant science Phone: E-mail: aliseidmohammed@gmail.com			
ECTS (CP)	3			
Work load	Lecture	Tutorial	Self-study	Total
Hours	32	0	49	81
Lecture days, Hours & Room	Tues day 4:55-5:45 am			
Tutorial/& Hours	TBA			
Target Group	Plant Science Students			
Year/Semester	Year 2, Semester II			
Pre-requisites	Intro. to statistics and Principles design and analysis of agricultural experiment			
Status of the course	Core			

I. Course Description

Introduction to scientific approach; research and its types; a brief history of Ethiopian research in plant sciences and its organization; principles of research planning; methods of gathering information for formulation of research questions, their prioritization; research proposal and its preparation;. farming systems research (FSR) and on farm research- introduction and methodology; the use of formal and informal methods of FSR approaches; laying out and conducting field and laboratory experiments - principles and practices; scientific reports- types and their characteristics; styles commonly used; principles of writing research papers; styles used by common scientific journals; presentations of research results.

II. Course Objective

The general objective of the course is to make students aware of the research methodology as applied to plant sciences. By the end of the course, the students will have: known about research; a brief history of research in plant sciences in Ethiopia; understood how to formulate a research project and how to execute it; had a general idea about farming research; been able to layout and conduct field experiments, and to write research reports and to present them.

III. Schedule of Lecture Topics, Activities and Readings

Lecture hrs	**Conceptual Focus**	**Activities/Tasks**	**Reading**
3	1. **Introduction** 1.1. Definitions and Scope of Agricultural Research Scientific approach in research method 1.3.Purpose of Research Types and Characteristics of research An overview Agriculture Research in plant science Current status of Agricultural Research in Ethiopia	- Introduce each other - Course guidebook will be provided to students - Listen to lecture, take short notes on the lesson treated -Take part in reading assignment	-Desai, Vandana and Potter, Robert B. (2006). *Doing Development Research*. SAGE Publication Ltd., London
4	**2. RESERCH PLANNING** 2.1.General principles in research planning 2.2 Identification of research problem 2.3. problems and priority setting 2.4 Steps in the planning process of Applied and Basic research 2.5 Research problems and research Questions 2.6 Problem –cause relationship their solution.	-Listen to lecture, take short notes on the lesson treated -Assignment submission -Forward doubts/ confusions during lectures - Reading assignments about problem identification and prioritization criteria	Randy R. (2005). *Research Methods for Community Change: A Project-Based Approach*. Sage Publications Inc., UK

4	**3. RESEARCH PROPOSAL WRITING** 3.1 Definition of Research Proposal 3.2 Techniques and formats of research Proposals 3.3 Quality of research proposal 3.4 Components of research proposal	-Listen to lecture, take short notes on the lesson treated -Group forming and proposal writing based on the selected/prioritized problem and presentation	-Reid, P. (2000). Handbook for preparing and writing research proposals. International Union of Forestry Research Organization, Vienna, Austria -Day, Robert A. (1998). *How to Write & Publish a Scientific Paper*. 5th ed. CambridgeUniversity Press
	4. Research Report Preparation/ presentation Types of reports General format of a research report Use of figures and tables Presentation of a research report	- Take lecture notes - Assignment 2: (Taking different secondary data and try to analyze and writing the report. i.e in scientific way) - Take part in reading assignment	
2	**5. On–farm experiment/ research** 5.1. Overview of on-farm research 5.2. Stage of on-farm research Characteristics of on-farm research 5.3. Implementing on-farm research 5.4. Benefit realization and recommendation	-Listen to lecture, take short notes on the lesson treated -Take part in reading assignment	-Shajahan, S. (2005). *Research methods for management* (3rd ed.). Mumbai: Jaico Publishing House
2	**6.Farmer Participatory Research** 6.1 Introduction to farmer participatory research Recent advances in FPR and FSR Collection and analysis of background information Planting and conduction participatory on-farm Experiment		-Randy R. (2005). *Research Methods for Community Change: A Project-Based Approach*. Sage Publications Inc., UK

Teaching and Learning Method

The mode of delivery of the course combines lectures, discussion, questioning and answering, readings, assignments, individual and /or group problem identification and presentation.

Lecture

Reflection: keep a weekly written reflection of your reactions, questions about the readings and discussion in class

Homework: Homework assignments will be given to help reinforce some topics covered or not covered in class

Proposal writing and Seminar: all students will be required to identify problems, prioritize, set hypothesis, writ and present research proposal with the available literature to successfully complete this course

Assessment Methods

Evaluation will be carried out based on continuous assessment which comprises relevant tests, assignments (proposal writing and presentation), mid- and final- examination.

Summary of Course Assignments, Test and Examination

Class participation/ reflections/attendance	**In %**
Home take assignments	5 %
Proposal writing and Presentation	20 %
Quiz	10 %
Test	10 %
Final Exam	50 %
Total	100%

Grading: as per the University's regulation

Required Reference Books

Cochran, W.G. and G.M. Cox.(2000). Experimental Design (2nd ed.). John Wiley and Sons.

Day, Robert A. (1998). *How to Write & Publish a Scientific Paper*. 5th ed. CambridgeUniversity Press

Denzin, Norman K. and Lincoln, Yvonna S (eds.). (2003). *Strategies of Qualitative Inquiry*.2nd edn. SAGE Publication Ltd., London.

Desai, Vandana and Potter, Robert B. (2006). *Doing Development Research*. SAGE Publication Ltd., London

Dooley, D. (1995). *Social research methods* (3rd ed.). Upper Saddle River, New Jersey: Prentice-Hall, Inc.

Gomez, K.A., & Gomez, A.A. (1984). *Statistical procedures for agricultural research*. New York: John Wiley and Sons, Inc.

Randy R. (2005). *Research Methods for Community Change: A Project-Based Approach*. Sage Publications Inc., UK

Reid, P. (2000). Handbook for preparing and writing research proposals. International Union of Forestry Research Organization, Vienna, Austria.

Shajahan, S. (2005). *Research methods for management* (3rd ed.). Mumbai: Jaico Publishing House

Approved

Instructor/ Tutor Name: Ali Seid Signature _______________

Department Head: Dr. Adem Mohammed Signature _______________

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CHAPTER 1. INTRODUCTION

1.1. Definitions and Scope of Agricultural Research

In this course, we will discuss/learn a set of theories/applications and sets of guidelines for the use of research methods in general and its applicability to agricultural sciences in particular.

Natural science investigation is based ultimately upon the researcher's assumptions about the interactions of biotic and abiotic factors and social problems. These assumptions guide his/her entire research operation from the selection of a problem for investigation to the analysis of data and the interpretation of the results. They influence the research methods he/she employs and the type of data thus obtained.

This course provides guidelines and suggestions for the development, preparation, and submission of proposals to funding organizations and donor agencies. Although many potential sources of research funding exist to an individual research scientist, e.g. governments, non-profit organizations and private operations, the competition for such funding is exceedingly high, and only well-conceived and well-packaged research proposals are likely to be successful.

The purpose of the course is designed to provide a systematic approach to the development of focused and significant research projects, tools, to prepare and write a well designed research proposal. In using the scientific method for conducting research, there are logical steps to be followed:

- (i) Identifying the problem
- (ii) Defining the problem
- (iii) Formulating the hypothesis
- (iv) Deductive reasoning
- (v) Testing the hypothesis

The topics covered addresses specific components of a research proposal, research process, report write-up and scientific paper writing. Although there are various approaches for writing a research proposal and report write-up depending upon donor or researcher interests, this course tries to follow standard methods that could be applied to natural science research.

- The *aim of research is to contribute to knowledge*, so that every new result adds to the previous state of knowledge, forming a basis for new thinking and interpretation, new implications, identification of needs for further research, etc. Research results, however, do not contribute to knowledge and development unless they are communicated effectively.

- Effective communication of science, both to scientists and to other audiences, is a very important component of the research process.

This course offers students time-tested advice and step-by-step instruction for:

- discovering a topic,
- writing proposals,
- conducting research, and
- Writing research reports and publication.

1.2 The Need for Scientific Research

- There is little doubt that research is needed in many different aspects of natural science, and in relation to social dimensions of communities and economies.
- With the large demands for research for various disciplines, yet limited resources to support such activities, it is extremely important that the research that is done is of highest quality and of immediate or potential significance
- In today’s environment, the need and demand for a better understanding about almost all aspects of sciences are exceeding the resources available for research required to provide the understanding
- We are confronted with a host of problems and needs that range from the local to the global scale of importance 9is it locally feasible/globally/regionally)
- A sound scientific methodology at least assures that the results of the research have high probability of being true
- Scientific method is the only one available to us for discovering reliable knowledge about nature/facts
- Reliable knowledge is knowledge that has a high probability of being true because it has been justified by a reliable method (i.e., the scientific method).
- It will be up to the investigator, as influenced by stakeholders, scientific collegues and others, to determine the relative significance and importance of the research
- Change in the relationship between science and society create new challenges for scientists
- In addition to the shortfall in available resources, to support trained researchers, research enterprises are becoming more complex, creating new kinds of situations and relationships among researchers.

- ❖ The above mentioned phenomena require an intimate knowledge of methods, techniques and social conventions of science.

1.3. Identifying and Prioritizing Research Needs

Before writing a research proposal, the investigator must first establish the important research needs that are appropriate for his or her research organizations

Prioritization of research problems will be very dependent on a number of factors, including:

- ❖ The significance of the research problem or need
- ❖ The capacity of the researcher or organization to address the need
- ❖ The existing or potential availability of resources to carry out the research
- ❖ The perception of the general public, the government, or others as to the importance of the problem
- ❖ The likelihood for the products and benefits to be derived from the research

The **identification and prioritisation** of research includes:

- ❖ Consideration of the mission and strategic plan of one's organization
- ❖ The input by stakeholders
- ❖ A realistic assessment of resource capacities and needs.

Defining problems:

- ❖ Analysis is an important first step in defining a problem
- ❖ This might be done by suggesting or enumerating reasons why a particular topic is chosen

Stakeholder needs

- ❖ Stakeholders are defined as people, groups, or organizations (and individual researchers) attention, resources, or output or are affected by the output
- ❖ Identification of the stakeholders concerns and needs is also very important to assist the individual researcher in identification of research problems and issues.
- ❖ One can make a start on analyzing stakeholder needs by asking key questions:
  - ❖ Who are the organizations stakeholders?
  - ❖ What do they from the research project?
  - ❖ What criteria do they use to evaluate your research?
  - ❖ How is your research (or organization) performing against those criteria?

Determining Resource Needs

- After one has identified and defined a specific research problem or need, it will be necessary to consider the research resources that will be needed
- Will the necessary personnel, equipment, facilities and other resource be available to realistically address the research problem?
- If not will it be possible to secure the necessary resources?
- Resource requirements can be categorized under at least 7 general areas:
- Human resources
- Facilities
- Equipment
    - Office supplies
    - Funding
    - Institutional support
    - Special considerations such as special research permits or authorization.

1.4. Traits of a Researcher

The ability to pursue research is largely based on one's capacity for it. The traits are:

- *Reasoning power:* The researcher must have capacity to solve problems deductively and inductively
- *Originality:* Have creative, imagination, initiative and fertility of rational ideas
- *Memory:* Have extensive, logical and ready command of facts
- *Alertness:* Have quick, incisive and responsive observation, thought and feeling
- *Accuracy:* Have precise, keen, regular, reliable observation, thought and feeling
- *Application:* Have power of concentration, sustained attention, pertinent and well-regulated effort
- *Cooperation:* Have the capacity for intellect, companionship, teamwork orientation and leadership qualities.
- *Moral attitude:* Intellectual wholesome moral standards, ideals, influence, etc.
- *Health*: Have nervous stability, physique, vitality, endurance
- *Zeal:* have deep interest in craving for original creative work.

1.5. An overview Agriculture Research in plant science

The agricultural sector in Ethiopia represents 45 % of the GDP and about 85 % of the population gains their livelihood directly or indirectly from agricultural production including livestock. The importance of agricultural research and its impact on development in Ethiopia

can hardly be over emphasized. Agricultural research started with the establishment of the Ambo and Jimma Colleges of Agriculture in 1947 and the Imperial College of Agriculture and Mechanical arts (today's Alemaya University) in 1953. Relative to other African countries, agricultural research in Ethiopia is quite young. Organized agricultural research activities and actual relations between agricultural research and development started with the inception of The Institute of Agricultural Research in 1966 (Tsedeke et al., 2004).
Other agricultural research centers established at various times include:

- ✓ The Plant Protection Research Center at Ambo – established in 1972 and merged with the Institute of Agricultural Research in 1995.
- ✓ Plant Genetic Resources Center – founded in 1974 and later became the Biodiversity Institute.
- ✓ Forestry Research Center (1975).
- ✓ Wood Utilization Research Center (1979).
- ✓ National Soils Laboratory (1989).
- ✓ Institute of Animal Health Research (IAHR, 1992)
- ✓ Higher education institutions historically involved in agricultural research
- ✓ include:
- ✓ Alemaya University (1953)
- ✓ Awassa College of Agriculture (1977)
- ✓ Wondo Guenet College of Forestry (1978)
- ✓ Faculty of Vetrenary Medicine at Debre Zeit (1979).
- ✓ Mekele University College (1994).

3. The Current National Agricultural Research System

In 1993, some IAR centers were decentralized to create independent research centers run by the respective regional governments and became the Regional Agricultural Research Centers (RARCs) under the respective regional bureaus of agriculture. In June, 1997, the Ethiopian Agricultural Research Organization (EARO), today's Ethiopian Institute of Agricultural Research (EIAR) was established and merged all the existing agricultural research institutions which included:

- ✓ The original IAR research centers at Holetta, Nazreth, Jima, Bako,
- ✓ Melka Werer, Ambo, Kulumsa and Pawe.
- ✓ Debre Zeit Agricultural Research Center (previously under Alemaya
- ✓ University)

- ✓ Biodiversity Institute, the Forestry Research Center,
- ✓ The Wood Utilization Research Center,
- ✓ the Institute of Animal Health Research
- ✓ National Soils Laboratory (all previously under the

Ministry of Agriculture).

The newly established research centers through the World Bank Agricultural Research and Training Program (ARTP) which include –

Jijiga (Somali Region), Shiket (Afar Region), Jinka (Southern Region),
Humera (Tigrai Region), Sekota (Amhara Region), and Yavello
(Oromia Region).

Chapeter Two

2. PRINCIPLES OF RESERCH PLANNING AND IDENTIFICATION OF RESEARCH PROBLEM

2.1 Definition of Research

Research

- It is defined as the ***careful, diligent, and exhaustive investigation*** of a specific subject matter, having as its aim the advancement of mankind's knowledge.
- It is the ***quest for basic information*** about specific subject matter and the development of guides and procedures for management.
- Its primary function is to provide a firm foundation for management
- It is also defined as a systematic and intensive process of investigation aimed at generating or expanding knowledge about a subject/object or a problem. It is a processes involving inter-related activities starting with the formulation of a researchable problem and ending with conclusions and recommendations derived from the analysis and interpretations of the findings of the study.

Scientific Research

- Is that which utilizes the scientific method.
- It is **systematic** and **controlled**, **empirical**, and **critical** investigation of hypothetical propositions about the presumed relations among natural phenomena.
- When we say that scientific research is **systematic and controlled**, we mean, in effect, that scientific investigation is ordered that investigators can have critical confidence in research outcomes
- Scientific investigation is **empirical**. If the scientist believes something is so, he must some how or other put his belef to a test outside himself. Subjective belief in other words, must be checked against objective reality.

Science

- **Science** is best defined as a careful, disciplined, logical search for knowledge about any and all aspects of the universe, obtained by examination of the best available evidence and always subject to correction and improvement upon discovery of better evidence.

- Is an 'objective, accurate, systematic analysis of a determinate body of empirical data, in order to discover recurring relationships among phenomena'?

Theory: In popular usage, a theory is just a vague and fuzzy sort of fact and a hypothesis is often used as a fancy synonym to `guess'. But to a scientist a theory is a conceptual framework that explains existing observations and predicts new ones.

A hypothesis is a working assumption. Typically, a scientist devises a hypothesis and then sees if it ``holds water'' by testing it against available data (obtained from previous experiments and observations). If the hypothesis does hold water, the scientist declares it to be a theory. Scientific knowledge comes from testing theories by logically deducing hypotheses from them, using experiment and careful observation to test the hypotheses, and revising theories that lead to incorrect predictions.

2.2 The Scientific Method

The **scientific method** is the process by which scientists, collectively and over time, endeavor to construct an accurate (that is, reliable, consistent and non-arbitrary) representation of the world.

Recognizing that personal and cultural beliefs influence both our perceptions and our interpretations of natural phenomena, we aim through the use of standard procedures and criteria to minimize those influences when developing a theory. As a famous scientist once said, "Smart people (like smart lawyers) can come up with very good explanations for mistaken points of view. "In summary, the scientific method attempts to minimize the influence of bias or prejudice in the experimenter when testing an hypothesis or a theory.

2.2.1 The scientific method has four steps

(i) ***Observation*** and description of a phenomenon or group of phenomena.

(ii) ***Formulation of an hypothesis*** to explain the phenomena. In physics, the hypothesis often takes the form of a causal mechanism or a mathematical relation.

(iii) Use of the hypothesis to ***predict*** the existence of other phenomena, or to predict quantitatively the results of new observations.

(iv) Performance of ***experimental tests*** of the predictions by several independent experimenters and properly performed experiments.

If the experiments bear out the hypothesis it may come to be regarded as a ***theory*** or law of nature (more on the concepts of hypothesis, model, theory and law below). If the experiments do not bear out the hypothesis, it must be rejected or modified. What is key in the description of the scientific method just given is the predictive power (the ability to get more out of the theory than you put in; see Barrow, 1991) of the hypothesis or theory, as tested by experiment. It is often said in science that theories can never be proved, only disproved. There is always the possibility that a new observation or a new experiment will conflict with a long-standing theory.

2.2.2 Testing hypotheses

As just stated, experimental tests may lead either to the confirmation of the hypothesis, or to the ruling out of the hypothesis. The scientific method requires that a hypothesis be ruled out or modified if its predictions are clearly and repeatedly incompatible with experimental tests. Further, no matter how elegant a theory is, its predictions must agree with experimental results if we are to believe that it is a valid description of nature. In physics, as in every experimental science, "experiment is supreme" and experimental verification of hypothetical predictions is absolutely necessary. Experiments may test the theory directly (for example, the observation of a new particle) or may test for consequences derived from the theory using mathematics and logic (the rate of a radioactive decay process requiring the existence of the new particle). Note that the necessity of experiment also implies that a theory must be testable. Theories which cannot be tested, because, for instance, they have no observable ramifications (such as, a particle whose characteristics make it unobservable), do not qualify as scientific theories.

If the predictions of a long-standing theory are found to be in disagreement with new experimental results, the theory may be discarded as a description of reality, but it may continue to be applicable within a limited range of measurable parameters. For example, the laws of classical mechanics (Newton's Laws) are valid only when the velocities of interest are much smaller than the speed of light (that is, in algebraic form, when $v/c \ll 1$). Since this is the domain of a large portion of human experience, the laws of classical mechanics are widely, usefully and correctly applied in a large range of technological and scientific problems. Yet in nature we observe a domain in which v/c is not small. The motions of objects in this domain, as well as motion in the "classical" domain, are accurately described through the equations of Einstein's theory of relativity. We believe, due to experimental tests, that relativistic theory provides a more general, and therefore more accurate, description of the principles governing our universe, than the earlier "classical" theory. Further, we find that the relativistic equations reduce to the classical equations in the limit $v/c << 1$. Similarly, classical physics is valid only at distances much larger than atomic scales ($x >> 10^{-8}$ m). A description which is valid at all length scales is given by the equations of quantum mechanics.

We are all familiar with theories which had to be discarded in the face of experimental evidence. In the field of astronomy, the earth-centered description of the planetary orbits was overthrown by the Copernican system, in which the sun was placed at the center of a series of concentric, circular planetary orbits. Later, this theory was modified, as measurements of the planets motions were found to be compatible with elliptical, not circular, orbits, and still later planetary motion was found to be derivable from Newton's laws.

Error in experiments have several sources. First, there is error intrinsic to instruments of measurement. Because this type of error has equal probability of producing a measurement higher or lower numerically than the "true" value, it is called random error. Second, there is non-random or systematic error, due to factors which bias the result in one direction. No measurement, and therefore no experiment, can be perfectly precise. At the same time, in science we have standard ways of estimating and in some cases reducing errors. Thus it is important to determine the accuracy of a particular measurement and, when stating quantitative results, to quote the measurement error. A measurement without a quoted error is meaningless. The comparison between experiment and theory is made within the context of experimental errors. Scientists ask, how many standard deviations are the results from the theoretical prediction? Have all sources of systematic and random errors been properly estimated? This is discussed in more detail in the in Statistics.

2.2.3 Common Mistakes in Applying the Scientific Method

As stated earlier, the scientific method attempts to minimize the influence of the scientist's bias on the outcome of an experiment. That is, when testing an hypothesis or a theory, the scientist may have a preference for one outcome or another, and it is important that this preference not bias the results or their interpretation. The most fundamental error is to mistake the hypothesis for an ***explanation of a phenomenon, without performing experimental tests***. Sometimes "common sense" and "logic" tempt us into believing that no test is needed. There are numerous examples of this, dating from the Greek philosophers to the present day.

Another common mistake is to ***ignore or rule out data which do not support the hypothesis***. Ideally, the experimenter is open to the possibility that the hypothesis is correct or incorrect. Sometimes, however, a scientist may have a strong belief that the hypothesis is true (or false), or feels internal or external pressure to get a specific result. In that case, there may be a psychological tendency to find "something wrong", such as systematic effects, with data which do not support the scientist's expectations, while data which do agree with those expectations may not be checked as carefully. ***The lesson is that all data must be handled in the same way.***

Another common mistake arises from the failure to ***estimate quantitatively systematic errors*** (and all errors). There are many examples of discoveries which were missed by experimenters whose data contained a new phenomenon, but who explained it away as a systematic background. Conversely, there are many examples of alleged "new discoveries" which later proved to be due to systematic errors not accounted for by the "discoverers."

In a field where there is active experimentation and open communication among members of the scientific community, the biases of individuals or groups may cancel out, because experimental tests are repeated by different scientists who may have different biases. In addition, different types of experimental setups have different sources of systematic errors. Over a period spanning a variety of experimental tests (usually at least several years), a consensus develops in the community as to which experimental results have stood the test of time.

A SCIENTIFIC MYSTERY-SOLVING STRATEGY

Question: You begin with a puzzle, a mystery, a surprising event: You don't understand a phenomenon which has occurred, or which occurs regularly.

Hypothesis: Try to imagine a process or situation which meets this criterion: If what you've imagined were really the case, the puzzling phenomenon would make sense.

Testing: Find out if the hypothesis itself makes sense, by exploring its other consequences: If it were correct, what else should be observed? What would show that the hypothesis is wrong?

Evaluation: Decide whether the results of testing warrant accepting the hypothesis as a plausible explanation for the phenomenon. Consider the possibility of further testing, and whether other hypotheses might provide a better explanation.

2.3 Types of Research

The first three are based on the basic aim of research (purposive nomenclature) and the last three refer to specific procedures in conducting the research (descriptive normative).

2.3. 1 Fundamental Research

- ❖ The purpose of research is the development of theories by discovering broad generalizations or principles
- ❖ It employs careful sampling procedures in order to extend the findings.
- ❖ It has little concern for application of findings to actual problems in areas considered to be the concern of the people other than the investigation.
- ❖ It is usually carried out in a laboratory situation, often with animals as subjects
- ❖ In the social sciences, this type of research has been primarily the activity of psychologists

2.3.2 Applied Research

- ❖ It has most of the characteristics of fundamental research, including the use of sampling techniques and the subsequent inference about the target population
- ❖ However, its purpose is improving a product or a process
- ❖ It also tests theoretical concepts in actual problem situation.

2.3.3 Action Research

- ❖ It is focused on the ***immediate application***, not on the development of theory, not upon general application
- ❖ It puts emphasis on a problem in a logical setting
- ❖ Its findings are to be evaluated in terms of universal validity
- ❖ Its purpose is to improve practices and, those who try to improve the practices. And at the same time generate knowledge

2.3.4 Historical Research

- ❖ It describes what it was?
- ❖ The processes investigation, recording, analyzing and interpreting the events of the past for the purpose of discovering generalizations that are helpful in understanding the present, and to a limited extent, in anticipating the future.

2.3.5 Descriptive Research

- It describes what is?
- It involves some type of comparison or contrast and may attempt to discover relationships that exist between existing non-manipulated ariables.

2.3.6 Experimental Research

- Describes what will be when certain variables are carefully controlled or manipulated
- The focus is on the relationship of variables
- Delebrate manipulations are always part of the experiment
- The researcher has a strong control over the environment being observed
- The research approach has its roots in the scientific practice of biologists and physicians, where variables are manipulated over time
- Numeric data is collected and causal or cancellations models are tested through statistical analysis

2.3.7 Survey Research

- The approach has its own roots in the work of sociologists
- The researchers typically a considerable sample to be analyzed which suggests the use of questionnaire with questions that are easy to be answered and that permit qualitative evaluation
- It is typically applied to validate models or hypothesis.

2.3.8 Case Research

- Roots mainly in business research
- Cases are analyzed either to build or validate models or theories typically through collection of textural data through interviews.

2.4. Research categories based on nature

Social scientists have for many years been involved in efforts to classify the research methods. One of the most distinct ways is the division of research methods into**:**

- ***Qualitative***
- ***Quantitative***

2.4. 1. QUALITATIVE RESEARCH

Focuses on the analysis of information to generate qualitative explanation of phenomena. The techniques used to achieve this goal depend on how the information is generated.

A number of **<u>approaches</u>**, which are applicable to the qualitative research process include:

- ❖ Interviewing
- ❖ Focus group discussion (FGD)
- ❖ Participatory rural appraisal (PRA), and
- ❖ Observation, among others.

Dimensions of qualitative research:

- ❖ The ***<u>purpose</u>*** of conducting the envisaged research
    - ❖ *Explanatory* (if the strategy is to determine "why" a certain phenomena occurs)
    - ❖ *Descriptive* (simply describe a phenomena by asking "how" and "who")
    - ❖ *Exploratory* (focuses on new issues, or explaining an event, and hence "why" is the question to answer).
- ❖ The *<u>intended use</u>* of the research findings on the type of research being undertaken:
    - ❖ Basic research
    - ❖ Applied research (Action research, impact assessment and evaluation)
- ❖ The way the research strategy is going to handle the issue of ***<u>time dimension</u>***:
- ❖ *Cross-sectional* (time series research)
- ❖ *Longitudinal* (the researcher observes the same people, group or organization across time periods)

The ***<u>research techniques</u>*** (data collection methods) to be applied during the research process:

- ❖ Experimental
- ❖ Historical
- ❖ Survey
- ❖ Etc

Because **qualitative research** methods are widely applied, it is important to appreciate the strengths and weaknesses.

Study method	Strengths	Weaknesses
Unstructured observation	❖ Gives a record of actual ❖ Participant observation can be less reactive	❖ Potential reactivity on the part of persons being observed ❖ Requires much time to conduct and write up ❖ Difficult and time consuming
Structured observation	❖ Gives a record of actual ❖ Easier to administer and to	❖ More time consuming ❖ Some behaviors are difficult or

	train data collectors ❖ Data are amenable to quantification	sensitive ❖ Focusing on a specific subject and may miss new or infrequent behaviors
Unstructured and semi-structured interviewing	❖ Can cover a large no. of topics in great depth ❖ Issues can be explored within a socio-cultural context	❖ Sample size is generally small ❖ Time consuming ❖ Requires highly skilled interviewers
Systematic interviewing	❖ Data are easily compared in different sites ❖ Standard data collection instruments are used ❖ Can be analysed using statistical analysis	❖ Respondents may not understand the exercise ❖ Some respondents may feel they are being tested
Focus groups	❖ Provides data on consensus, mainstream opinions ❖ Encourage debate and discuss a key topic ❖ Can be used to assess feasibility of intervention	❖ Does not pick up the full range of beliefs ❖ Logistic problems in getting groups of people togethe at specfic time ❖ Some partyicipants may dominate others
PRA	❖ Local people crate and own data ❖ A high level of rapport s built between investigators and local people	❖ Often difficult to include all members of the community (unrepresentative) ❖ Less likely to obtain information on highly sensitive topics like sexual behavior

2.4.2. QUANTITATIVE RESEARCH

Focuses on the analysis of information to *generate quantifiable results*. To attain this goal, quantitative research relies on ***statistics***. Indeed, quantitative research is about *using statistical techniques to generate and analyze quantitative data*.

The main branches of statistics applicable to quantitative research are:

- ❖ Techniques used in general **research design**, particularly **sampling procedures** (first step in data collection)
- ❖ Techniques for description and display data (**descriptive statistics).** Frequency distribution, data tabulation and graphic display are included.
- ❖ Inferential statistics (making decisions from the data). No meaningful statements can be made about the population from sample results without resort to the use of this statistics. (the basis are probability theory).

Definition of terms commonly used in quantitative research

(a) **An attribute:** is a characterstic that is qualitative and not measurable but can be observed or identified and described as present or absent.

(b) **A variable**: is a measurable attribute or characterstic of a given phenomenon (objec, process, event, etc.) which can take different values in a given population or sample of elements.

(c) **An element**: is an individual unit in a given population on which the measurment about the value of a variable takes place.

(d) **Data**: an assumed facts or evidence that are collected as a result of observation.

(e) **Population**: is a total set of individual elements of given phenomenon under study.

(f) **A sample**: is a subset of the total population consisting of only a portion of all the elements in the population.

(g) **A random sample**: is a subset of a population selected in such a way that each member of the population has equal chance of being selected.

2.4 Sampling Techniques

WHY SAMPLE?

There are two reasons for sampling:

- ✓ To get a general impression of the total population of interest. In this case the selection is quite subjective.
- ✓ For purposes of obtaining estimates on certain characteristics of the population.

- Reasons that makes sampling useful (considerations regarding):
  - ❖ Time
  - ❖ Cost and available resources, and
  - ❖ Practicability

Basic considerations you should take into account before drawing a sample:

- ❖ A clear definition of the population from which the sample is drawn,

- ❖ The sample must be of adequate size, and
- ❖ The sample must be representative of the population

The three basic considerations are related to a number of factors including:

- ❖ The nature of the study (research) problem,
- ❖ The type of variable being measured,
- ❖ The objective of the study,
- ❖ The research questions,
- ❖ The available resources (time, money, personnel, etc.), among others.

TYPES OF SAMPLING

- ***Simple Random Sampling****:*
  - ❖ Is a procedure where all the members of a given population have an equal chance (probability) of being included in the sample and every possible sample an equal chance of being drawn?
  - ❖ Although it is unbiased, it has the following limitations:
    - ❖ Requires a listing of all the members in a given population
    - ❖ Use of random number tables makes the procedure quite tedious and time consuming
- ***Systematic Sampling****:*
- ❖ The elements to be included in a sample are picked at a constant interval.
- ❖ It is a quicker method of obtaining a sample compared to simple random sampling.
- ❖ The greater disadvantage is biases

- ***Stratified Sampling:***
  - ❖ The population of interest is first stratified on the basis of selected criteria, i.e., dividing the population into mutually exclusive sets or strata
  - ❖ From each stratum, a set of elements is then either randomly (stratified random sampling) or systematically (stratified systematic sampling)
  - ❖ The advantage in stratified sampling is that it allows all variations in the population to be reprsented in the sample although not all members of the population have an equal chance of being selected.
  - ❖ It, however, requires prior information about the population under study so that stratification can be done before actual drawing of sample.

- ***Cluster Sampling:***
  - Is appropriate where the population of interest exists in distinct orders.
  - There should be homogeneity between the clusters and great variability within the clusters.
  - Requires a large sample size to achieve the same level of reliability of estimates.
- ***Multistage Sampling:***
  - Refer to a sampling procedure, which involves sampling within already selected sampling units.
  - It is a combination of many techniques.
  - Usually used in cluster cases.

Chapter Three

3. GUIDE TO WRITING EFFECTIVE RESEARCH PROPOSAL

- The objectives of this chapter are:
  - To understand the major components of a research proposal
  - To introduce the important steps leading to the write-up of the research proposal
- The guide covers the major categories in a research proposal
- Remember these are ‘guidelines,’ not a ‘recipe for success’ or a ‘how-to-do-it’
- Merely they indicate the conceptual breakdown of any research proposal

The main purposes of writing a research proposals:

- They *convince* others that your research is worth undertaking.
- They enable you to *demonstrate expertise and competency* in your particular area of study.
- They may *serve as a contract* between the researcher and her funders.
- They serve as a *planning tool* for the researcher.

3.1 BASIC STEPS in Writing Research Proposal

The proposal should follow in sequence the steps of the research process. The proposal should be similar to the research paper report in style and format. The research report and the proposal differ in that, for example, a description of methods to be used will of necessity employ future tense in the proposal, because the work at this stage has not yet been done. Similarly, the purpose of the study should be explained in the present tense in the proposal and in the past tense at the study's completion. In the final research report write-up, much of this prose can be revised through appropriate tense changes to reflect that the work is now completed.

The basic steps to be followed include:

Step 1: Identify researchable problem

Step 2: Identification of a potential sponsor

Step 3: Contact key people who can provide assistance in planning your proposal

Step 4: Write a well, reasoned proposal

3.2 COMPONENTS OF A RESEARCH PROPOSAL

Adaptation of Selected Oat (*Avena sativa*) Varieties at Highland Area of Dessie Zuria District

Sponsoring Organization: Wollo University

Ali Seid Assen (Principal Investigator, PhD, Assistant Professor; Mobile +251 9 10 17 47 13; Email: aliseha@yahoo.com)

Ali Seid Mohammed (Co-Investigator, MSc, Lecturer; Mobile +251 9 13 91 80 87; Email: aliseidmohammed@gmail.com)

Preliminary pages

Title: Consideration and nature of research Title

- The title of the proposal should be a succinct summary of the topic and usually should not exceed 17 words.
- The title should include key terms that readily identify the scope and nature of the study, it should tell what the proposal is all about.
- it should be informative, specific and concise and is relevant to the intended contents of the proposal.
- Unnecessary words or waste words that say nothing, such as "A Study of ...," “Observation of ....”, “Examination of....”, “A note on...”, “Investigation on...”. etc. should always be avoided.
- It is usually be typed using all capital letters
- Abbreviations are not used in the title
- Journals or other publishers or research institutions give instructions to authors as to the length of the title to few words as much as possible.

3.2 Table of Contents

- Essentially, the table of contents for the proposal lists all of the elements of the proposal, with accompanying page numbers.
- These elements generally include the following items: title page, abstract, table of contents, introduction, and review of literature, methodology, reference list, and appendices.
- The table of contents should be double-spaced between entries; entries longer than one line should be single-spaced.

1. INTRODUCTION

The introduction persuades the reader that the topic is important and that the objective of the research is justified. The introduction presents:

- At greater length than in the abstract, the problem to be addressed,
- Should describe the nature and purpose of the study,
- Present the guiding research questions, and explain the significance of and justification and hypothesis for conducting the study.
- Terms likely to be used throughout the proposal should be defined in this chapter.

In developing this chapter, consider the following guidelines:

- Briefly discuss the historical developments of events regarding the specific topic you are interested to study
- Describe your basic assumptions that led you to study the topic.
- Justify why you think there is still a need to further study the topic. The descriptions of the historical developments helps in justification.
- Briefly describe how you intend to go about conducting the study. Provides the structure to be followed in conducting the study.

1.1. Background Information

- This show the state of the art of a particular field of endeavor. Shows the historical development of events regarding to the specific topic. This helps to make clear what you wanted to do.
- This provides information or the reason to justify the study

1.2. The Research Problem (Statement of problem)

- The purpose is to further increase the understanding of the significance of the proposed research
- This section is the most critical task in writing research proposal (i.e., the central point in any research).
- Without a research problem, there is no real thinking, just wandering, dreaming or associating.
- Many fail at writing good research proposal and fail to get acceptance by donors or institutions because they do not know really what they want to describe, explain or understand their topic of interest.
- Two mistakes are common in a writing a research proposal (i) choice of a “subject” that is all too broad, and (ii) complicated statement of the research questions or problem statement.
- Asking (formulating) a good question requires imagination and insight as well as ‘knowledge’ of your discipline.
- Trivial every day questions are not necessarily research questions. A research question is a question formulated with a clear purpose and so precisely so that it can be answered using scientific research methodologies.
- The following questions helps in clarifying research problems:
    - Is the problem interesting?
    - Is the problem new?

- Will the study add to knowledge?
- Is the problem feasible?
- Has anyone else had a claim to it?

- Leading questions that can help you to formulate a research problem include:
    - "What" do you want to know"
    - "Where" do you want to do the research?
    - "How" is the situation? What state of affairs or processes do you want to describe?
    - "When"?. What time span will you study?
    - "Why" will you study this? To what purpose?
    - "Which" consequences will the knew knowledge have?
- Rules in defining a research problem:
    - Be sure that the topic chosen is neither too vague nor too broad in scope
    - To make the problem clearer and more understandable, state it as a question which will require a definite answer
    - Carefully state the limits of the problem, eliminating all aspects and factors which will not be considered in the study
    - Define any special term that must be used in the statement of the problem or throughout the study proposal.
- When you have thought through all this, you must then state your questions or research problem in one sentence.

Example: "What consequences has (policy x) had for irrigation development in drylands of Ethiopia in 1970 to 2000?"

The next step is to specify what you mean by the words:

- "Consequences"- what do you mean by?
- What was "policy x" all about
- What aspect of "irrigation development" do you mean?

Such questions come to your mind from your reading, talking with others, listening news, watching debates, meetings, on TV, etc..

1.1 Justification (Importance) of the Study

- This sub-section addresses the likely contribution to knowledge that the research will make and its place in current debate/theory.
- Describe the value of specific applications of knowledge to be gained and the potential importance of these applications

- Describes the gaps that the proposed research is intended to fill
- In addition to the theoretical significance of the research problem, the practical/policy implications should be clearly stated.

1.2 Defining the Objectives of the Study

- This section should specify the measurable outcomes of the research, i.e., end products.
- Objectives must be typically very brief (specific) and achievable.
- **General objective** provides a short statement of the scientific goal being pursued by the research.
- The **specific objectives** are operational in nature.
- Do not confuse objectives with goals. The latter are conceptual, ultimate and more abstract. Objectives are specific and immediate.
- It is always wise to list specific objectives, no more than a sentence or two a piece, in approximate order of their importance or potential contributions
- The objectives must neatly fit into the statement of the problem
- It is important to distinguish the specific objectives from the means of achieving them, such as conducting fieldwork, organizing workshops, etc.
- Objective emphasizes what will be done, whereas a method will explain how it will be done.
- Consider using bullets, numbers, or indentations to call attention to your objectives in the text.

1.5 The Hypotheses

- ***Meaning of Hypotheses***
  - ♦ A hypotheses is a conjectural statement of the relationship between two or more variables
  - ♦ Hypotheses are statements about the relationship between variables
  - ♦ Hypothesis carry clear implications for testing the stated relationship
  - ♦ The hypotheses statements contain two or more variables that are measurable or potentially measurable
- ***Types of Hypotheses***

There are two types of hypotheses:

- ♦ **The Null Hypotheses**: is a non-directional statement of condition between variables
  It states that there is **no significant difference** between two parameters
- ♦ **The Alternative/Research hypotheses**

It is a directional statement of a relationship between variables

It states that there is significant difference between two parameters.

1.6 Delimiting the study

- Identify the boundaries of the research (scope)
- Describe the limitations (weaknesses in terms of methodology) so that the results can be interpreted accordingly.

2. REVIEW OF RELATED LITERATURE

What is a review of the literature?

A ***literature review*** is an account of what has been published on a topic by accredited scholars and researchers. It is not just a descriptive list of the material available, or a set of summaries.

2.1. Purpose

- Your purpose is to **convey to your reader what knowledge and ideas** have been established on a topic, and what their strengths and weaknesses are.
- **Expands** the introductory chapter to address the questions raised
- Provides the **theoretical basis** for the research question
- Helps the researcher in the **interpretation of results or findings**.
- Helps the researcher to outline the **implications** of his study
- Helps to **further define** the research problem

2.2 Basic Guidelines

- The task of reviewing is the most difficult section for a beginning researcher
- As a piece of writing, the literature review must be defined by a guiding concept (e.g., your research objective, the problem or issue you are discussing, or your argumentative thesis
- It is not necessary to review all the literature in the field particularly if you are dealing with a specific research topic.
- What you need are materials that have direct relevance to the study
- It is an extremely important part of a thesis. In fact it is the most publishable part of the study.

- Enlarging your knowledge about the topic, writing a literature review lets you **gain and demonstrate skills i**n two areas: (i) **information seeking**: the ability to scan the literature efficiently, using manual or computerized methods, to identify a set of useful articles and books critical appraisal: (ii) The ability to apply principles of analysis to identify unbiased and valid studies.

(i) Basic Premises/Considerations

- It must provide a **historical background** of the subject to be studied (clear background)
- It must adequately present any and all **relevant materials** that are available showing:
    - Difficulty of the problem
    - The research design
    - Procedures
    - Instruments
    - Analysis employed
- It should help in the **development of the theoretical framework** (clear statement of the problem)
- It must present a **summary relationship to the model or framework** being considered for the study

(ii) Common Errors in Reviewing Literature

- Too frequently, researchers rely solely on **secondary materials or sources** such as abstract, literature reviews done by other researchers and the like
- Very frequently, researchers concentrate **only on the findings in research reports**. The important parts also include overall methodology, sampling, research design, methods of analysis, etc.
- Researchers usually **overlook various sources** particularly those from developing countries other than developed countries.

Literature Search Strategies

- You can find highly relevant materials in other fields. This is how you expand your literature
- Put together all the materials that deal with similar topics to understand the relationship between available materials

- Normally, books in the library are arranged systematically. From the catalogue card, it is possible to identify a book that is closely related to your study. Look also in the shelf closer to that book.
- When you are not sure about the availability of materials in your research topic, refer to the list of references at the end of a journal article you have found gives you the related relevant materials.

Other rules of Thumb

- Cite those references that deal with every key variable
- Pay more attention to articles dealing with more than one variable
- Cite references that deal with similar or conceptually related variables
- Your headings should reflect your major variables. If your headings coincide with your topics in the first chapter, then you have a framework
- Use Index Cards (Bibliographic and Subject Matter)

Questions that Guide for Reviewing Related Literature

- What is the research all about?
- What are the independent and dependent Variables?
- Who were the respondents? How many households?
- What was the research design?
- What were the experimental treatments?
- What kind of data analysis was employed?
- What were the major findings?
- What were the researcher's conclusions?
- How do these bits of information relate to other research reports or similar topics?

2.3 Theoretical/ Conceptual Framework

- This presents the theory from which the research problem was derived
- This is a discussion of the theory which serves as the basis for the study

3. MATERIALS AND METHODS

Purpose

- This section shows how the research objectives/hypotheses will be answered/tested in the most rigorous way.
- Describes in detail the specific methods and the materials needed to accomplish the research.

- Explains the procedures to be followed. It is not necessary, however, to describe in detail a procedure already published, so cite the original reference but explain modifications.
- Provide a clear and complete descriptions for all experimental, analytical, and statistical procedures
- The section should include enough information so that another researcher can repeat the procedures and expect to get similar results
- It is very useful to consider questions such as:

“Where?”	Important to describe where the study will explicitly takes place.
“How?”	provide a detailed description of what will occur from the time the project starts until it ends, i.e., how you will do the research
“When?”	present the methods in a logical sequence of activities in a time frame.
“Why?”	justify the chosen methods, especially if they are new or unique. Also explains why the planned activities are expected to produce certain outcomes.

3.1 Description of the Study Area

- Describing the biophysical environment of the study area is very important
- Suggestion for content include:

  Location and physiography

  Climate

  Geology and soils

  Population and production systems

3.2 Methodology

Experimental Plan. The hypothesis or questions being asked and the methodology being applied to the proposed project should be stated explicitly. Specifically, this section must include:

- A description of the investigations and/or experiments proposed in the sequence in which the investigations or experiments are to be performed
- Techniques to be used in carrying out the proposed project; including the feasibility of the techniques
- Results expected
- Means by which experimental data will be analyzed or interpreted
- Means of applying results or accomplishing technology transfer, where appropriate
- Pitfalls that may be encountered
- Limitations to proposed procedures; and

- A tentative schedule for conducting major steps involved in these investigations and/or experiments

- This is the most important part of your proposal. Outline for each of the specific aims listed in the previous section (using the same numbering) how you will proceed to answer the questions posed.
- Provide enough detail so the reviewer can judge if the experiment is likely to work.
- Be sure to incorporate appropriate controls in your experiments whenever necessary.
- You do not need to give details about common procedures since these can be referenced. For example, molecular biological methods that are described in a manual, such as ***Maniatis,*** do not need to be detailed (i.e., buffers, times of incubation, etc.).
- Basic protocols that are integral to the proposed work should be detailed. Reviewers will look for indications that you have carefully thought out every step in the proposed procedure.
- If you are not sure that every step is feasible, so indicate and describe what alternatives exist if the experiment does not work.
- Plan to design experiments that will yield results no matter how they come out.
- An important aspect of the Experimental Plan section is how the data will be interpreted -- especially so for quantitative data. Grants are seldom funded just to make measurements! Grant proposals are frequently criticized because the results are "purely descriptive." What is the meaning of the data you hope to collect and how does it relate to the overall biological problem? Explicit interpretations are a key element in convincing reviewers that papers resulting from your work will become a significant contribution to the field rather than confounding the research area so that others will have to "mop up" afterwards, as often happens.
- At the end of the Experimental Plan section, it is wise to add a paragraph or two about possible pitfalls since nothing is guaranteed to work. If you inform the reviewer about the major limitations, you make it clear that you have thought about them. Again, it is wise to plan for contingencies so that you do not "paint yourself into a corner." There are several type of pitfalls that you should be aware of which occur in proposals and also in real grant applications:

The Experimental Design/Research Design

- ***It is the plan, structure and strategy of the investigation***
  - the **plan** is the overall scheme to be followed in conducting the research

- The **structure** is the more specific outline of how the variables are operationalized
- The **strategy** is a description of details such as methods to be employed in collecting and analyzing the data.

- The design of planned experiments or the sampling protocol of surveys, should be conveyed clearly and concisely
- Describe clearly and carefully your experimental subjects, numbers, treatments, environmental conditions, measurements, field layout and statistical models

It will often dictate by the necessary and appropriate **statistical tests** or other evaluation tools that can dictate the hypothesis.

Describing the variables (parameters) of the study

There are two common ways of categorizing variables, namely independent and dependent variables:

- The *independent variable* is the presumed *cause*
- The *dependent variable* is the presumed *effect*

It is always necessary to define the clarity of the variables

Describe/list the parameters to be studied and State any assumptions you made and state quantities in standard units.

Sampling Techniques

- A sample is part of a population which is observed in order to make inferences about the whole population
- Considerations to be taken in selecting/ determining sample are:
  - *Homogeneity* sample taken from a heterogeneous population will not be representative of the population.
  - *Size of the population* if the population is large, you need a sample.
  - *Cost* size of sampling is based on the cost
  - *Precision* if to achieve precision, you will need a larger sample because the larger the sample, the more precise will be the result.
- There are two general types of sampling methods (probability and non-probability)

- In **probability sampling** , each individual is selected randomly
    - *Random sampling* Everyone has equal chance of being selected
    - *Systematic sampling* This technique starts by numbering consecutively all individuals in the population

      The first sample is selected through a simple random process. Then, the succeeding samples are chosen at pre-established
    - *Stratified sampling* Applicable when the population is not homogenous

      Divide the population into homogenous groups
- In **non-probability sampling** there are *judgement, quota and accidental* sampling.

The Questionnaire/Interview Methods

The Questionnaire

- Is a set of questions, arranged in sequence and designed to be self administered.
- The instructions are directed to the respondent.
- It has an advantage in that it is *less expensive, ensures uniformity, respondents have confidence* to express their views
- Used if respondents are literate
- When you are using a questionnaire method explain:
    - Why the questionnaire method is most suitable?
    - Include a proposed questionnaire as an appendix
    - Explain whether a questionnaire has been pre-tested or how this will be done?
    - How will sample will be chosen?

The Interview

- Is also a set of questions, but the questions are meant to be asked by interviewer
- It has advantages in that it yield much better information, more flexible, the interviewer observes, if the respondent misunderstood, the interviewer explains.
- In case of interviewing, who will do it and how will they be trained?

In both cases there is a need to:

- List down research objectives
- For each objective list/prepare possible questions

Data Collection and Analysis

- Describe exactly how you are going to collect your data
- Describe how you are going to proceed in using questions/interview/other methods
- Discuss how you will present and analyze your data
- There are two major types of data analysis:

Quantitative Analysis This include *Descriptive statistics* and *ANOVA*

Qualitative Analysis Interpreting information

Materials (Facilities and Equipment)

- It is certain that you will require the use of specific facilities and equipment to carry out your research
- List the specific materials that will be required such as:

Laboratory facilities

Field equipment

Computer facilities

Etc.

4. WORKPLAN (TIMETABLE) AND BUDGET

- You need to present timetable/work plan/schedule for each activity to be implemented
- The budget section is a statement of proposed support and expenditures
- A poorly presented budget probably reflects a poorly developed proposal
- State also if there is special collaboration/Cooperation

4.1. Sample Work and Budget plan

4.1.1 Work Plan

Table 1. Activity plan of the research work

S/N	Activity	Month											
		Apr	May	J	J	A	S	O	N	D	J	F	M
1	Collection of oat seeds												
2	Land rent and preparation												
3	Recruiting guard												
4	Preparation of land and experimental plots												
5	Collection of soil samples												
6	Sowing oat seeds												
7	Weeding oat plots												
8	Agronomic data collection												
9	Harvesting oat at 10% flowering												
10	Harvesting oat at maturity												
11	Analysis of forage samples												
12	Follow up of activities												
13	Data analysis and write up												

4.2.2. Budget Plan

Table 2. Land rent and labor cost

S/N	Description	Unit	Quantity	Cost (Eth Birr)	
				Unit	Total
1	Land rent	LS	-	-	6500
2	Land preparation	Man day			
3	Measuring agronomic parameters	Man day			
4	Guard	Month			
5	Weeding	Man day			
				Sub-total	

Table 3. Perdiem

S/N	Description	Duration in days	Perdiem rate (Birr)	Total payment (Birr)
1	Selection of experimental area			
2	Collection of seed sources and other supplies			
3	Follow up of field activities			
4	Follow up of activities during laboratory analysis			
			Sub total	

Table 4. Soil laboratory analysis cost

S/N	Type of Analysis	Total Composite Sample	Unit Cost/Sample	Total Cost (Birr)
1	Sample preparation			
2	Texture			
3	pH			
4	CEC			
5	Total Nitrogen			
6	Available phosphorus			
			Total Budget	

Table 5. Chemical analysis of forage samples

S/N	Type of analysis	Unit	Quantity	Unit price (Birr)	Total price (Birr)
1	Dry matter determination	No. of samples			
2	Crude protein determination	No. of samples			
3	Lipid determination	No. of samples			
4	Ash determination	No. of samples			
5	Acid detergent fiber	No. of samples			
6	Neutral detergent fiber	No. of samples			
7	Acid detergent lignin	No. of samples			
				Sub total	

Table 6. Budget summary

S/N	Budget description	Total cost (Birr)
1	Land rent and labour cost	
3	Perdiem	
4	Soil laboratory analysis cost	
5	Chemical analysis of forage samples	
6	Contingency (5%)	
	Grand total	

Chapter V. BIBLIOGRAPHIC CITATIONS

(i) Footnoting

- Footnotes are very useful devices because they serve a number of purposes
- They enable you to substantiate your presentation by citing other authorities
- They also enable you to present explanatory statements that would interfere with the logic of your text
- Traditionally, footnote citations are placed at the bottom of the page
- They are separated from the text by a horizontal line from the text margin.

(ii) Abbreviations

- You may use abbreviations in bibliographic and footnote citations if you want to conserve space. Examples: bk., bks. = book, books.

(iii) Bibliography (Reference/Literature Cited)

- Listing of materials that helped in developing the proposal (list of materials that were cited or mentioned in the proposal)
- There are many ways of presenting the bibliography ***but be accurate and consistent*** in the way you list

- ♦ Follow guidelines demanded by the particular journal, proceeding, etc. They do have their own style of citations.
- ♦ Don't fail to include citations of possible reviewers if at all relevant to the research
- ♦ Citing a source without having read/seen the original can lead to embarrassment and loss of credibility if the secondary source from which you gained the information is in error.
- ♦ General rule:

Author (s). Year of Publication. Title of Work. Publication data.

In-text references citations

References are citations of other works such as books, journal articles, or private communications. References in text are treated somewhat differently from references in the complete list at the end of a paper.

- Use the author-date format to cite references in text. For example: as Smith (1990) points out,
- For two-author citations, spell out both authors on all occurrences.
- For multiple-author citations (up to five authors) name all authors the first time, then use et al., so the first time it is Smith, Jones, Pearson and Sherwin (1990), but the second time it is Smith et al., with a period after "al" but no underlining.
- For six or more authors, use et al. the first time and give the full citation in references.
- Include page reference after the year, outside quotes but inside the comma, for example: The author stated, "The effect disappeared within minutes" (Lopez, 1993, p. 311), but she did not say which effect. Another example would be: Lopez found that "the effect disappeared within minutes" (p. 311). Notice also that the sentence is capitalized only if presented after a comma, as a complete sentence.
- If two or more multiple-author references which shorten to the same "et al." form, making it ambiguous, give as many author names as necessary to make them distinct, before et al. For example: (Smith, Jones, et al., 1991) to distinguish it from (Smith, Burke, et al., 1991).
- Join names in a multiple-author citation with and (in text) or an ampersand (&) in reference lists and parenthetical comments. For example: As Smith and Sarason (1990) point out, the same argument was made by in an earlier study (Smith & Sarason, 1990).
- If a group is readily identified by its initials, spell it out only the first time. For example, "As reported in a government study (National Institute of Mental Health [NIMH], 1991), blah blah..." and thereafter, "The previously cited study (NIMH, 1991) found that...

- If the author is unknown or unspecified, use the first few words of the reference list entry (usually the title), for example: ("Study Finds," 1992).
- If citing multiple works by the same author at the same time, arrange dates in order. In general, use letters after years to distinguish multiple publications by the same author in the same year. For example: Several studies (Johnson, 1988, 1990a, 1990b, 1995 in press-a, 1995 in press-b) showed the same thing.
- For old works cite the translation or the original and modern copyright dates if both are known, for example: (Aristotle, trans. 1931) or (James, 1890/1983).
- Always give page numbers for quotations, for example: (Cheek & Buss, 1981, p. 332) or (Shimamura, 1989, chap. 3, p. 5).
- For e-mail and other "unrecoverable data" use personal communication, for example: (V.-G. Nguyen, personal communication, September 28, 1993). These do not appear in the reference list.

Abbreviating within a reference

Here are approved abbreviations for use in a reference list:

- chap. for chapter
- ed. for edition
- rev. ed. for revised edition
- 2nd ed. for second edition
- Ed. for Edited by
- (Eds.) for multiple editors
- Trans. for Translated by
- p. for page number, with a space after the period
- pp. for page numbers in encyclopedia entries, multi-page newspaper articles, chapters or articles in edited books, but not in journal or magazine article citations, where numbers alone should be used (see examples of reference formats).
- Vol. for Volume
- vols. for volumes
- No. for Number
- Pt. for Part
- Suppl. for Supplement,
- Tech. Rep. for Technical Report

Quotations: When a direct quotation is used, always include the author, year, and page number as part of the citation.

A. A quotation of fewer than 40 words should be enclosed in double quotation marks and should be incorporated into the formal structure of the sentence. Consider the following example:

> Patients receiving prayer had "less congestive heart failure, required less diuretic and antibiotic therapy, had fewer episodes of pneumonia, had fewer cardiac arrests, and were less frequently intubated and ventilated" (Byrd, 1988, p. 829).

B. A lengthier quotation of 40 or more words should appear (without quotation marks) apart from the surrounding text, in block format, with each line indented five spaces from the left margin.

References

General Rule:

- *Pagination:* The References section begins on a new page.
- *Format:* The references lists are organized alphabetically by surnames of first authors.
- Most reference entries have three components:
  - (i) ***Authors:*** Authors are listed in the same order as specified in the source, using surnames and initials. Commas separate all authors. When there are seven or more authors, list the first six and then use "et al." for remaining authors. If no author is identified, the title of the document begins the reference. The first author always starts with its surname followed by initials. The rest of authors are listed following the first author either starts by initials followed by surnames or viceversa.
  - (ii) ***Year of Publication***: In parentheses following authors, with a period following the closing parenthesis. Or without parenthesis following authors, with a period following authors and after it. If no publication date is identified, use "n.d." in parentheses or without parenthesis following the authors.
  - (iii) ***Source Reference***: Includes title, journal, volume, pages (for journal article) or title, edition, city of publication, publisher (for book). [**Note:** Italicize titles of books, titles of periodicals, and periodical volume numbers.]

Examples of sources

(i) Journal article

Murzynski, J., & Degelman, D. (1996). Body language of women and judgments of vulnerability to sexual assault. *Journal of Applied Social Psychology, 26,* 1617-1626.

(ii) Book

Paloutzian, R. F. (1996). *Invitation to the psychology of religion* (2nd ed.). Boston: Allyn and Bacon.

American Psychiatric Association. (1990). *Diagnostic and statistical manual of mental disorders* (3rd ed.). Washington, DC: Author.

(note: "Author" is used as above when author and publisher are identical.)

(iii) Article or chapter in an edited book

Shea, J. D. (1992). Religion and sexual adjustment. In J. F. Schumaker (Ed.), *Religion and Mental Health* (pp. 70-84). New York: Oxford University Press.

(iv) Web document on university program or department Web site

Degelman, D., & Harris, M. L. (2000). *APA style essentials.* Retrieved May 18, 2000, from Vanguard University, Department of Psychology Web site: http://www.vanguard.edu/faculty/ddegelman/index.cfm?doc_id=796

(v) Stand-alone Web document (no date)

Nielsen, M. E. (n.d.). *Notable people in psychology of religion.* Retrieved August 3, 2001, from http://www.psywww.com/psyrelig/psyrelpr.htm

(vi) Stand-alone Web document (no author, no date)

Gender and society. (n.d.). Retrieved December 3, 2001, from

http://www.trinity.edu/~mkearl/gender.html

Journal article from database

Hien, D., & Honeyman, T. (2000). A closer look at the drug abuse-maternal aggression link. *Journal of Interpersonal Violence, 15,* 503-522. Retrieved May 20, 2000, from ProQuest database.

Abstract from secondary database

Garrity, K., & Degelman, D. (1990). Effect of server introduction on restaurant tipping. *Journal of Applied Social Psychology, 20,* 168-172. Abstract retrieved July 23, 2001, from PsycINFO database.

(ix) Letter to the editor

O'Neill, G. W. (1992, January). In support of DSM-III [Letter to the editor]. *APA Monitor,* 4-5.

(x) Magazine article

Gardner, H. (1991, December). Do babies sing a universal song? *Psychology Today*,70-76.

(xi) Newsletter article

Brown, L.S. (1993, Spring). My research with oranges. *The Psychology Department Newsletter*, *3*, 2.

The date is given as it appears on the publication. For anonymous newspaper articles.

(xii) Pamphlet

Just Say No Foundation. (1992). *Saving our youth.* (9th ed.) [Brochure]. Washington, DC: Author.

(xiii) Anonymous or unknown author (common in newspapers):

Caffeine linked to mental illness. (1991, July 13). *New York Times*, pp. B13, B15.

(i) **Books:**

Steel, R.G.D., and J.H. Torrie. 1980. *Principles and procedures of statistics*: *A biometrical approach* (2nd ed.). McGraw-Hill, New York.

OR

Steel, R.G.D., and Torrie, J.H. 1980. *Principles and procedures of statistics: A biometrical approach* (2nd ed.). McGraw-Hill Publishing Co., New York.

OR

Steel, R.G.D., and J.H. Torrie (1980). *Principles and procedures of statistics: A biometrical approach* (2nd ed.). McGraw-Hill, New York.

OR

Steel, R.G.D., and J.H. Torrie. 1980. Principles and procedures of statistics: A biometrical approach (2nd ed.). McGraw-Hill, New York.

OR

Steel, R.G.D., and J.H. Torrie. 1980. *Principles and procedures of statistics: A biometrical approach*. Second edition. McGraw-Hill, New York.

OR

Steel, R.G.D., and J.H. Torrie. 1980. *Principles and procedures of statistics: A biometrical approach* (2nd ed.). PP 600, McGraw-Hill, New York.

Stoddart, L.A., A.D. Smith, and T.W. Box. 1975. *Range management*. McGraw-Hill, New York.

OR

Stoddart, L.A., A.D. Smith, and T.W. Box. 1975. *Range management*. McGraw-Hill, New York.

OR

Stoddart, L.A., A.D. Smith, and T.W. Box. *Range management*. McGraw-Hill, New York, 1975.

(ii) Journal article

Spitch, M. L., Verzy, H. N., & Wilkie, D. M. (1993). Subjective shortening: A model of pigeons' memory for event duration. *Journal of Experimental Psychology: Animal Behavior Processes, 9,* 14-30.

Karmin, H.H., and A.J. Utrsop. 1959. Preliminary evaluations of exotic germplasm. *Agronomy Journal 51*: 687-689.

OR

Karmin, H.H., and A.J. Utrsop. 1959. Preliminary evaluations of exotic germplasm, *Agronomy Journal*, 51, 687-689.

OR

Karmin, H.H., and A.J. Utrsop. 1959. Preliminary evaluations of exotic germplasm. *Agronomy Journal*, *51*: 687-689.

Karmin, H.H., and A.J. Utrsop. Preliminary evaluations of exotic germplasm. *Agronomy Journal* 51: 687-689, 1959.

Oltjen, R.R., H. Swan, T.S. Rumsey, D.J. Bolt, and B.T. Weinland. 1973. Fedlot performance and blood plasma amino acid pattern in beef. *J. Nutr*. 103: 1131-1137.

***(iii)* Article or chapter in an edited book**

Diress, T.A., K.O. Farah, and H. Mitiku. 1999. Land use and vegetation changes in the semi-arid area of Aba'ala: Aerial photo analysis and field survey. **In:** H. Mitiku, T. Teka, A. Alemayehu, T. Diress, Z. Merha (Eds.*) Proceedings of the National Workshop on Challenges and Opportunities for Research and Development in Pastoral and Agro-pastoral Areas of Ethiopia*, Held from 16-18 December 1998 (pp 39-50). Mekelle University, Ethiopia.

Walker, B.H., and I. Noy-Mier. 1982. Aspects of the stability and resilience of savanna ecosystems. **In:** B.J. Huntley, and B.H. Walker (Eds.) *Ecology of tropical savannas* (pp 556-590). Spring Vertag, Berlin.

Goodman, M.M. 1999. Choosing germplasm for breeding programme success. **In:** *Crop Improvement for Sustainable Agriculture*, Gallaway, M.B., and C.A. Francis (Eds). University of Nebrsaka Press, Lincolin.

(iv) **Others**

Tassew, W.K. 1995. Forest policy analysis and woodland clearing in a closed economy, the Ethiopian case. Unpublished master's thesis, Department of Economics, Wagengen Agricultural University, The Netherlands.

Tadingar, T. 1994. Pastoral development in sub-Saharan Africa: The role and significance of indigenous technical knowledge. *The African Pastoral Forum*, PINEP (Pastoral Information Network Programme) Working Paper Serie No. 1, University of Nairobi, Kenya.

ILCA (International Livestock Center for Africa). 1981. New ways for old worlds: Development and research, new approach to the Ethiopian rangelands development project. *ILCA Bulletin*,vol. 15:12-13, Addis Ababa, Ethiopia.

Freud, S. (1961). The ego and the id. In J. Strachey (Ed. and Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 19, pp. 3-66). London: Hogarth Press. (Original work published 1923)

In text this would be cited as (Freud, 1923/1961).

a) In the Text

<u>Option One</u>

Stoddart *et al*. (1975) provide slightly different definitions of rangeland

According to Stoddart *et al*. (1975), a slightly different definitions of rangeland was provided

Income generated from selling hunting privileges can exceed that from livestock on some ranches (Ramsey 1965, Henson *et al*. 1977, Burger and Teer 1981).

Rangeland wildlife have potential as sources of meat for human consumption in many African countries(Casebeer 1978).

......the quality of water from overland flow that can be trapped in reservoirs (Branson *et al*. 1981)

.... increasing (Burger and Teer 1981).

The FAO (1982) define "permanent pasture" as ....

Option Two

Stoddart *et al*. (1975) provide slightly different definitions of rangeland

According to Stoddart *et al*. (1975), a slightly different definitions of rangeland was provided

Income generated from selling hunting privileges can exceed that from livestock on some ranches (Ramsey, 1965; Henson *et al*., 1977; Burger and Teer, 1981).

Rangeland wildlife have potential as sources of meat for human consumption in many African countries (Casebeer, 1978).

CHAPTER FOUR

4. Research Report Preparation/ presentation

Writing a scientific paper is an integral part of the research processes:
Problem identification → Hypothesis formulation → Design and conduct of expt. → Data analysis and hypothesis testing → writing up the results → Publish.

- The key factors in publishing a paper is knowledge of the principles of writing a scientific paper.
- Since science generates science, there is an obligation to publish research results if you are a scientist.

Types of scientific publications

- Journals
- Research reports
- Bulletins
- Annual reviews
- Conference/workshop proceedings
- Newsletters, etc.

What is a primary research paper?

- It is an account of unpublished original research.
- Written in a form that allows peers to repeat the experiment and verify the results
- Published in a journal available to the scientific community and indexing services

Questions before you start writing

- Do I have results representing an advance in knowledge/practice?
- Which journal to publish?
- Know editor's questions. They usually ask does the paper represent an advance in knowledge or practice.

Five steps procedure to assess you results before you write

- Analyze and tabulate your data
- Write down the main findings and conclusions
- Assess the firmness of the conclusions
- Discuss your conclusions with experienced researchers/ scientists
- Assess your conclusions in the light of comments and criticisms and decide whether to proceed or not.

Which journal to write for (Selection of a journal)?

- Determined by the nature of your work
- The reputation of a journal
- Its circulation
- Its frequency of publication
- Its page cost, etc.

Organisation Layout of a Research Paper

- There is no standard format
- Requirements of journal vary from discipline to discipline
- The writer is advised to follow the 'instructions to authors' of the chosen journal.

4.1. Parts of the Dissertation (M.Sc. Thesis or Ph.D. Dissertation):

Title

Signature Page

Copyright (Optional)

Acknowledgments

Abstract

Table of Contents

List of Tables and List of Illustrations

Acronyms/Abbreviations

Chapter I. Introduction, or Statement of the Problem

Chapter II. Review of the Literature and Research Questions

Chapter III. Methodology

Chapter IV. Results

Chapter V. Discussion

Chapter VI. Conclusion

References

Appendices/Annexes.

4.2. The most usual structure of a paper to be published in a journal

Title immediately followed by name of author (s)

Abstract

Introduction

Review of the Literature (Optional)

Methodology

Results

Discussion

Conclusion

Acknowledgments

References

Appendices/Annexes (Optional)

4.3. PRELIMINARIES OF A RESEARCH PAPER

Title

- The title of the research paper, like the title of the proposal, should summarize the project, should not generally exceed 17 words, and should not include unnecessary words such as "A Study of...."
- The title should include key terms that readily identify the scope and nature of the study; usually typed in all capital letters.
- It is a starting point for attracting a reader’s attention
- Characteristics of a good title are **brevity** (briefness) and **specificity** (specific to the point).
- A good title adequately describes the contents of the paper clearly
- A general title may disappoint a reader

Authorship

- Who? In what sequence?
- Only those who contributed to the work, in order of magnitude of their contributions.
- Give the addresses of each author.

Copyright (applies only for Desertion or Thesis)

Copyrighting the dissertation, although highly desirable, is optional. Candidates who wish to may apply for a copyright for their dissertations, through University Microfilms Incorporated (UMI) or other avenues.

Acknowledgments

Acknowledgments give credit for external support received throughout the dissertation process and recognize generally the contributions of committee members and others who made important contributions. Acknowledgments also express gratitude for the use of copyrighted or otherwise restricted materials, as appropriate. A doctoral candidate may choose to dedicate the dissertation to a person or persons who have had significant impact on the author's work. This dedication, when included, should be brief and is best placed at the end of the acknowledgments section.

This comes after the conclusion and before reference for a journal paper

Abstract

Purpose:

- Guide subject-matter experts in assessing contents of the paper
- Provide maximum possible information to peripheral readers
- Assist abstracting journals for indexing services

Ingredients:

- Statement of the problem and objectives
- Methods used (very briefly)
- Major results or findings
- Concluding statement (s).

Important attributes:

- It is a brief summary of the research
- The abstract, which **must not exceed 350 words** for the final dissertation (**do not exceed 250 words for a journal paper),** is a **concise (brief),** comprehensive summary of the contents of the paper. Generally written after the write up is complete.
- The abstract should be readable, coherent, well-organized, concise, and **self-contained** because the abstract is often printed separately.
- It contains information that is contained in the text

Table of Contents (applies only for Desertion or Thesis)

- The table of contents should list in order of appearance all components of the dissertation, including all headings and subheadings, with the correct corresponding page numbers. The table of contents should be double-spaced between entries; entries longer than one line should be single-spaced.

- The page numbers for materials preceding Chapter I (Introduction) should be in **lower-case roman numerals**, while all subsequent materials should be listed with **standard Arabic numerals**.

List of Tables and List of Illustrations (applies only for Desertion or Thesis)

- Separate lists should be created for tables and illustrations that appear in the text of the document.
- Illustrations appropriate for use in dissertations include figures, maps, diagrams, photos, and plates.
- These lists should include the number and full name of each table or illustration, listed in order of appearance in the text, followed by the number of the page on which the table or illustration appears.
- Tables and illustrations are usually numbered sequentially in Arabic numerals, the first digit representing the chapter, followed by a decimal and the table or illustration's number within that chapter, e.g. 4.12 (the twelfth table or illustration in chapter 4).
- The list of tables and the list of illustrations should be double-spaced between entries; entries longer than one line should be single-spaced.

4.4. MAIN BODY OF A RESEARCH PAPER

4.4.1. Introduction.

- As in the proposal, the introduction presents the problem addressed by the research.
- Gives sufficient background information to allow readers to understand the results of the study.
- It is described in such a way that readers will know the current status of research conclusions on the topic, the theoretical implications associated with the results of previous research on the subject, and the statement of a hypothetical resolution of the issues to be tested by the research described.
- As in the proposal, the introduction should describe the nature and purpose of the study, present the guiding research questions, and explain the significance of and justification for conducting the study. Terms likely to be used throughout the paper should be defined in this section.
- A statement of objectives is included and a research hypothesis.

4.4.2. Review of the Literature (Optional)

- The review of the literature provides or summarizes the present study in the context of previous research.
- The review should be similar to the review of literature in the proposal but should reflect any change of focus or direction that resulted from the research process.
- Again, this section may present the hypothesis or research questions and the relationship of these to the previous findings.

4.4.3. Materials and Methods (Methodology)

- The methodology section of the paper should build on the description of methods outlined in the proposal.
- Labelled subsections similar to those in the proposal should be included.
- These may include a section describing participants or subjects, a section describing testing or other measurement procedures undertaken with the participants, and a section discussing limitations of the methodology. (The descriptions of the analyses which appeared in the proposal are usually incorporated in the results section of the final dissertation.)
- Describe (in past tens or past perfect tense) the methods and materials used so that others may repeat the experiment and validate the result.

4.4.4. Results and Discussion

4.4.4.1 Result

- The results section summarizes the data collected and details the statistical treatment of that data.
- Present your results in a logical sequence using only observations pertinent to your stated objectives.
- After a brief statement of the main results or findings of the study, the data are reported in sufficient detail to justify the conclusions.
- Tables and illustrations (e.g., figures et al.) may be used to report data when these methods are seen to present the data more clearly and economically.
- Do not list replicate observations in your tables. Give only means and measures of variability
- Use tables to present exact values and figures to show trends and relationships
- All tables and illustrations used should be mentioned in the text, with appropriate titles or captions and enough explanation to make them readily identifiable.
- Avoid repetition of numerical data from the tables and figures in the text

4.4.4.2. Discussion

- What do my results mean and what are their implications?
- Should interpret your results clearly, concisely and logically. For each objective, describe how your results relate to meeting that objective.
- In the discussion section, the major results are picked or summarized, evaluated, and interpreted with respect to the original research questions and hypotheses and related with *previous works*..
- In this section, the investigator is free to examine, interpret, and qualify the results, as well as to draw inferences from them.
- Theoretical and practical consequences of the results and the validity of conclusions may appropriately be discussed in this section.
- The limitations of the study and suggestions for future work may also be included.
- Emphasize on new results and suggest new lines of work or further research.

4.4.5. Conclusion and Recommendations

- Should describe briefly what you did, the main results and recommendations for further research or applicability.
- Implications what the findings of the research imply (consider suggestions)..

4. References

- The reference list at the end of the paper should list all works cited in the paper, and all items listed as references must have been cited in the text.
- Special attention should be given to ensure appropriate citations of less common sources, such as unpublished manuscripts.
- Again, the APA Manual can provide guidance for ensuring accuracy in these details.

5. APPENDICES (ANNEXES)

- Materials that document important components of the research process that would be too lengthy, awkward, or distracting to include within the text should be included as appendices in the final document.
- These materials may include pertinent raw data, materials, consent forms, letters of introduction to subjects, questionnaires, survey forms, and the like.
- The appendix section should begin with its own cover page.
- Each appendix may have its own cover page.
- The word "APPENDIX" should appear in all capital letters.

Chapter five

5. On-Farm Research Background

5.1. General over view On-farm research

Farmers have often evaluated a new practice by applying it to a small field and comparing the results with nearby fields, or by splitting a field and applying the new practice on one side and their normal practice on the other. This allows for a local comparison of how a practice "looks." It can be an important first step. The problem comes when you want more than a "look." It is simply not possible to make reliable comparisons of yields and other "quantitative" data without a scientific approach (Veseth et al., 1999).

On-farm research is in fact that "look" in combination with a scientific approach. An on-farm trial aims at testing a technology or a new idea in farmer's fields, under farmers' conditions and management, by using farmer's own practice as control. It should help to develop innovations consistent with farmer's circumstances, compatible with the actual farming system and corresponding to farmer's goals and preferences. An on-farm-trial is not identical to a demonstration field, which aims at showing farmers a technology of which researchers and extension agents are sure that it works in the area (RNR-RC Jakar, 2001).

Some basic principles for on-farm research are:

- ***Keep it real****:* The experiments must address problems that are important to farmers. The farmers' practice should be included as one of the treatments in the experiment. The non-experimental variables of an experiment should reflect farmers 'actual practice (CIMMYT,1988).
- ***Keep it simple****:* Limit your experiment to a comparison of two (or maximum three) treatments. The research objective has to be a single researchable question. Many test plots are too complicated because they are looking at too many treatments. On-farm research must be practical for the farmer by using plots that are field-scale with standard farm implements (Sundermeier, 1997).
- ***Go step by step****:* Farmers usually do not adopt entire new systems of production; they go step-by-step adapting components of the technology. Therefore the on-farm-trial should not include too many new steps at once. The success of innovation is measured by scale of adoption by farmers (RNR-RC Jakar, 2001).
- ***Remain objective****:* The results may not turn out as you hoped or planned. Be prepared to accept and learn from negative results (RNR-RC Jakar, 2001).

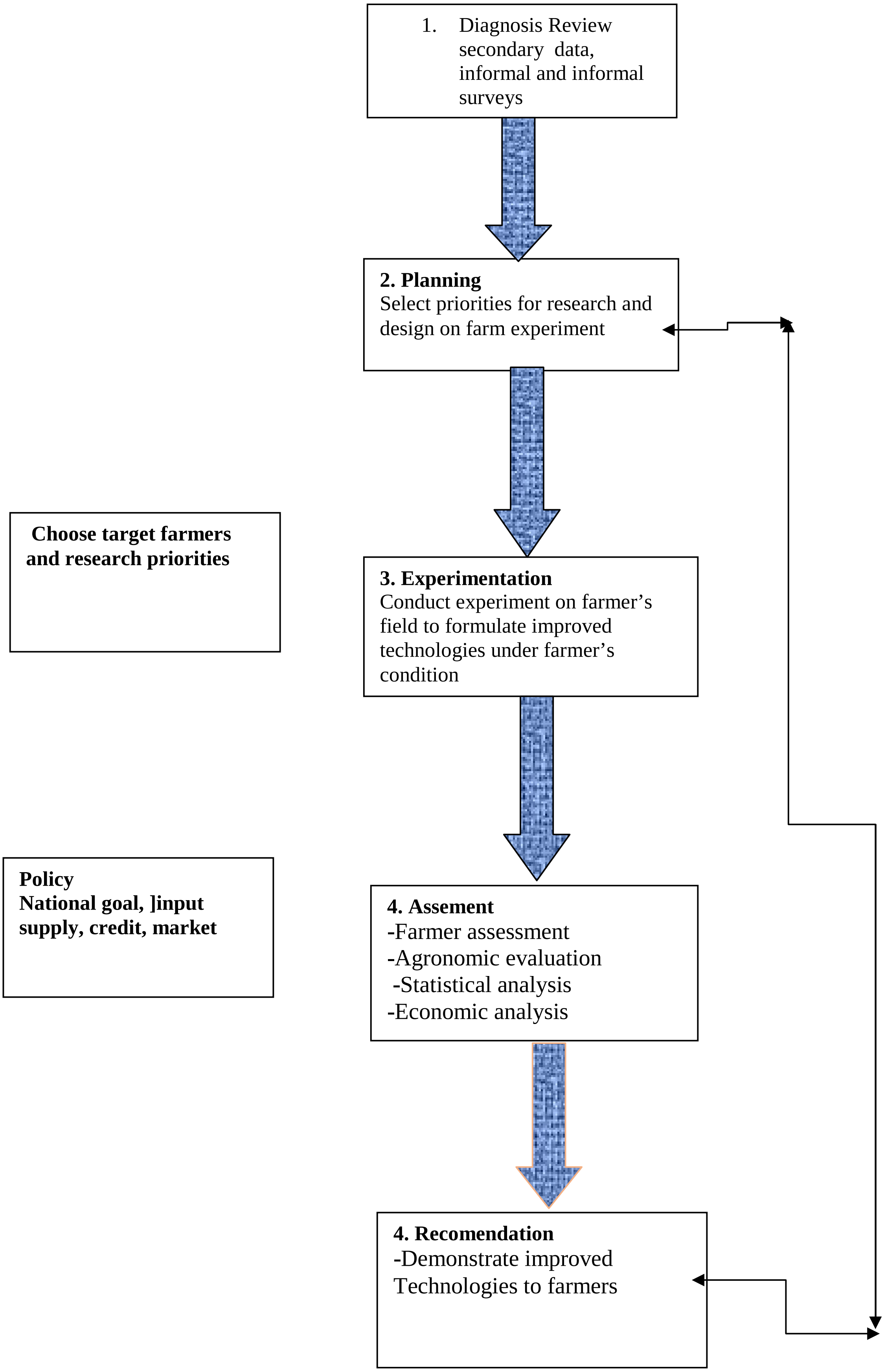


Figure 1 Stages of on-farm research

5.2 Types of on-farm research

On-farm research can differ according to:

- the chosen objective
- the selected location
- the type of design used
- the degree of farmer involvement

5.2.1. Researcher-designed and managed trials

The objective is to assess the performance of the new technology under various biophysical Conditions. Research has shown promising results in on station trials. Now the concerned researcher wants to evaluate the new technology in multi-location as the on station trial does not represent the wide range of conditions (e.g. soil fertility, weed flora, altitude, rainfall, farmers' conditions). Usually plots are of small size

5.2.2 researcher-designed and farmer-managed trials

The objective is to get farmer feedback on specific prototypes and to conduct economic analysis. Researcher-designed and managed trials have confirmed that the new technology will work in farmers' conditions, therefore it is planned to implement the trial on a wider scale with active involvement of the farmers. Researchers are interested in getting the information on biophysical, economical and farmer's assessment of the technology. Plots are often larger than in Researcher-designed and managed trials

5.2.3. farmer-designed and –managed trials

The farmer experiments on their own and the objective is to assess farmer innovation and acceptability. Farmers are aware of a given technology, they like what they see and would like to experiment it by themselves or farmers are aware of a problem and would try some methods to solve them. Researchers want to know to which extent and how a technology is adapted by farmers. Constant monitoring and recording of farmers' comments is necessary (RNR-RC Jakar, 2001).

5.3. Stakeholders of on-farm trials

Stakeholders in an on-farm trial:

- The *farmers* who are the clients for the out-coming results.
- The *extension agents* who should help the farmers to overcome their problems and improve their economic situation. On-farm trials can give them valuable information in this respect.

- The researchers who need to apply promising on-station results under farmer’s conditions before releasing the technology to the extension service.
- The policy makers that are interested in an efficient and participatory technology development, since other more top-down approaches have proven futile.

5.4. Planning and Implementing On-Farm Research

All experiments have certain things in common, so designing an on-farm experiment usually includes the following steps:

- ✓ *Establish your goal and objectives*
- ✓ *Determine what treatments you will use and what your check plot or control will be*
- ✓ *Select a site*
- ✓ *Determine how best to lay out your plots on the selected site*
- ✓ *Determine what data you will collect and how you will collect it*
- ✓ *Determine how the data will be evaluated*
- ✓ *Determine how the data will be shared with others*

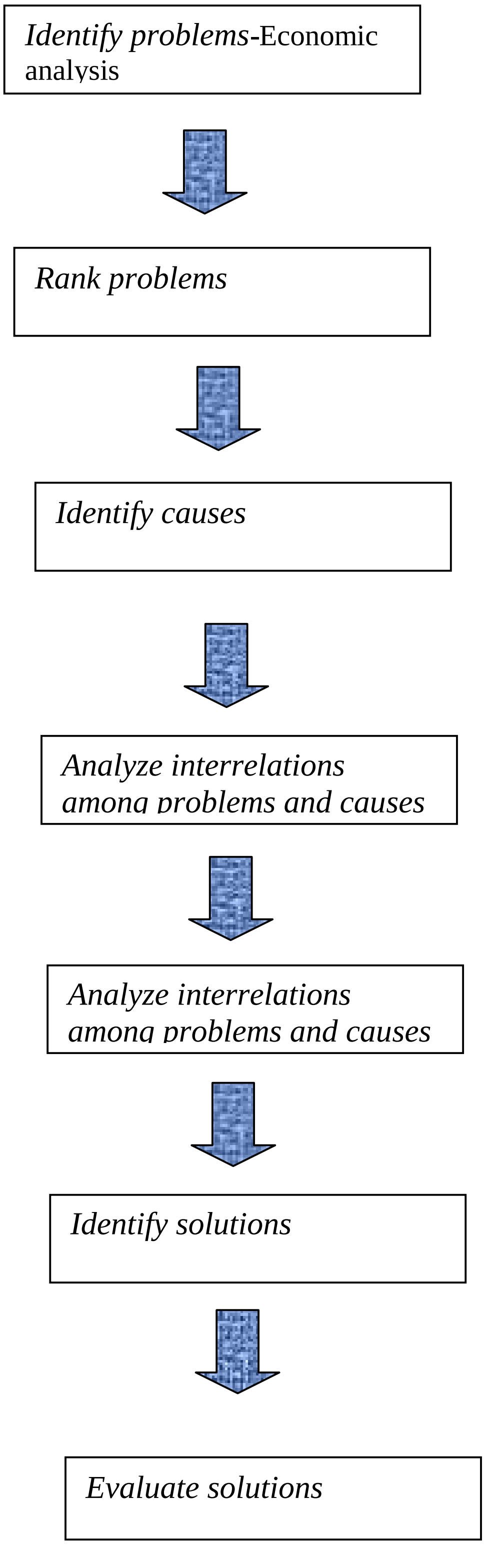


Figure 2. Steps in participatory research planning process

The list of possible solutions will be narrowed by evaluating each solution according to a number of criteria. These criteria involve

- ✓ *probability that the technology will function*
- ✓ *profitability*
- ✓ *compatibility with the farming system*
- ✓ *contribution to reducing risk*

- ✓ *need for institutional support (extension, provision inputs, credit)*
- ✓ *ease of testing by farmers and*
- ✓ *ease of carrying out the on-farm research activity*

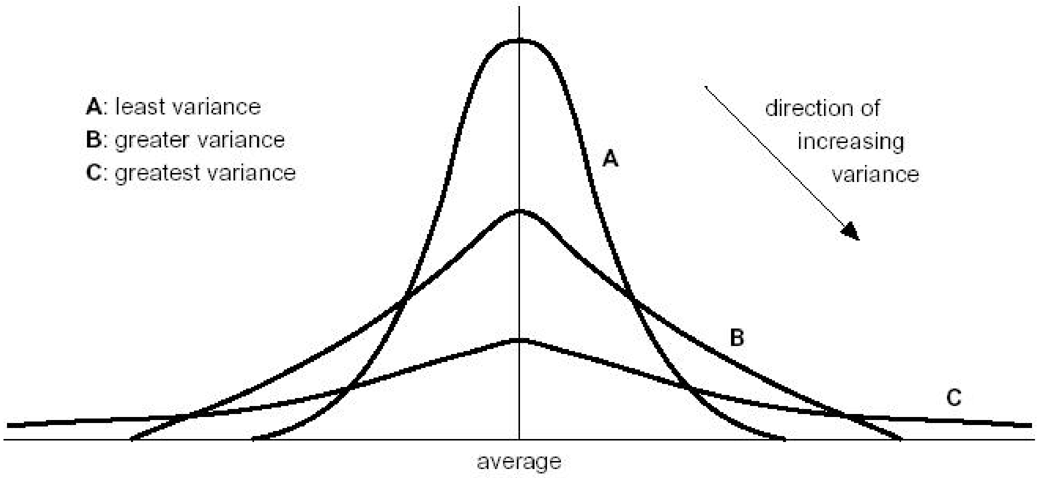
5.5 Basic statistical principles in on farm experiment

Much of the mathematics of statistics is based on what's called the ***normal distribution***.

A frequency distribution that is shaped like a bell (see Figure 2) is called a normal distribution. In many situations, this normal curve describes the frequency of events or characteristics that occur in populations.

Variation is due to many factors (genetic, environmental, managerial, and so forth) acting upon individuals or individual plots within a particular population. Some of these factors are obvious and can be accounted for others cannot. In statistical terms, the measure of this naturally occurring difference is called the ***variance***.

The variance is described by how wide the bell-shaped curve spreads and is a measure of how far from the average the population can go. The variance is a small number when the population is grouped tightly about the average and a large number when the population spreads widely.



A, B, and C are three populations with the same average, but with different variances.

Figure 3: Normal distribution Curve and variance

5.5.1. Replication, randomization* and *use of a control

Replication, ***randomization***, and ***use of a control*** are essential in designing an experiment because they help to separate out treatment effects from natural levels of background variation. Without these three factors, any data you gather will be just about worthless. In research, ***error*** refers to anything besides your treatment effects that is measured. Setting up the experiment in a structured way helps to reduce the amount of error in your experiment;

replication, randomization, and use of a control allow you to use statistics to actually separate out error from treatment effects in your measurements (Sooby, 2001).

5.5.1.1. Replication

In an experiment, replication or repetition means that individual treatments have been applied to more than one plot. Replication is necessary because all test plots are not identical, and that leads to variation in the data you collect; you will not get exactly the same results from two plots that received the same treatment. You can take steps to minimize the effect of variation if it has an identifiable cause, but there will always be some variation among plots that cannot be controlled. The purpose of replication is to allow you to make a more accurate estimate of how each treatment performed even though there is uncontrolled variation in the experiment. Replication of treatments increases your ability to detect differences in treatment means. Having more replications allows you to identify (statistically) smaller differences in treatment means than you could identify with fewer replications (Davis et al., 1999).

5.5.2.2. Randomization

Randomization is one of the basic principles of experimental design. It makes valid the estimate of experimental error which is essential for comparing treatments. It is a procedure for allocating treatments so that each experimental plot has the same chance of receiving any treatment. The process of randomization can be done with a table of random numbers or by drawing lots (Gomez, 1972).

Randomization in an experiment means that the treatments are assigned to plots with no discernable pattern to the assignments. The reason randomization is important is that the positioning of treatments within the block (other word for replicate) may affect their performance. One example of this is an experiment testing five corn hybrids (labeled 1 through 5) in which you plant the hybrids in the same order in each block: 1, 2, 3, 4, then 5 (see Figure 3). If hybrid 2 is naturally much taller than the others, it can slightly shade the hybrids planted next to it (hybrids 1 and 3) and unfairly make them look a little bit worse than they would look if they were not planted next to hybrid 2 (Davis et al., 1999). Apart from the competition for light there is namely also the competition for nutrients (Colley and Myers, 2007).

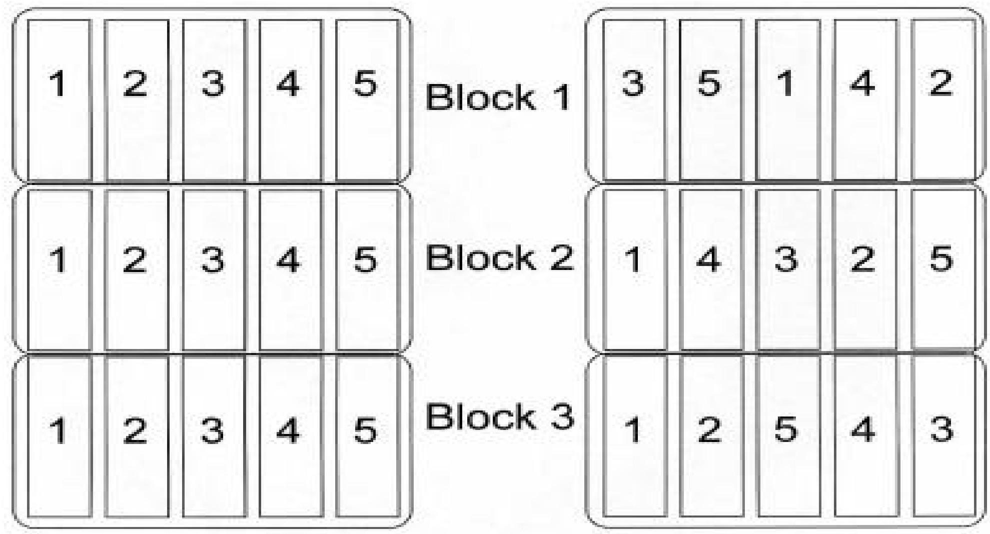


Figure 3. Randomization and non-randomization of treatments

5.6. Choice of statistical design

Experimental design is a way to arrange treatments in a field so that error and bias are reduced and the data may be accurately analyzed using statistics. Design and analysis fit together to make a meaningful whole. If an experiment has a poor design, you can't have confidence in what the data are telling you. Standard experimental formats or designs are usually used in on-farm research. The criteria used to select which design fits which experiment depends on the number of treatments under investigation. If you want to compare two levels of a treatment, you can use a design called a **paired-comparison**. An easy statistical analysis, the t-test, can be performed on the data to detect any significant differences. If you want to add more levels of treatments, you can use a **randomized complete block design**. A **split plot design** allows you to see how different treatments interact. These designs can provide you with more information than the paired comparison but also require more sophisticated statistical analyses and more space in the field (Sooby, 2001).

5.7. Analyzing the Results of On-Farm Research

Data collected in the trial must first be converted to commonly used units prior to analysis and summary (Miller et al.). Much can be learned from simply looking over the data without using statistical methods. Statistics are an additional tool to assess the data which can be used to assess the effects of natural variability between plots and the likelihood that the differences measured are due to the treatments (Colley and Myers, 2007). Statistical analysis may not be necessary if treatment differences are very large and consistent; treatment means may then be sufficient (Davis et al., 1999). However, often it can be difficult to tell just by looking at the data whether any differences are due to random variation or to treatment effects. Statistical analysis re-orders the data that were randomized in the field and performs mathematical computations to determine the probabilities that the differences were caused by normal variation or by the treatments. The results of the data analysis give you the basis for making conclusions on the effects of the treatments. Analyses can be performed using different confidence levels. Professional researchers typically choose a 95% confidence level, which means that there is a 95% chance that the measured differences are due to the treatments rather than to random variation or error. There is a 5% chance that the analysis will lead you to conclude there were differences where there were none or vice versa. In scientific literature, this chance of wrongly interpreting the data is indicated as $p < 0.05$ (probability is less than 5% that the analysis is picking up on nonexistent differences or not measuring real differences). In reality, you will never be 100% sure that you have proved or disproved your hypothesis. Statistics are based on tendencies and likelihoods, never on certainties (Sooby, 2001).

The probability level can feasibly range from 0.001 to 0.2 (0.1- 20%), depending on the economic or environmental implication of choices between management options being tested, interactions with other managements practices, the grower's experience and other factors (Veseth et al., 1999). A common statistical tool for on-farm tests is **LSD**, which is calculated through standard analysis of variance (ANOVA) statistical analysis software or can be calculated by hand. The LSD is a calculation based on the variability of treatment results within the trial and is used to help separate the effects of natural field variability from the treatment effects. If the difference between treatment means in a trial are equal to or larger than the LSD, the difference is statistically significant and believed to be due to the treatment effect and not natural field variability. On the other hand, if the difference between treatment means is smaller than the LSD, the differences are more likely due to natural field variability.
The LSD is only used if the ANOVA analysis determines that treatment differences are significant (Veseth et al., 1999).

Proper statistical analysis can be done if your experiment was designed according to the principles outlined in this manual, but proper analysis can be complicated greatly if these principles were not followed. Specialized statistical software is available, but most spreadsheet software can calculate simple statistics. Excel is a helpful program for inputting and analyzing data collected (Davis et al., 1999).

5.8. Reporting On-Farm Research

The on-farm trial report should ideally follow the lay-out of a scientific research article and Include the following sections and subsections:

5.8.1. Introduction

- Background; problem formulation (consultation stakeholders)
- Previous research conducted related to identified problem
- Rationale/Justification (prioritization and targeting) and objectives of the research
- Expected impact of research (eg cost-benefit analysis)

5.8.2. Literature review

- The review of the literature provides or summarizes the present study in the context of previous research.
- The review should be similar to the review of literature in the proposal but should reflect any change of focus or direction that resulted from the research process.
- Again, this section may present the hypothesis or research questions and the relationship of these to previous findings.

5.8.3. Materials and Methods

- Experiment area (location and description)
- Treatments (number, level, general description)
- Sites description and experiment design
- Non-experimental variables (type of data collected and observations made)
- Statistical analysis

5.8.4. Results

- Agronomic
- Statistical

5.8.5. Discussion

- Discussion of agronomic data
- Economic analysis and farmers' assessment

5.8.6. Recommendations

- Should describe briefly what you did, the main results and recommendations for further research or applicability.
- Implications what the findings of the research imply (consider suggestions).

CHAPTER SIX

6. FARMER PARTICIPATORY RESEARCH

6.1. Participatory research: History approaches and models

Farmer participatory research emerged as a response to the generation of inappropriate technologies by scientists at research stations whose work was based on the transfer of technology model. Those working in this field began to develop a series of new research approaches that would result in technologies that would be beneficial to, and therefore adopted by, small farmers. The transfer-of-technology model was predominant in the 1950s and 1960s. The fact that small farmers did not adopt the technology packages developed at research stations led researchers to conclude that farmers were backward or ignorant, and that the key to success lay in creating a better extension service. Thus, the training and visit system (T&V) of Agricultural Extension was widely implemented. In the 1970s and early 1980s, non-adoption, still a problem, was attributed to constraints occurring at the farm level.

Farming systems research arose as a response, emphasizing research at the farm level to diminish constraints to the adoption of new technologies. It has received increased attention and recognition since the ―Farmer First‖ (Chambers et al., 1989). Participatory technology development (Jiggins and De Zeeuw, 1992) concepts were introduced in the late 1980s. Finally, in the 1990s, some researchers came to believe that the problem was not the farmers, but the inappropriate technologies they were being encouraged to adopt. This marked the emergence and gradual evolution of farmer participatory research, an approach aimed at creating appropriate technology for small farmers (Chambers et al., 1989; Cramb, 2000) and for organic and biodynamic agriculture (Ponzio et al., 2013).

The concepts of "farmer participatory research" started to spread by the acknowledgement that the active participation of the final users of the research products to the research activity itself would have enhanced the efficiency of the identified technological solutions and facilitate their adoption, also enabling the farmers to become active proposers of key research objectives from their side, in line with their actual emerging needs (Lockeretz, 1987; Bachinger et al., 2000).

6.2 Farmers' Local Knowledge role and impacts

As anyone who has worked closely with farmers knows, they possess knowledge about their crops, their farming environment, and their socioeconomic conditions. In many instances they can clearly articulate the rationale behind their management practices and their decisions. This knowledge, which has been documented formally by numerous social and biological scientists, includes their soils and productive environments (Bellon and Taylor 1993; Kamangira 1997; Edwards 1987), their crops and crop varieties (Richards 1986; Sperling et al. 1993), insects and pests (Bentley 1992; Bentley and Rodriguez 2001), and soil and water management practices (Wilken 1987; Lamers and Feil 1995). Understanding this knowledge is a fundamental step towards generating a dialogue between farmers and scientists. It is a key reference point that farmers use to make decisions and to communicate among themselves. Scientists need to understand farmers 'knowledge if they want to contribute to farmers 'welfare by providing new information to them, by developing appropriate technologies with them, or communicating effectively with them. To understand farmers 'knowledge, scientists must first elicit and analyze it. Farmers 'knowledge can be classified into three categories: perceptions, taxonomies, and rules of thumb. Distinct methods are required to elicit and analyze these different kinds of knowledge. (Jayanthi, *et.* A*l* 2008)

TRADITIONAL VS PARTICIPATORY APPROACHES

	Traditional (linear)	**Participatory (Innov Sytems)**
Main objective	Technology transfer	Building farmer capacity to use knowledge
Opportunities analysis	Outsiders	Farmers, facilitated by outsiders
Methods	Messages, fixed packages	Options considered
Farmer behavior	Adopt, adapt or reject	Choose from basket and experiment/ innovate
Intended outcomes	Widespread adoption of package	Wider choices, enhanced adaptabilities
Main extension mode	Extension worker to farmer	Farmer to farmer
Role of R&E	Teacher, trainer	Facilitator

type	characteristics
contractual	scientists contract with farmers to provide land or service
consultative	scientists consult farmers about their problems and then develop solutions
collaborative	scientists and farmers collaborate as partners in the research process
collegiate	scientists work to strengthen farmers' informal research and development systems in rural areas

Table 2. A classification of participatory research strategies

6.3. Main Types of Farmer Participatory Research

6.3.1- Researcher-Managed On-Farm Trials

In this type the researchers work in farmers' fields to develop technology for farmers or to test and validate research findings obtained in the research station. They generally design, implement and evaluate the technology in the farmers' fields, or they define the research agenda and design trials which farmers are allowed to implement under their supervision. The experimental designs used in this approach are similar to those used in research stations. The relationship between the researcher and farmer is hierarchical. Researchers are the main decision-makers, setting the research agenda and designing and implementing trials. The researchers identify the problem upon which research is based.

6.3.2- Consultative Researcher-Managed On-Farm Trials

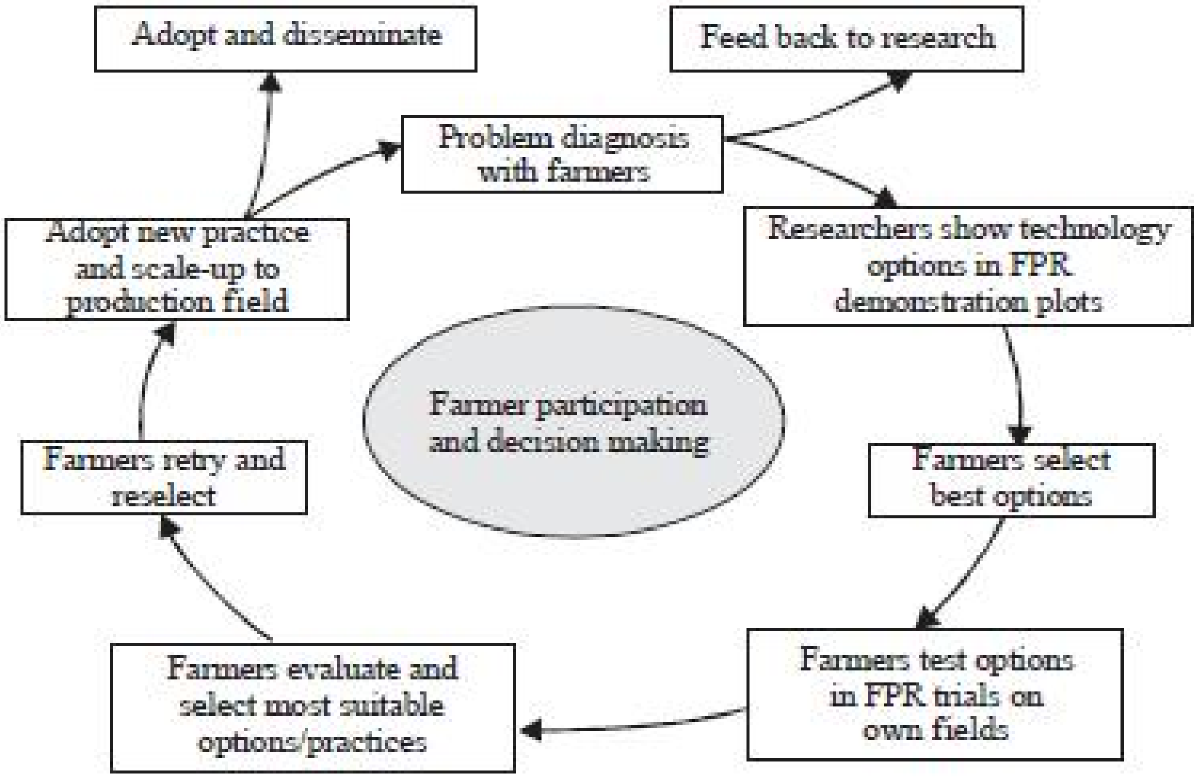
Farmers are consulted by researchers about their needs, problems, goals and preferences. They are also asked about their agricultural practices and knowledge of the local environment, resource availability. Researchers may also ask farmers for feedback on their perceptions of the new technology under study. Farmer's consultation is aimed primarily at assisting researchers in interpreting farmers' circumstances, problems, or needs, and to arrive at experimental designs for trials which often will not include farmer participation in the initial stages of on-farm testing. (Ashby, 1990). The technologies are developed for farmers based on the researchers' understanding of their farming systems.

6.3.3- Collaborative Farmer-Researcher Participatory Research

Farmers and researchers work together on problem definition, design, management and implementation of trials, and evaluation. In the early phases of the process, scientists and farmers discuss potential areas for collaborative research and choose decision-making and evaluation criteria. By combining informal research by farmers with formal on-farm testing procedures, indigenous knowledge and science-based knowledge are mixed to meet farmers' needs. Ideally, a collaborative relationship means balanced participation in and control over the research process in order to achieve the objectives of both farmers and scientists.

6.3.4- Farmer-Managed Participatory Research

Farmers are the main actors and decision-makers. Developing technology through a process that includes problem definition, trial design, the implementation of experiments, and the evaluation of results. In the diagnostic phase, farmers identify the problems and needs they want to address. In the planning and design phase, they choose the most important problem, identify potential solutions, design prototype technology, and decide how to test it. In the experimentation phase, they test and evaluate the technology. Finally, in the adaptation and validation phase, farmer’s further test the technology developed prior to dissemination (Ashby, 1995). The experimental capacity and indigenous knowledge of farmers are used to the maximum in this approach. The scientist's role is to assure that the community's local experimental capacity is fully utilized and to link farmers to information and resources for which the community has expressed a need but which are unavailable at the local level**.**



Some of the strengths of participatory research are (Critchley**, 1999):**

- ✓ The technology is easy to adopt and to spread;
- ✓ It can empower individual farmers and rural communities;
- ✓ Strengthens the link between farmer, extension worker and researcher;
- ✓ Farmer experimentation directs the research agenda.

Some of the weaknesses/ constraints are:

- ✓ Initially it takes more time and resources;
- ✓ It requires skills, change of attitude and flexibility of mind on the part of both farmers, extension and research staff, which is often lacking.

Barriers to Farmer Participatory Research

- ✓ Farmers are difficult for scientists to reach
- ✓ Farmers and scientists have different observation styles
- ✓ Farmers and scientists have different experimental style
- ✓ Farmers and scientists have different economies
- ✓ Scientists aren't Peace Corps volunteers
- ✓ There are many local natural environments, each with unique research needs
- ✓ Perhaps the greatest single 'reason FPR has failed for small farmers is social distance between farmers and scientists.