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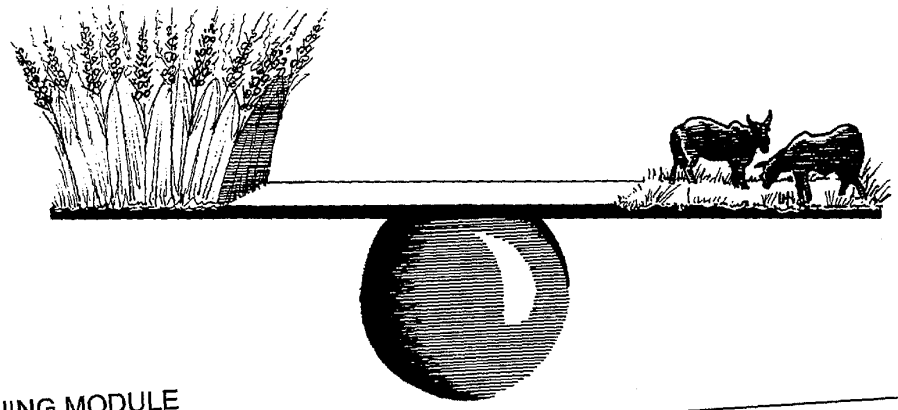

A TRAINING MODULE

Priority Setting for Agricultural Research Programs

JUNE 1996

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Preface

The International Service for National Agricultural Research (ISNAR) is mandated to assist national agricultural research systems (NARS) in developing countries in strengthening their agricultural research management. Through its training unit and in collaboration with national agricultural research organizations (NAROs) and management development institutes (MDIs), ISNAR produces training modules in agricultural research management. These training modules provide "researchers-trainers" with both a training plan and training materials designed to improve the knowledge, attitudes, and skills needed to manage agricultural research effectively.

The Agricultural Research Management Training (ARMT) project aims at institutionalizing agricultural research management training in the Southern African Development Community (SADC) countries as well as improving the management capacity of research leaders. The current phase of the project, sponsored by the United States Agency for International Development (USAID), includes the development of a series of training modules on research management to facilitate the training of national trainers in order to ensure a sustainable capacity for training in the region.

Each draft training module comprises a curriculum, including learning objectives for each day's activities; descriptions of the training approach, methods, and techniques; and master copies of handouts, worksheets, overhead transparencies, and other training media that can easily be reproduced for distribution among participants in the workshop. In addition, the training modules include evaluation forms and a recommended bibliography for use by the trainers.

Texts and exercises from the region and from other parts of the world were collected to create the training modules. Whenever possible, the training design team has acknowledged original sources. In order to ensure the relevance of the basic materials and cases to the region, this training module was designed in partnership with NARS and tested in a draft version during two-week workshops in the SADC region.

The first week of these workshops, brought together SADC trainers from MDIs and universities, and senior researchers from NAROs. ISNAR subject-matter and training specialists led the learning process and collected feedback from the participants to improve the training module. Feedback was incorporated and the module was further tested during the second week. The "new trainers," the main users of this module, led the workshop for national program leaders and senior scientists. The module was further improved by the participants.

This is the resulting version of the module, which was tailored to SADC users through this process. The trainers are expected to use the module to facilitate planning and implementation of training/workshop programs in the region. The researchers are expected to use the module to provide their colleagues with the opportunity to analyze NAROs' approaches and assessing ways of improving them within their organizations. In addition, the researchers are expected to assist national trainers in implementing training events in their respective countries.

It is hoped that the trainers and researchers will adapt the module to respond to their specific needs and share the changes with Eastern and Southern African Management Institute (ESAMI) and ISNAR as a contribution to improving the materials for the benefit of the region.

ESAMI and ISNAR thank all the research management specialists, national trainers, and those who participated in designing, testing, and improving the module for their very valuable contributions.

Director General, ESAMI

Dr. Christian Bonte-Friedheim
Director General, ISNAR

Acknowledgements

The conduct of the activities to design, test, and produce the SADC/ESAMI/ISNAR training modules would not have been possible without the active participation and support of the ISNAR management, resource persons and training team, USAID and SADC/SACCAR officers in Gaborone, Botswana, and ESAMI/ISNAR officers in Arusha, Tanzania.

ESAMI and ISNAR are very thankful to USAID, sponsor of this project. Special thanks go to L. Setshwaelo, the manager of the ARMT Project based in Arusha, Tanzania.

Special thanks are due to the training team responsible for the initial design of the training modules. This team was composed of Lisette Staal, ISNAR/ESAMI consultant and team leader; Robert Obura, Egerton University, Kenya, ISNAR/ESAMI consultant; Mick Mwala, University of Zambia, ISNAR/ESAMI consultant; and members of the ISNAR training team, composed of Zenete Peixoto Franca, Jacobine Verhage, Richard Claase, André Schaareman, Fionnuala Hawes, and Albertine Huybrechts. ISNAR also thanks Judy Kahn who edited this module.

The content of this module was revised and a second draft version was produced under the guidance of Brad Mills (ISNAR Research Officer, outposted in KARI, Kenya). ISNAR is very thankful to Brad for his contributions towards the production of this training module and for leading its test during the regional (SADC) training-of-trainers workshop, together with Zenete Peixoto Franca (ISNAR Training Specialist), in Lesotho.

Sincere thanks are due to Willem Janssen (ISNAR Senior Officer) for his guidance on the content of the first draft training module and assistance to Mick Mwala (School of Agricultural Science, University of Zambia) and ISNAR Training Team.

Source of Material

This training module was developed for the SADC/ESAMI/ISNAR Agricultural Research Management Training (ARMT) Project. It comprises information from several publications of the ISNAR. Other sources are cited as footnotes and listed in the bibliography of this document.

A New Module

This training module was designed in a format that includes an introduction, a training plan, instructors' notes, texts, exercises, overhead transparencies, worksheets, and evaluation forms.

Sponsor

This material was produced for the SADC/ESAMI/ISNAR ARMT, funded by the United States Agency for International Development (USAID).

SADC/ESAMI/ISNAR

Agricultural Research Management Training Project

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SADC/ESAMI/ISNAR
Agricultural Research Management Training Project

Introduction

Agriculture continues to play a major role in the economy of the SADC countries (Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe) by providing food, energy, and some income for the majority of the population and raw material for the growth and development of the manufacturing industries. However, environmental problems such as soil degradation, deforestation, and the severe drought of the recent past remain serious constraints on national development. At the same time, the increased demand for food (due to rapid population growth), raw materials, and improved technologies present new challenges to agricultural research.

The responsibility for co-ordinating research and training in agriculture and natural resources in attaining SADC's goal of food security is vested in the Southern Africa Co-ordinating Committee on Agricultural Research (SACCAR). Early in its formation (1984), SACCAR recognized that national agricultural research systems (NARS) could greatly enhance their efficiency and effectiveness in technology generation and delivery if their management could be improved. In particular, the planning and management of human, financial, physical, and agricultural resources could be improved as could the procedures for prioritizing research programs and linkages with policymakers and external sources of knowledge. The ARMT Project was conceived and developed in 1987 to address these concerns. The evaluation of Phase I in 1990 recommended that one way to make training sustainable was to institutionalize it in the region. The first step in this process was the integration of the project into a regional management development institution (MDI)—Eastern and Southern African Management Institute (ESAMI). This was to be followed by institutional capacity building in the region, of which the present exercise of training module development is an integral part.

This project, which covers the period 1992–1995, is a collaborative venture among three partners: ESAMI, as the main executing agency; ISNAR, as a joint executing agency; and SACCAR, which provides the strategic regional perspective to the project.

The project is based in ESAMI's headquarters in Arusha, Tanzania. It is implemented through a network of SADC MDIs and individual experts from the region. This design aims to ensure adaptation and institutionalization of research management training.

Goal of the Project

The aim of the project is to *strengthen* the capacity of agricultural and natural resource policymakers and research managers in planning, organizing, and managing research systems in order to increase their efficiency and effectiveness in addressing the region's food problems.

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Objectives of the Project

The objectives of the project are the following:

a. to increase understanding among high-level officials on the role of research in promoting and sustaining agricultural development;

b. to strengthen the capacity of national research leaders to plan, program, budget, and monitor research programs of relevance to national development goals;

c. to foster human resource development in agricultural research management within the member countries;

d. to build the skills of middle-level research administrators in the management of agricultural research activities;

e. to work towards building a base for a sustained capacity in management training for agricultural research within SADC.

Phase I laid the foundations for building specific skills and providing the knowledge and tools that helped SACCAR realize substantial progress in achieving its two main goals:

a. increased co-operation in research on agriculture and natural resources;

b. improvement in the capacities of individual countries to undertake carefully prioritized research and training projects.

This in turn enabled SADC countries to make progress towards achieving important goals in

a. increased agricultural productivity;

b. higher incomes and creation of employment in the rural areas.

Phase II is concentrating on the institutionalization and sustainability of the AMRT Project activities.

Target Audience

The ARMT Project aims at training the following persons:

a. **policymakers**: board of governors, agricultural research council members, planners, executive officers in the NARS, permanent or principal secretaries, and those responsible for the long-range objectives of a NARS

b. **senior research managers**: senior managers and executives of the system, for example, directors general/directors and their assistants—those responsible for overseeing the implementation of policies

c. **middle-level research managers**: research co-ordinators, station heads—those responsible for supervising research operations at research stations, laboratories, institutes, etc.

The Modules

The ARMT Project strives to *institutionalize* and *sustain* management training within the SADC countries. The comprehensive action plan includes several training modules, which are to be used by ESAMI, MDIs, and NARS to implement workshops for training their local personnel. This will contribute to capacity building and, hence, sustainability and institutionalization of management training in the region. The modules aim to help MDIs and NARS develop their own capacity for gender-balanced multidisciplinary in-service training.

Eight modules form the core of the ARMT Project

1. Priority Setting for Agricultural Research Programs
2. Planning, Monitoring, and Evaluation of Research Projects
3. Information Management for Research
4. Scientific Writing and Presentation
5. Research Program Formulation
6. Financial Management in Research on Agriculture and NRM
7. Strategic Planning
8. Gender Analysis for Management of Research in Agriculture and Natural Resources

The Workshops

The modules provide the basis for trainers to prepare and deliver workshops. The majority of the modules are designed to run for five days. However, the training modules on Gender Analysis for Management of Research in Agriculture and Natural Resources and Information Management for Research are designed to run for four days and 10 days respectively.

Overview of the Module

Priority Setting for Agricultural Research Programs

Overview of the Module

Priority Setting for Agricultural Research Programs

Introduction

Priority setting aims to select the best portfolio of research activities for a certain research system, institution, or program. The primary objective of priority setting is to make the most effective use of the resources available for research.

Priority setting has a number of additional benefits. In the process of priority setting, existing resource allocations are normally reviewed. Even when the priorities are not strongly modified after a priority-setting exercise, it may be decided that the existing resource allocation did not reflect those priorities, thereby leading to a budget revision.

A priority-setting exercise may clarify differences of opinion that exist within the organization and may provide the occasion for debating and resolving those differences. It may therefore help to reach consensus on the objectives of the institution and to increase the internal cohesion.

Clearly set priorities help to make institutional management more transparent and unambiguous. They provide guidance to management, and if clearly exposed, they clarify the expectations of personnel and stakeholders.

Objectives

At the end of the workshop the participants will be able to do the following:

1. Discuss the process of setting priorities within their organizations.
2. Discuss the need to set priorities.
3. Identify the existing structure and mechanisms for resource allocation within their institutes.
4. Discuss appropriate institutional structures and levels for priority setting.
5. Identify key processes that should guide any priority-setting exercise.
6. Identify objectives that are operationally meaningful for priority setting.
7. Identify methods and list criteria for choosing those priority-setting methods.
8. Indicate how spreadsheets can be used in priority setting.
9. Implement the congruency model, which prioritizes by magnitude of production.
10. Identify major constraints and allocate those constraints to major research themes.
11. Implement an economic surplus analysis of agricultural research benefits.

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12. Explain the scoring method, the criteria used, and the data requirements.
13. Identify sources of information needed for different priority-setting methods.
14. Describe a protocol for approval and implementation of priority-setting results.
15. Plan actions for future activities in priority setting.

Duration

The workshop is planned for five days.

Topics to be covered

1. Introduction.
2. Importance of priority setting.
3. Institutional structures and levels of priority setting.
4. Basic processes of priority setting.
5. Identifying research objectives.
6. Methods to define research priorities.
7. Identification of research target zones.
8. Using spreadsheets in priority setting.
9. Application of congruency methods.
10. Identification of major research themes through constraints analysis.
11. Identification of the potential generation and adoption of technologies.
12. Estimating economic surplus benefits.
13. Scoring: inclusion of multiple criteria in priority setting.
14. Data collection.
15. Managing the priority-setting process.
16. Drawing a plan.
17. Participant action plan approach (PAPA).

Target Audience for the Priority Setting for Agricultural Research Programs Workshop

The workshop is intended for agricultural research program leaders and scientists. SADC, ESAMI, and ISNAR strongly encourage a balanced selection of participants equally representing males and females.

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Training Approach

This training module provides trainers with the information, specific activities, and materials they need to effectively plan and deliver a training program. Because each trainer and each training situation is unique, planning is critical to the success of any program. This module encourages participation and provides hands-on, problem-solving experiences and exercises.

Applying the Experiential Learning Cycle

This training approach is based on experiential learning theory (Kolb and Fry 1975; McCaffery 1986) and is participatory by design. It is a learner-centered approach involving experience followed by a process of reviewing, reflecting, and applying what has been learned. Participatory methods keep learners active in the learning process. They are involving and interactive, and they encourage communication and group work. They are action oriented and experience based.

This experiential and participatory approach was chosen to enhance effective skill transfer, to facilitate conceptual and attitudinal development, and to encourage appropriate changes in participants' behavior. The experiential learning cycle is especially useful for skill training because most of its techniques are designed to involve the participants in practicing the skill. The experiential model helps people assume responsibility for their own learning because it asks them to reflect on their experience, draw conclusions, and identify applications. Participants ground the lessons in their actual work environment by considering the question of what can or should be done differently as a result of this training experience.

To be effective this module must be applied in both the design and delivery stages of training. The sessions, activities, and notes in this module present trainers with guidelines for reaching the training objectives by applying the experiential training methodology. An understanding of the adult learner, the role of the trainer as a facilitator, and of the experiential learning cycle is important to this approach.

The Adult Learner

Understanding the adult learner is critical to the success of this training approach. The adult learner has particular needs (Knowles 1978; McCaffery 1986; Zemke and Zemke 1981). Adult learners need continual opportunities to identify their needs and recognize the relevance of their learning in terms of their own lives. Adult learners need self-directed learning opportunities in which they can actively participate. They need to actively think, to do, to reflect on experiences, to discuss with others, and to practice and learn new skills. The adult learner needs interactive communication with both the trainer and fellow learners, which is different from one-way teacher-to-student communication. The learner needs to continually reassess the question, "Where am I now and where do I want to go?"

The Trainer

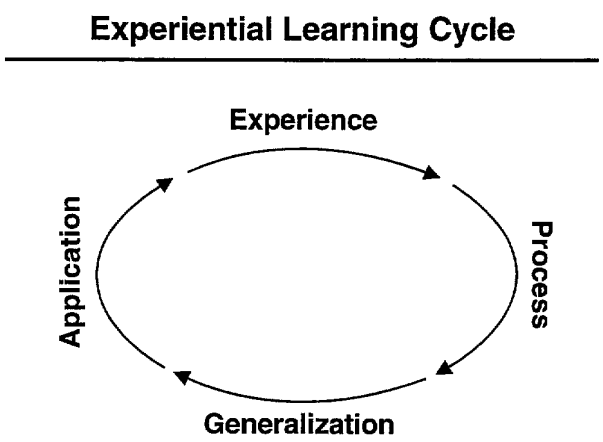
The role of trainer/facilitator is to manage or guide the training process rather than to manage the content of learning. Adult learners need to be able to share the responsibility for learning with the trainer. The experience of adult learners should be viewed and used as a rich resource in the learning environment and they should be encouraged to contribute to the learning environment whenever possible.

The Experiential Learning Cycle[1]

Experiential training or *learning* is a phrase often heard in the educational world. The strength of the approach is in the completeness of its cycle, which consists of four stages, each as important as the preceding or following one. The four stages are (1) experience, (2) process, (3) generalization, and (4) application.

The term "experiential" is often misused in practice. Experiential training seems to mean letting people participate in a presentation, having a question and answer session after a lecture, or a role play or case study without the subsequent steps of the model. The final stages are often left out of the design of the program. As a result, the power of experiential learning is significantly diminished or negated altogether. The stages of the experiential learning cycle are outlined below.

Figure 1: Experiential learning cycle



Source: McCaffery (1986) and adapted from Kolb and Fry (1975).

Experience: The experience stage is the initial activity and data-producing part of the cycle. This phase is structured to enable participants to "do" something. "Doing" includes a range of activities, such as participating in a case study, role play, simulation or game, or listening to a lecture, watching a film or slide show, practicing skill, or completing an exercise.

Process: In this stage, participants reflect on the activity undertaken during the experience stage. They share their reactions in a structured way with other members of the group. They may speak individually, in small groups, or as a full training group. They discuss both their intellectual and attitudinal (cognitive and affective) reactions to the activities in which they have engaged. The trainer helps the participants to think critically about the experience and verbalize their feelings and perceptions as well as draws attention to any recurrent themes or patterns which appear in the participants' reactions. The trainer must also help the participants conceptualize their reflections so they can move toward drawing conclusions.

1. The section on the experiential learning cycle is adapted from USDA/OICD/ITD (no date), *Agricultural Trainer Development, Training of Trainers, Instructors Manual*, and McCaffery, J.A., "Interdependent Effectiveness: A Reconsideration of Cross-Cultural Orientation and Training," *International Journal of Intercultural Relations*, 1986.

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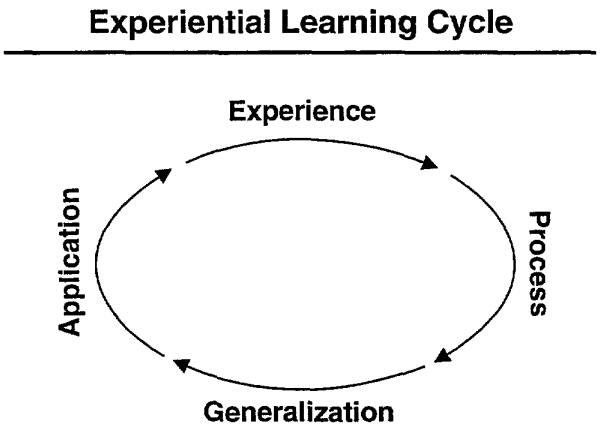

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Generalization: In the generalization stage, the participants form conclusions and generalizations that might be derived from, or stimulated by, the first two phases of the cycle. The trainer must help participants think critically to draw conclusions that might apply generally or theoretically to "real life." This stage is best symbolized by the following questions: "What did you learn from all this?" and "What more general meaning does this have for you?"

Application: After participants have formed some generalizations, the trainer must guide the participants into the application stage. Drawing upon the insights and conclusions reached during the generalization stage (and previous stages), participants can begin to incorporate what they have learned into their lives by developing plans for more effective behavior in the future. Techniques used to facilitate the application stage can include action plans, reviewing each other's action plans, formulating ideas for action, sharing action plans with the whole group, and identifying additional learning needs. The trainer assists during this process by helping participants to be as specific as possible.

Participant Action Plan Approach

An integral aspect of the workshops is the ultimate application of the skills by the participants in the work environment. The participant action plan approach (PAPA) was developed by the United States Office of Personnel Management to help participants consider specific applications of lessons learned during training on their job sites. Participants commit themselves to action through a written plan developed at the end of the workshop. PAPA can help participants transfer what they learned in the workshop to their jobs, thus reaching the application stage of the experiential learning cycle.

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The Training Plan

How the Module is Organized

INTRODUCTION

The module provides the trainer all the information and materials required for planning and implementing a five-day workshop. It contains suggested activities that have been field tested, with instructions for trainers. The trainer is encouraged to draw on these ideas to devise tailor-made exercises appropriate for his or her specific training situation. The training plan section is organized in the following way:

1. Pre-workshop instructions
2. Tips for trainers
3. Daily training program. For each day this section provides
   - overview
   - schedule
   - checklist for trainers
   - instructions to trainers
   - summary of overheads
   - participant handouts
4. Overheads and reference materials are organized by day and session. These are located in a section following the daily training program.

MATERIALS

Overview: Includes the day's learning objectives and a list of required participant handouts.

Schedule: Includes suggested times. However, each trainer must consider the timeframe based on the situation and participants, and revise as appropriate.

Trainers' checklist for planning: Helps the trainer collect and compile the materials required for each day.

Instructions to trainers: Provides the trainer with specific information on the flow of the sessions and instructions on how to facilitate activities. A sample format of the "instructions to trainers" appears on the next page.

Participant handouts: Handouts that the trainer distributes to the participants are numbered in order by day and by session. For example *Day 1/Session 1/Handout 1 (1.1.1).*

Overheads: A summary of the overheads used appear in reduced format at the end of each session. Full-size copies of the overheads are organized by day in annex 2. Like the handouts, they are numbered *Day 1/Session 1/Overhead 1 (1.1.1).* Overheads are available in **paper copies**.

Evaluation form (day five): A diskette with the text of the evaluation form in WordPerfect 5.1 is included and, if necessary, may be adjusted to meet your needs.

A Sample Format
Instructions to Trainers

DAY ONE — **Session 4**
Basic Processes in Priority Setting

Instructions to Trainers

15:45 – 17:00 Session 4. Basic Processes in Priority Setting

The suggested time and title of each section.

RATIONALE — It is important for participants to keep in mind some basic principles when analyzing research priorities, regardless of the particular method chosen to assist with the analysis.

OBJECTIVE — By the end of this session, the participants will be able to do the following:

- Identify key processes that should guide any priority-setting exercise.

The objectives are stated in terms of participants' ability by the end of each session.

PROCEDURE — Training techniques: presentation, modified "trip around the tables."

Various training techniques employed during the session are listed.

PRESENTATION — (*experience*) Distribute handout 1.4.1. Give a brief presentation focusing on the basic processes of priority setting. You will find the information in the handout very useful. Nine overheads support the presentation: 1.4.2 through 1.4.10. At the end of the presentation be sure to ask the participants if they have any comments or questions, or if they need clarification. (15 minutes)

EXERCISE 4 — **Exercise 4. Priority-setting analysis.** (55 minutes)

Each exercise is numbered chronologically. The title for each exercise appears here.

1. Distribute handouts 1.4.2, 1.4.3, and 1.4.4. Go over the instructions with the participants step by step. Ask if clarifications are needed. (5 minutes)

Time: Total time for an activity appears in parentheses.

Phase 1. Group work

2. Divide the participants into four groups. Invite them to elect a rapporteur.
3. (*experience*) As the groups work, circulate from group to group to check progress. Clarify any concerns the groups may have while they are working. Be sure to remind the groups of the time remaining in this exercise.
   Groups read, discuss, and respond to the questions assigned to them. Be sure that all participants read handout 1.4.4. (15 minutes)

The stage of the experiential learning cycle is identified in italics.

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Tips for Trainers

As a trainer, you are responsible for creating the learning environment and maintaining the flow of the workshop. You must be aware of the participants' needs and be sensitive to their concerns. Following in brief are several tips to help you achieve a successful workshop.

Ten tips for your success as a trainer:

1. Begin your working day by presenting:
   - objectives
   - schedule

   Make sure that the trainees are aware of what they are expected to learn each day.
2. Manage time wisely. Time is a motivating factor in training. If you slow down, the participants will lose interest and commitment.
3. Give brief presentations. Encourage your trainees to speak up and participate actively in discussions and exercises.
4. Follow the instructions of the proposed exercises:
   - use different techniques;
   - promote active participation;
   - increase interest and level of motivation.
5. Avoid "short cuts" while working on topics. Keep the same level of interest while making presentations, doing exercises, and listening to reports. Remember that as a trainer you are responsible for the results of the five-day workshop.
6. Don't let your interest and willingness to teach diminish. Show care for the participants' learning and be patient!
7. Be an attentive and good listener. The participants expect you to value their ideas and to look at them while speaking. These positive attitudes increase your credibility with the participants.
8. Praise your trainees for their efforts and for good performance. This shows that you recognize their input and this consequently increases their level of motivation.

9. Make sure that your trainees feel positive and that they are satisfied with the workshop. Ask for their feedback at the end of each day.
10. Be confident of your success as a trainer. Go through the whole plan and be well prepared. Let them see you are competent and selfconfident.

MANAGING GROUPS

Many of the exercises require the participants to work together in small groups, and then there must be a way to share the information with the rest of the workshop participants. The most common way is to have group presentations. You are responsible for managing the group activities and ensuring active participation. These tips will help:

TIPS FOR FACILITATING GROUPS

Seven tips for facilitating group exercises:

1. Be attentive to and supportive of the participants' needs in any situation.
2. Help them to understand the steps they must take to accomplish all the tasks.
3. Manage time effectively. Be sure to remind participants of the time remaining. Be firm! Keep to the schedule.
4. Show interest and be willing to assist them at all times. Circulate from group to group while they are working.
5. Follow the entire process. Remain in the classroom during all activities.
6. Provide the groups with constructive feedback.
7. Always summarize the major points made by the groups and relate them to the objectives of the session and exercise.

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Pre-workshop

Pre-workshop

Instructions to Trainers

INTRODUCTION

As a trainer, you are responsible for the preparation and management of the entire program. This often requires pre-workshop actions. You must discuss the pre-workshop responsibilities with the workshop's sponsoring institutions. Some things that you must be sure to arrange are included in the following list. There may be several others. Pre-planning is essential to the success of your training workshop.

ACTIONS NEEDED

You must arrange for the following points long *before* the workshop starts:

1. In pre-workshop communication, be sure to inform the participants of any information they will require prior to arriving at the workshop. This can be accomplished by means of a pre-workshop letter. Consult with the sponsoring institutions for plans for pre-workshop communication with participants.
2. Arrange for appropriate officials to welcome the participants.
3. Compile a notebook for each participant. This notebook will be used by the participant to organize the training materials from each session. Before it is distributed at the workshop, each notebook should contain the following items:
   - welcome letter
   - workshop prospectus
     - tentative schedule (five days)
     - registration form

   Samples of these items appear on the following pages.
4. Plan for implementing systematic activities. Prepare yourself to instruct participants during the opening session on the systematic activities of the workshop:
   - review of daily activities
   - daily PAPA exercise
   - daily brief evaluation

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5. At the end of each day:
   - Invite a volunteer to prepare and present the following morning a brief report, reviewing the day's activities and summarizing major lessons learned. Provide the volunteer with transparencies of the day's objectives to facilitate his/her presentation, which should be delivered in 10 minutes.
   - Distribute the PAPA forms and invite the participants to list major skills from the day's activities which could be applied in their job environment. Request that they keep the PAPA forms in their own notebooks. You will ask them to review these forms during the last day when they fill out the action plan for the follow-up process.
   - Distribute the evaluation form and invite the participants to briefly evaluate the day's activities. Collect the forms and summarize the results to report back to them the following morning. Note that it is necessary to cluster the answers in the evening.
   - The participants should evaluate the diverse features of the day's activities. You should provide the participants with a copy and/or list of these on the overhead during the evaluation session.
6. Arrange for the certificates to be ready for distribution at the end of the workshop.

COURSE-SPECIFIC REQUIREMENTS

Many exercises in the workshop will be computer based in small groups. The following is therefore required:

1. To set clear criteria to select participants, which include knowledge of how to use the computer and spreadsheets.
2. An appropriate venue where a minimum of four computers are installed in advance.
3. A color printer.

Dear Participant,

Welcome to the Workshop on Priority Setting for Agricultural Research Programs, which has been organized by SADC/ESAMI/ ISNAR.

We hope you will enjoy the coming five days. Our aim is to help you to improve your skills to carry out the priority-setting process in your organization. Various subjects will be discussed. First we will consider the theoretical aspects, and then you will be given practical work to do using up-to-date training techniques. All of the exercises will be reviewed and discussed by the participants.

We realize that the process of priority setting is not easy. There are ways to improve your knowledge and skills to facilitate your job performance. This workshop will give you a chance to examine your current activities related to priority setting, and suggest improvements or alternatives.

We wish you a pleasant and productive workshop.

Best regards,

SADC/ESAMI/ISNAR Trainers
on Priority Setting for Agricultural Research Programs

Priority Setting for Agricultural Research Programs

Workshop Prospectus

Introduction

Priority setting aims to select the best portfolio of research activities for a certain research system, institution, or program. The primary objective of priority setting is to make the most effective use of the resources available for research.

Priority setting has a number of additional benefits. In the process of priority setting, existing resource allocations are normally reviewed. Even when the priorities are not strongly modified after a priority-setting exercise, it may be decided that the existing resource allocation did not reflect those priorities, thereby leading to a budget revision.

A priority-setting exercise may clarify differences of opinion that exist within the organization and may provide the occasion for debating and resolving those differences. It may therefore help to reach consensus on the objectives of the institution and to increase the internal cohesion.

Clearly set priorities help to make institutional management more transparent and unambiguous. They provide guidance to management, and if clearly exposed, they clarify the expectations of personnel and stakeholders.

Goal of the Workshop

To provide the program leaders and scientists with a systematic approach to developing priority setting, which ensures improvement of research performance to attain national objectives.

Duration of the Workshop

The workshop is planned for five days.

Workshop Objectives

1. Discuss the process of setting priorities at their organizations.
2. Discuss the need to set priorities.
3. Identify the existing structures and mechanisms for resource allocation within their institutes.
4. Discuss appropriate institutional structures and levels for priority setting.
5. Identify key processes that should guide any priority-setting exercise.
6. Identify objectives that are operationally meaningful for priority setting.
7. Identify methods and list criteria for choosing priority-setting methods.
8. Indicate how spreadsheets can be used in priority setting.
9. Implement the congruency model, which prioritizes by magnitude of production.
10. Identify major constraints and allocate those constraints to major research themes.
11. Implement an economic surplus analysis of agricultural research benefits.
12. Explain the scoring method, the criteria used, and the data requirements.
13. Identify sources of information needed for different priority-setting methods.
14. Describe a protocol of approval and implementation of priority-setting results.
15. Plan actions for future activities in priority setting.

Workshop Format

At each event, the trainers will train a maximum of 20 program leaders and senior scientists per training session in priority setting. The workshop is designed to provide an interactive learning environment. Sessions generally include a brief presentation and participatory exercises. The participant action plan approach (PAPA) is integrated throughout the workshop to encourage participants to consider the application of newly acquired skills in their organizations.

Expected outputs

The expected outputs of the workshop are the following:

1. Improved priority-setting skills among agricultural research managers (program leaders and scientists).
2. Improved commitment among agricultural research managers to work as a team towards establishing, within the institute, a priority-setting working group.
3. Action plans designed by the participants to implement activities related to priority setting in their respective organizations.

Priority Setting for Agricultural Research Programs - Workshop Schedule

Day One	Day Two	Day Three	Day Four	Day Five
08:30 - 09:00 *Welcome* **09:00 - 10:30** *Session 1. Introduction. PAPA. Exercise 1*	**08:30 - 09:00** *Opening of the day's activities* **09:00 - 10:30** *Session 5. Identifying research objectives. Exercise 5*	**08:30 - 09:00** *Opening of the day's activities* **09:00 - 10:30** *Session 9. Maps: identifying research target zones. Exercise 9*	**08:30 - 09:00** *Opening of the day's activities* **09:00 - 10:30** *Session 12. Research alternatives: identification of potential generation and adoption of technologies. Exercise 12*	**08:30 - 09:00** *Opening of the day's activities* **09:00 - 10:30** *Session 15: Managing the priority-setting process. Exercise 15*
Tea/coffee break	**Tea/coffee break**	**Tea/coffee break**	**Tea/coffee break**	**Tea/coffee break**
10:45 - 13:00 *Session 2. Importance of priority setting in agricultural research. Exercise 2*	**10:45 - 13:00** *Session 6. Methods to define research priorities. Exercise 6*	**10:45 - 11:00** *Session 9. (Continued)* **11:00 - 13:00** *Session 10. Application of congruency methods. Exercise 10*	**10:45 - 13:00** *Session 13. Estimating economic surplus benefits. Exercise 13*	**10:45 - 11:10** *Session 15. (Continued)* **11:10 - 13:00** *Session 16: Data collection. Exercise 16*
Lunch	**Lunch**	**Lunch**	**Lunch**	**Lunch**
14:00 - 15:30 *Session 3. Institutional structures and levels of priority setting. Exercise 3*	**14:00 - 15:30** *Session 7. Research alternatives: identification of research target zones. Exercise 7*	**14:00 - 15:30** *Session 11. Identification of major research themes through constraints analysis. Exercise 11*	**14:00 - 15:30** *Session 14. Scoring: inclusion of multiple criteria in priority setting. Exercise 14*	**14:00 - 15:30** *Session 17: The priority-setting process. Exercise 17*
Tea/coffee break	**Tea/coffee break**	**Tea/coffee break**	**Tea/coffee break**	**Tea/coffee break**
15:45 - 17:00 *Session 4. Basic processes in priority setting. Exercise 4* **17:00 - 17:30** *Feedback on the day's activities, PAPA*	**15:45 - 16:15** *Session 7. (Continued)* **16:15 - 17:00** *Session 8. Using spreadsheets in priority setting. Exercise 8* **17:00 - 17:30** *Feedback on the day's activities, PAPA*	**15:45 - 17:00** *Session 11. (Continued)* **17:00 - 17:30** *Feedback on the day's activities, PAPA*	**15:45 -17:00** *Session 14. (Continued)* **17:00 - 17:30** *Feedback on the day's activities, PAPA*	**15:45 - 16:15** *Session 17. (Continued)* **16:15 - 17:15** *Session 18: Participation Action Plan Approach (PAPA) and Evaluation* **17:15 - 17:30** *Final remarks and closing*

SADC/ESAMI/ISNAR Workshop on Priority Setting for Agricultural Research Programs

Registration form

Instructions: We would like your help in making this activity as beneficial to you as possible. In order to do this we request that you provide us with some information. Below you will find a number of questions relating to your background and expectations for the workshop. Most questions can be answered simply by placing a check in the appropriate space. Where a written answer is required, please print your reply clearly in the space provided. Please consider your responses carefully and answer truthfully. Everything you say will be held in strictest confidence. The information will be used only to help us make our activities more responsive to your needs.

Last name		First name	

Function in this meeting	❒ Participant ❒ Facilitator/presenter ❒ Organizer ❒ Observer ❒ Other _____
Title	❒ Dr. ❒ Mr. ❒ Mrs. ❒ Ms. ❒ Ing. ❒ Other _____
Gender	❒ M ❒ F
Date of birth	m d y / /19

Degree		Year
	❒ Diploma	19....
	❒ B.Sc.	19....
	❒ M.Sc.	19....
	❒ Ph.D.	19....

Other degree	
Year of other degree	19....

Position (type)	❒ Policymaker ❒ Senior manager ❒ Middle manager ❒ Researcher ❒ Information specialist ❒ Technician ❒ Other _____
Position (type)	
Department	
Institute	
Name of your immediate supervisor	
Your institute's address	
Telephone no./ Email	
Telex no./ Fax no.	
Expectations	Participants are requested to fill in two items on the reverse side of this sheet.

What particular topics would you like emphasized in this workshop?	

What other management topics would you like to see covered in future events?	

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DAY ONE

Priority Setting for Agricultural Research Programs

DAY ONE — Overview

Objectives

By the end of the day the participants will be able to do the following:

1. Discuss the background, rationale, objectives, and schedule for the five-day workshop.
2. Explain the use of participant action plan approach (PAPA).
3. Identify the trainers and trainees.
4. Discuss the process of setting priorities in their organizations.
5. Discuss the need to set priorities.
6. Explain why formal priority-setting methods are necessary.
7. Explain that a formal priority-setting process does not replace personal judgement, knowledge, and experience.
8. Identify the existing structure and mechanisms for resource allocation within their institutes.
9. Discuss appropriate institutional structures and levels for priority setting.
10. Assist in developing an internal priority-setting process for their institutes.
11. Identify key processes that should guide any priority-setting exercise.

Participant Materials

Workshop notebook (includes welcome letter, tentative five-day schedule, and workshop prospectus)

Handouts

1.1.1 Overview
1.1.2 Tentative Schedule
1.1.3 Participant Action Plan Approach (PAPA)
1.1.4 Exercise 1. Interactive Exercise (seven sheets to be cut into 21 forms)
1.1.5 Exercise 1. Exercise Sheet (list of questions)
1.2.1 Importance of Priority Setting in Agricultural Research (summary of presentation)
1.2.2 Exercise 2. Reflecting on Priority Setting as a Tool for Research Management
1.2.3 Exercise 2. Worksheet
1.2.4 Models of Priority Setting for Public Sector Research (text)
1.3.1 Institutional Structures and Levels of Priority Setting (summary of presentation)
1.3.2 Exercise 3. Institutional Structures and Levels of Priority Setting
1.3.3 Exercise 3. Worksheet
1.3.4 A General Model for Research Program Planning (text)

1.3.5 Priority Setting into the 21st Century: a Position Paper by the Priority-Setting Working Group (executive summary of the text)
1.4.1 Basic Processes of Priority Setting (summary of presentation)
1.4.2 Exercise 4. Priority-Setting Analysis
1.4.3 Exercise 4. Worksheet
1.4.4 Processes and Methods for Research Programme Priority Setting: the Experience of the Kenya Agricultural Research Institute Wheat Programme
1.4.5 Strengths and Weaknesses of the Day
1.4.6 Guidelines to Provide Feedback on the Workshop
1.4.7 PAPA Form — First Stage

Priority Setting for Agricultural Research Programs

DAY ONE — Tentative Schedule

08:30 - 09:00	**Welcome**
09:00 - 10:30	**Session 1. Introduction to the Workshop** – Workshop introduction, objectives, and schedule – Overview of day one – Introduction of PAPA – Interactive exercise (1)
10:30 - 10:45	Tea/Coffee Break
10:45 - 13:00	**Session 2. Importance of Priority Setting in Agricultural Research** (Presentation and exercise 2)

13:00 — 14:00 Lunch

14:00 - 15.30	**Session 3. Institutional Structures and Levels of Priority Setting** (Presentation and exercise 3)
15:30 - 15:45	Tea/Coffee Break
15:45 - 17:00	**Session 4. Basic Processes in Priority Setting** (Presentation and exercise 4)
17:00 - 17:30	**Feedback on the Day's Activities and PAPA**

Priority Setting for Agricultural Research Programs

DAY ONE — Checklist for Trainers

Pre-workshop preparation

Compile a notebook for each participant. The participant will use the notebook throughout the workshop to organize the training materials. Before they are distributed each notebook should include the following: welcome letter, tentative five-day schedule, and workshop prospectus.

Handouts

		Yes ✔	No ✔
1.1.1	Overview	❒	❒
1.1.2	Tentative Schedule	❒	❒
1.1.3	Participant Action Plan Approach (PAPA)	❒	❒
1.1.4	Exercise 1. Interactive Exercise (seven sheets to be cut into 21 forms)	❒	❒
1.1.5	Exercise 1. Exercise Sheet (list of questions)	❒	❒
1.2.1	Importance of Priority Setting in Agricultural Research (summary of presentation)	❒	❒
1.2.2	Exercise 2. Reflecting on Priority Setting as a Tool for Research Management	❒	❒
1.2.3	Exercise 2. Worksheet	❒	❒
1.2.4	Models of Priority Setting for Public Sector Research (text)	❒	❒
1.3.1	Institutional Structures and Levels of Priority Setting (summary of presentation)	❒	❒
1.3.2	Exercise 3. Institutional Structures and Levels of Priority Setting	❒	❒
1.3.3	Exercise 3. Worksheet	❒	❒
1.3.4	A General Model for Research Program Planning (text)	❒	❒
1.3.5	Priority Setting into the 21st Century: a Position Paper by the Priority-Setting Working Group (executive summary of the text)	❒	❒
1.4.1	Basic Processes of Priority Setting (summary of presentation)	❒	❒
1.4.2	Exercise 4. Priority-Setting Analysis	❒	❒
1.4.3	Exercise 4. Worksheet	❒	❒
1.4.4	Processes and Methods for Research Programme Priority Setting: the Experience of the Kenya Agricultural Research Institute Wheat Programme	❒	❒
1.4.5	Strengths and Weaknesses of the Day	❒	❒
1.4.6	Guidelines to Provide Feedback on the Workshop	❒	❒
1.4.7	PAPA Form — First Stage	❒	❒

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Overheads

		Yes	No
1.1.0	Priority Setting for Agricultural Research Programs	❒	❒
1.1.1	Workshop Goal	❒	❒
1.1.2	Major Objectives	❒	❒
1.1.3	Expected Outputs	❒	❒
1.1.4	Workshop Duration - Five Days	❒	❒
1.1.5	Background - Why Priority Setting?	❒	❒
1.1.6	Workshop Flow	❒	❒
1.1.7	Objectives of Day One (2 overheads)	❒	❒
1.1.8	Schedule of Day One	❒	❒
1.1.9	Participant Action Plan Approach	❒	❒
1.1.10	Why PAPA?	❒	❒
1.1.11	Uses of PAPA	❒	❒
1.1.12	Steps in PAPA	❒	❒
1.1.13	Step 1: In-course Activities, Stage 1	❒	❒
1.1.14	Step 2: In-course Activities, Stage 2	❒	❒
1.1.15	Step 3: Follow-up Activities	❒	❒
1.1.16	PAPA First Stage Form	❒	❒
1.2.1	Objectives of Session 2	❒	❒
1.2.2	Definition of Priority Setting	❒	❒
1.2.3	Why Set Priorities?	❒	❒
1.2.4	Priority Setting: A Structured Analysis	❒	❒
1.2.5	Why use Structured Methods?	❒	❒
1.2.6	However	❒	❒
1.2.7	When to use Priority Setting	❒	❒
1.3.1	Objectives of Session 3. Institutional Structures and Levels of Priority Setting	❒	❒
1.3.2	External Versus Internal Priority-Setting Process	❒	❒
1.3.3	Priority Setting in Agricultural Research	❒	❒
1.3.4	At Cabinet (Policy) Level	❒	❒
1.3.5	At Sectoral (Ministry) Level	❒	❒
1.3.6	At Program Level	❒	❒
1.3.7	At Project/Institute Level	❒	❒
1.3.8	Structure of the Research Institute	❒	❒
1.3.9	Information Flows and Institute Structure	❒	❒
1.4.1	Objectives of Session 4. Basic Processes in Priority Setting	❒	❒
1.4.2	Principles of Priority Setting	❒	❒
1.4.3	Developing a Priority-Setting Process	❒	❒
1.4.4	1. Identify Research Objectives	❒	❒
1.4.5	2. Identify Options for Research	❒	❒
1.4.6	3. Information Needs	❒	❒

		Yes	No
1.4.7	4. Identify Methods to Measure Contribution	❒	❒
1.4.8	5. Translate Results into Decisions	❒	❒
1.4.9	Exact Method may vary, but Principles do not	❒	❒
1.4.10	Implementation Example	❒	❒

Materials

• Overhead projector	❒	❒
• Projector screen	❒	❒
• Flipchart stands (minimum two)	❒	❒
• Flipchart paper/pads (about 10 per day)	❒	❒
• Markers for writing on newsprint	❒	❒
• Markers for writing on transparencies	❒	❒
• Blank transparencies	❒	❒
• Stapler	❒	❒
• Tape (strong masking tape and regular tape)	❒	❒
• Push pins	❒	❒
• Glue	❒	❒
• Pencils/note pads/pens	❒	❒
• Pencil sharpeners	❒	❒
• Extension cords	❒	❒
• Certificates	❒	❒
• Photocopying facilities	❒	❒
• Spare bulbs for overhead projector	❒	❒
• Extra notepads and pens	❒	❒
• Scissors	❒	❒

DAY ONE

Welcome and Session 1 Introduction to the Workshop

Instructions to Trainers

PRE-SESSION

Distribute notebooks to participants. Make sure the cards are ready for exercise 1.

08:30 – 09:00 Welcome

SESSION 1

09:00 – 10:30 Session 1. Introduction to the Workshop

OBJECTIVES

By the end of this session, the participants will be able to do the following:

- Discuss background and rationale for the workshop: goals, general objectives and expected outputs. The prospectus provides this information.
- Describe the workshop schedule for the entire five days. A copy of the schedule is in their notebooks.
- List the objectives of day one. Copies of the objectives and schedule are distributed.
- Explain the use of the participant action plan approach (PAPA).
- Identify trainers and trainees.

PROCEDURE

Training techniques: presentation, PAPA, interactive exercise.

(experience) Give a brief presentation providing background and rationale for the workshop. State the goals, general objectives of the workshop, and expected outputs. Explain the five-day schedule of activities (a copy of the schedule is available in the participants' notebooks). Seven overheads support the presentation 1.1.0 through 1.1.6. At the end of the presentation introduce the objectives and schedule of day one. Distribute handouts 1.1.1 and 1.1.2. Use overheads 1.1.7, 1.1.7a, and 1.1.8. Ask if clarification is needed. (30 minutes)

PAPA

Introduction of Participant Action Plan Approach (PAPA)

PRESENTATION

(*experience*) Introduce the participant action plan approach (PAPA) to the workshop participants using overheads 1.1.9 through 1.1.16. You will find the key points (listed below) and handout 1.1.3 very useful. Distribute handout 1.1.3.

Encourage the participants to begin formulating action ideas as the workshop progresses. (15 minutes)

Five basic steps

PAPA requires that participants develop action plans at the end of the workshop. They will prepare a list of activities that they want to try when they return to their jobs. The plans are based on the workshop activities just experienced. After some time has elapsed (usually six months later), the participants are contacted to evaluate which activities they have actually been able to implement. The five steps involved in carrying out this process are as follows:

Step 1. Planning for PAPA

In this step, the persons conducting the workshop determine the specific activities needed to apply PAPA, considering the available resources and the needs of the organizations involved. The trainers assign and schedule the tasks necessary to carry out the approach.

Step 2. In-course activities

This step consists of two stages. At the beginning of the workshop, trainers introduce participants to the idea of an action plan. They are asked to record, throughout the workshop, new ideas they may want to try when they return to their jobs.

At the end of the workshop, participants are asked to write an action plan. This is an edited list of new, workshop-related activities that they plan to try when they return to their jobs.

Step 3. Follow-up activities

At a scheduled time after the training (usually six months later), participants are interviewed or contacted by questionnaire. They are asked which of their planned activities they have been able to achieve up to that time, and what other activities they have attempted as a result of the workshop. Participants are also asked what effect their new activities have had on their work environment, and what problems, if any, they encountered in trying them.

Step 4. Analysis and conclusions

In this step, the data collected during the follow-up are categorized and displayed to show the extent and type of change resulting from the implementation of the action plan. The information can be displayed in the form of descriptions of behavior change. It can be summarized numerically (e.g., how many of the participants changed in certain ways). It

can also be reported using a combination of narrative experience and numbers.

Step 5. Report

The findings from the analysis, conclusions, and recommendations regarding the workshop are reported in a form that meets the information needs of the organizations involved. The format may be an oral report, but a written document is preferred.

Information that can be collected

PAPA gathers information about participants' behavioral changes on the job due to the workshop. Since the trainer asks questions during the follow-up, data can also be obtained on the following:

reaction—how well participants liked and accepted the workshop (viewed six months after its completion)

learning—the skills, knowledge, attitudes, etc., participants felt they acquired during the workshop

results—the impact the participants felt that the workshop had on their organization or work environment

Uses of PAPA

Participants commit themselves to action through a written plan developed at the end of the workshop. They leave a copy of the plan with the trainer for follow-up purposes.

Participants know that someone will be asking about efforts they have made to implement the action plan. This can motivate them to actually try new activities on the job. Thus, PAPA can help participants transfer what they learned in the workshop to their jobs—PAPA becomes a part of the workshop itself.

Besides directly helping participants with the transfer of skills and knowledge, the action plan process can play a role in supervisor/subordinate discussions of workshop utilization. In working with employees after the workshop, supervisors can help them implement the action plans and thus encourage and support the transfer of learning to the job.

Resources needed to use PAPA

No complex skills or knowledge are required for using PAPA. It does not require previous evaluation experience. No statistical tests are employed in the analysis. If interviews are used to collect follow-up information, interviewing skills are needed. A general ability to synthesize data and draw logical conclusions is also important.

The major resource required is time, mainly time to collect the data about changed job behavior and time for analysis. However, the trainer can take shortcuts in using the approach and still produce valuable information about the workshop.

Reference

United States Office of Personnel Management. (no date.) Assessing Changes in Job Behavior Due to Training: A Guide to the Participant Action Plan Approach. Washington, D.C.: Productivity Research and Evaluation Division, United States Office of Personnel Management.

EXERCISE 1

Interactive exercise 1. "Getting to know each other." (60 minutes)

1. (*experience*) Distribute a form to each participant (see handout 1.1.4). Note that each form has a different question. You must cut the forms before the session. Each participant fills out a form. Based on the information on the form, the participants introduce themselves to the group.
2. (*process*) Ask the participants how they felt doing this exercise. What have they learned about themselves? Others?
3. (*generalize*) How will this information/experience be useful during this workshop?
4. (*experience*) Distribute handout 1.1.5 and ask participants to complete the form in their own time. This will help them get to know each other better.

CLOSURE

Closure (5 minutes)

1. *(application)* Ask the participants "How will you apply the lessons learned as a result of this session in your job?
2. Make a transition to the next session.

10:30 – 10:45 Tea/Coffee Break

DAY ONE

Session 1
Summary of Overheads

Priority Setting for Agricultural Research Programs

1.1.0

Workshop Goal

To provide program leaders and scientists with a systematic approach to developing priority setting, which ensures improvement of research performance to attain national objectives

1.1.1

Major Objectives

Participants to be able to:

- discuss the process of setting priorities in your organizations
- discuss the need to set priorities
- identify existing structures and mechanisms for resource allocation within their institutes, discuss appropriate institutional structures, and level for priority setting
- identify criteria for choosing priority-setting methods
- indicate the use of spreadsheets in priority setting
- implement the congruency model
- identify major constraints in priority setting and allocate the constraints to major research themes
- explain the scoring method, the criteria used, and data requirements
- describe a protocol of approval and implementation of priority-setting duties
- plan actions for future activities in priority setting

1.1.2

Expected Outputs

- Improve priority-setting skills among agricultural research managers
- Improve commitment among agricultural research managers
- Design action plans to implement activities related to priority setting in your organization

1.1.3

Workshop Duration - Five Days

1.1.4

Background - Why Priority Setting?

- Selects best portfolio of research activities for a research system, institution, or program
- Makes effective use of resources available for research
- Allows for review of resource allocations to research
- Clarifies opinions in organizations on research programs
- Promotes an environment of consensus in research programs
- Identifies key persons responsible for prioritization of research allocation
- Helps to make institutional management transparent.
- Provides guidance to management, clarifies expectations of personnel and stakeholders

1.1.5

Workshop Flow

Session	Sequence	Content
2	*Why* P.S.?	Rationale
3	*Where* P.S.?	Locations
4, 6, 8	*How* P.S.?	Process, Methods, Tools
5, 7, 9, 11, 12, 15	*What* P.S.?	Objective, Zones, Themes Information/Data
10, 13, 14	*How* P.S.?	Congruency Analysis Economic Surplus Benefit Scoring
16, 17	*Managing* P.S.	Institutions

1.1.6

Objectives of Day One

1. Discuss background, rationale, objectives, and schedule
2. Explain the use of the participant action plan approach (PAPA)
3. Identify trainers and trainees
4. Discuss the process of setting priorities in your organizations
5. Discuss the need to set priorities
6. Explain why formal priority-setting methods are necessary

1.1.7

Objectives of Day One

7. Explain that a formal priority-setting process does not replace personal judgement, knowledge, and experience
8. Identify the existing structure and mechanisms for resource allocation in your institutes
9. Discuss institutional structures and levels for priority setting
10. Assist in developing an internal priority-setting process for your institutes
11. Identify key processes that should guide any priority-setting exercise

1.1.7a

Schedule of Day One

08:30 – 09:00	Welcome
09:00 – 10:30	Session 1. Introduction to the Workshop
	Tea/Coffee Break
10:45 – 13:00	Session 2. Importance of Priority Setting in Agricultural Research
	Lunch
14:00 – 15:30	Session 3. Institutional Structures and Levels of Priority Setting
	Tea/Coffee Break
15:45 – 17:00	Session 4. Basic Processes in Priority Setting
17:00 – 17:30	Feedback on the Day's Activities and PAPA

1.1.8

Participant Action Plan Approach

1.1.9

Why PAPA?

- Systematic and continuous planning of future activities by trainees as training evolves
- Formal link between trainees and trainers for follow-up activities: which skills have been used in the job?
- Further involvement of trainee in improving the training material after training event

1.1.10

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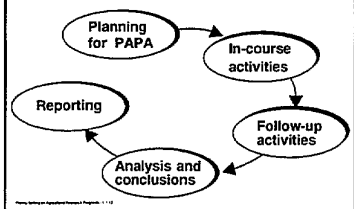
Uses of PAPA

- Assess the transfer of skill to work place
- Determine the impact of change introduced
- Identify problems of implementation
- Decide how to modify the course
- Evaluate the most useful parts/quality of training

1.1.11

Steps in PAPA



1.1.12

Step 2: In-course Activities

Stage 1

Objectives:

- introduce PAPA to participants
- identify possible action ideas to be tried on the job

Procedure:

Jot down action ideas during the training

- use format provided (annex 1)
- do it at end of last session each day
- confer with other participants/trainers periodically

1.1.13

Step 2: In-course Activities

Stage 2

Objectives:

- develop action plan

Procedure:

- prepare preliminary list of action items
- confer with partner
- finalize and prioritize list of action items
- report individual action plans
- make copy and submit to trainer

1.1.14

Step 3: Follow-up Activities

Trainers	Participants
• Formulate and send questionnaire →	• Fill out and return questionnaire
• Analyze and Interpret data	
• Prepare report →	• Receive report and send feedback
• Modify course content	

1.1.15

PAPA Questionnaire, First Stage
Ideas for action items

Date :

Workshop title :

Date/Venue :

Name :

Organization :

Ideas I would like to try when I return to work at my research institute, based on what I have learned in this training workshop

1.1.16

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Special Notes to Trainers

1. Make sure that the notebooks are ready for distribution. Remember the notebooks are comprised of the following:

   - welcome letter
   - workshop prospectus
     - tentative schedule (five days)
     - registration form

2. Make sure that the cards for the interactive exercise (handout 1.1.1) are cut out.

3. Make sure that you staple all exercise instructions and worksheets together one day before the sessions.

4. Make sure that Microsoft Excel software is installed on the computers used at the workshop.

5. Note that a diskette is enclosed in the module with an Excel spreadsheet to accompany Sessions 10 through 14. In addition you also find the evaluation forms in Wordperfect 5.1 to use if necessary.

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Handout - Overview of Day One

Priority Setting for Agricultural Research Programs

Objectives

By the end of the day the participants will be able to do the following:

1. Discuss the background, rationale, objectives, and schedule for the five-day workshop.
2. Explain the use of participant action plan approach (PAPA)
3. Identify the trainers and trainees.
4. Discuss the process of setting priorities in their organizations.
5. Discuss the need to set priorities.
6. Explain why formal priority-setting methods are necessary.
7. Explain that a formal priority-setting process does not replace personal judgement, knowledge, and experience.
8. Identify the existing structure and mechanisms for resource allocation within their institutes.
9. Discuss appropriate institutional structures and levels for priority setting.
10. Assist in developing an internal priority-setting process for their institutes.
11. Identify key processes that should guide any priority-setting exercise.

Participant Materials

Workshop notebook (includes welcome letter, tentative five-day schedule, and workshop prospectus)

Handouts

1.1.1 Overview
1.1.2 Tentative Schedule
1.1.3 Participant Action Plan Approach (PAPA)
1.1.4 Exercise 1. Interactive Exercise (seven sheets to be cut into 21 forms)
1.1.5 Exercise 1. Exercise Sheet (list of questions)
1.2.1 Importance of Priority Setting in Agricultural Research (summary of presentation)
1.2.2 Exercise 2. Reflecting on Priority Setting as a Tool for Research Management
1.2.3 Exercise 2. Worksheet
1.2.4 Models of Priority Setting for Public Sector Research (text)
1.3.1 Institutional Structures and Levels of Priority Setting (summary of presentation)
1.3.2 Exercise 3. Institutional Structures and Levels of Priority Setting
1.3.3 Exercise 3. Worksheet
1.3.4 A General Model for Research Program Planning (text)
1.3.5 Priority Setting into the 21st Century: a Position Paper by the Priority Setting Working Group (executive summary of the text)

1.4.1 Basic Processes of Priority Setting (summary of presentation)
1.4.2 Exercise 4. Priority-Setting Analysis
1.4.3 Exercise 4. Worksheet
1.4.4 Processes and Methods for Research Program Priority Setting: the Experience of the Kenya Agricultural Research Institute Wheat Program
1.4.5 Strengths and Weaknesses of the Day
1.4.6 Guidelines to Provide Feedback on the Workshop
1.4.7 PAPA Form — First Stage

Handout - Tentative Schedule of Day One

Priority Setting for Agricultural Research Programs

08:30 - 09:00	**Welcome**
09:00 - 10:30	**Session 1. Introduction to the Workshop** – Workshop introduction, objectives, and schedule – Overview of day one – Introduction of PAPA – Interactive exercise (1)
10:30 - 10:45	Tea/Coffee Break
10:45 - 13:00	**Session 2. Importance of Priority Setting in Agricultural Research** (Presentation and exercise 2)

13:00 — 14:00 Lunch

14:00 - 15.30	**Session 3. Institutional Structures and Levels of Priority Setting** (Presentation and exercise 3)
15:30 - 15:45	Tea/Coffee Break
15:45 - 17:00	**Session 4. Basic Processes in Priority Setting** (Presentation and exercise 4)
17:00 - 17:30	**Feedback on the Day's Activities and PAPA**

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Participant Action Plan Approach (PAPA)

As part of this training, you will do an exercise designed to help you apply what you have learned. You may not find everything taught in the training appropriate to your specific situation. In some cases, you may want to adapt some of the materials to fit your particular job or work setting.

To do this, the participant action plan approach (PAPA) was developed by the United States Office of Personnel Management. PAPA is an easy-to-use method for determining how you changed your job behavior as a result of your attendance at a training course or program. The method generates data that enables the trainers to answer questions such as the following:

1. What happened on the job as a result of the training?

2. Are changes that occurred the ones intended by those providing the training?

3. What may have interfered with participants trying to use on the job what they learned in the training?

With the information from PAPA, trainers (as evaluators) can also decide if the training course should be modified, and in what ways. Managers can use the information to determine the worth of the training and make informed decisions about its future.

Workshop Activities

The method consists of two stages. At the beginning of the training you are introduced to the idea of an action plan and are asked to consider throughout the workshop tasks that you might want to do differently when you return to your job as a result of the training. Then, at the end of the training you are asked to write an action plan. This is a list of new, workshop-related activities that you plan to try when you return to your job.

Follow-up Activities

At a scheduled time after the workshop (usually several months), you will be interviewed or contacted by questionnaire. You will be asked which of your planned activities you have been able to implement up to that time, and what other new activities you have attempted as a result of having attended the training. You will also be asked what effect your new activities have had on your work environment, and what problems, if any, you encountered in trying them.

FIRST STAGE

PAPA - ideas for action items

Date : _____

Workshop title: SADC/ESAMI/ISNAR Workshop on Priority Setting for Agricultural Research Programs

Date/Venue : _____

Name : _____

Organization : _____

Ideas I would like to try out when I return to work at my research institute, based on what I have learned in this training workshop.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Note: You can use the workshop objectives, what you learn during the workshop, the handouts, conversations with participants and trainers, etc., to come up with ideas.

Guidelines for Writing Action Items

The most important characteristic of an action item is that it is written so you — or someone else — *will know when it occurs.* One way to help achieve this is to use specific *action verbs.* The following is a list of such verbs:

Mental Skills		Physical Skills	Attitude
State	Discriminate	Execute	Choose
Name	Classify	Operate	Volunteer
Describe	Generate (solution)	Repair	Allow
Relate	Apply (a rule)	Adjust	Recommend
Tell	Solve	Manipulate	Defend
Write	Derive	Handle	Endorse
Express	Prove	Manufacture	Co-operate
Recount	Analyze	Calibrate	Accept
	Evaluate	Remove	Decide to
		Replace	Agree

As you are working on the action items, ask yourself *Is the behavior described observable? Will it be obvious to me or others when it happens?*

The following are examples of the action items: *As a result of being in this training I plan to:*

1. *Describe* this workshop to my superior within a week of my returning to the job. As a result, my supervisor will know the contents of the training workshop, how I can apply what I learned to the job, and whether or not others in the organization will attend.

2. *Handle* every piece of paper only once to improve the management of my own time. Begin as soon as I am back on the job.

3. *Apply* the principles of performance analysis to the problem of incomplete or tardy case reviews in my research institute and request assistance from the training unit, as needed. As a result I will know whether training is required and/or if some other solution is appropriate. Begin within a month after returning.

4. *Talk* with my employees directly about a problem which arises, rather than avoiding a confrontation; discuss the situation in order to reach mutual understanding.

5. *Within* two weeks after I return, I will implement a _____ research management procedure/process in my research institute.

Implementing the Action Item

As you proceed to develop action items, *be sure to think of yourself in your actual job setting*, implementing the activity you have described.

If you have an idea of *when* you will be able to begin implementing the action items, make a note of it. Three categories can be chosen: 1) as it arises (you do not know when the opportunity to try this item will occur, 2) within two months, and 3) after two months.

You may find that you cannot try out your ideas exactly as you envisioned them, or that it is difficult to be specific. That is all right. It is still important to write out your *intent*, as a tentative plan, knowing you may have to modify it once you are back on the job. *Try to develop at least two or three action items*. One may not work, so it is handy to have others.

SECOND STAGE

ACTION PLAN

Date: _____

Workshop Title: SADC/ESAMI/ISNAR Workshop on Priority Setting for Agricultural Research Programs

Name: _____

Organization: _____

Action Items	Start to implement action plan (check if known)		
I plan to:	Within 2 months	After 2 months	As arises

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Questions about Your Action Items

1. *Preliminary nature of plan*

   - Were you specific in writing the action item?
   - What will you need to do when you return to work to find out which actions are possible?

2. *Resources*

   - Who would be carrying out the proposed action, or helping with it (formally or informally)?
   - Are the skills for carrying it out available?
   - How much time would this take?
   - Are there special materials or equipment required?
   - What is involved in obtaining them?
   - Will you be using a tool or system or aid from this training workshop?
   - If so, how much adaptation is required?
   - Is continual monitoring or follow through required?
   - If so, who will do it?

3. *Implementation*

   - Do you have the authority to implement the action?
   - If not, who does?
   - How do you think you can go about getting approval?
   - What do you think the degree of support is for your idea?
   - Will you need to sell people on it?
   - If so, who?

4. *Effects*

   - Whom will this action affect?
   - How will it affect them?
   - Will anyone be the worse for the results?
   - Will anyone be improved?
   - What will be affected?

5. *Environment*

   - What factors in the organizational environment might interfere with your doing this?
   - What factors in the organization will support your effort?

Forms for Interactive Exercise

Note to trainer:

Each one of the following forms has a different question for participants. Be sure to photocopy and cut the forms as indicated before session 1 begins.

Name _____

Institution _____

Area of Research _____

I feel motivated to participate in priority-setting process in my organization _____

_____

_____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Cut here

Name _____

Institution _____

Area of Research _____

When participating in priority-setting exercise, I feel disappointed with myself when _____

_____

However, my reaction is _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Cut here

Name _____

Institution _____

Area of Research _____

As a research manager responsible for setting priorities for research activities in my organization, I would describe myself as _____

because _____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Name _____

Institution _____

Area of Research _____

As a researcher I dislike being frustrated. That is why I _____

_____

To improve my morale and _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Cut here

Name _____

Institution _____

Area of Research _____

During this sharing exercise I feel _____

_____

because _____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Cut here

Name _____

Institution _____

Area of Research _____

While setting priorities to define research program and projects, I think of farmers as _____

_____

because _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Name _____

Institution _____

Area of Research _____

When I am among strange researchers, I _____

_____

because _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

.....Cut here ✂.....

Name _____

Institution _____

Area of Research _____

When I am participating in a group discussion on priority setting, I tend to be _____

_____

That is why I expect my team members to be _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

.....Cut here ✂.....

Name _____

Institution _____

Area of Research _____

I am sure I could do a better job in setting priorities for research if _____

_____

because _____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Name _____

Institution _____

Area of Research _____

When I am participating in setting priorities exercise I feel irritated with _____

_____

because _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Cut here ✂

Name _____

Institution _____

Area of Research _____

While planning to set priorities for my organization, I prefer to discuss my thoughts and doubts with _____

_____

because _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Cut here ✂

Name _____

Institution _____

Area of Research _____

When I am involved in priority-setting exercise, I like myself _____

_____

However, _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

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Name _____

Institution _____

Area of Research _____

I think my priority-setting skills _____

_____

because _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Cut here ✂

Name _____

Institution _____

Area of Research _____

I perceive that I like to participate in priority-setting exercise when _____

_____

because _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Cut here ✂

Name _____

Institution _____

Area of Research _____

As researcher, I like myself when _____

_____

and I dis;ike myself when _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Name _____

Institution _____

Area of Research _____

I think that my peers in researchers perceive me as _____

_____

because _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Cut here

Name _____

Institution _____

Area of Research _____

When I discuss priority-setting methods with my peers I _____

_____

because _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Cut here

Name _____

Institution _____

Area of Research _____

People who really get to know me as a researcher say _____

_____

because _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Name _____

Institution _____

Area of Research _____

My best professional quality is _____

_____

This helps me _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Cut here

Name _____

Institution _____

Area of Research _____

When participating priority-setting exercise, I perceive myself as a person who _____

_____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

Cut here

Name _____

Institution _____

Area of Research _____

My perception on setting priorities for research is that _____

_____

because _____

_____

My major expectation for this five-day workshop is _____

_____

The trainer will request you to introduce yourself to the group using this information

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Interactive Exercise

Questions

1. I feel motivated to participate in priority-setting process in my organization when

   _____

   During this workshop I expect _____

   _____

2. When participating in priority-setting exercise, I feel disappointed with myself when

   _____

   However, my reaction is _____

   _____

3. As a research manager responsible for setting priorities for research activities in my organization, I would describe myself as,

   _____

   because _____

   _____

4. As a researcher I dislike being frustrated. That is why I _____

   _____

   to improve my morale and _____

   _____

5. During this sharing exercise I feel _____

   _____

   because _____

   _____

6. While setting priorities to define research program and projects, I think of farmers as

   _____

   because _____

   _____

7. When I am among strange researchers, I _____

   _____

   because _____

   _____

8. When I am participating in a group discussion on priority setting, I tend to be

   _____

   That is why I expect my team member to be _____

   _____

9. I am sure I could do a better job in setting priorities for research if _____

   _____

   because _____

   _____

10. When I am participating in setting priorities exercise, I feel irritated with _____

    _____

    because _____

    _____

11. While planning to set priorities for my organization, I prefer to discuss my thoughts and doubts with

    _____

    because _____

    _____

12. When I am involved in priority-setting exercise, I like myself _____

_____

However _____

_____

13. I think my priority-setting skills _____

_____

because _____

_____

14. I perceive that I like to participate in priority setting when _____

_____

because _____

_____

15. As a researcher, I like myself when _____

_____

and I dislike myself when _____

_____

16. I think that my peers in research perceive me as _____

_____

because _____

_____

17. When I discuss priority-setting methods with my peers I _____

_____

because _____

_____

18. People who really get to know me as a researcher say _____

_____

because _____

_____

19. My best professional quality is _____

_____

This helps me _____

_____

20. When participating in priority-setting exercise, I perceive myself as a person who _____

_____

because _____

_____

21. My perception on setting priorities for research is that _____

_____

because _____

_____

DAY ONE

Session 2
Importance of Priority Setting in Agricultural Research

Instructions to Trainers

SESSION 2

10:45 – 13:00 Session 2. Importance of Priority Setting in Agricultural Research

RATIONALE

Research managers are often reluctant to set priorities because they do not want to state openly that some research will have to be left out. They are under political pressure to consider all possible research. Furthermore, they are very suspicious of a formal priority-setting process; they see it as a technocratic, bureaucratic process replacing scientists' judgement. This session will help research managers understand why priority setting is necessary and why they may want to consider a formal priority-setting process.

OBJECTIVES

By the end of this session, the participants will be able to do the following:

- Discuss the process of setting priorities in their organizations.
- Discuss the need to set priorities.
- Explain why formal priority-setting methods are necessary.
- Explain that a formal priority-setting process does not replace personal judgement, knowledge, and experience.

Use overhead 1.2.1 to present the objectives.

PROCEDURE

Training techniques: presentation, group work.

PRESENTATION

(*experience*) Give a brief presentation on the importance of priority setting. Seven overheads support the presentation: 1.2.2 through 1.2.8. At the end of the presentation distribute handout 1.2.1 and be sure to ask participants if they have any comments or questions, or if they need clarification. (15 minutes)

EXERCISE 2

Exercise 2. Reflecting on priority setting as a tool for research management. (1 hour 55 minutes)

Phase 1. Group work

1. Distribute handouts 1.2.2, 1.2.3, and 1.2.4. Handout 1.2.2 gives clear instructions for the exercise. Go over the instructions with the participants step by step. Ask if any clarification is needed. (5 minutes)

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2. Divide the participants into four groups in a random fashion.

3. *(experience)* Groups discuss and respond to the questions. While the groups work, circulate from group to group to check progress. Clarify any concerns the groups have while they are working. (45 minutes)

Phase 2. Presentation and discussion

4. *(experience, process)* Rapporteurs present the groups' results. Approximately five minutes is available for each group. Remain on time. (20 minutes)

5. *(generalize)* At the end of the exercise, discuss the groups' responses and provide feedback on the content of the presentations. Ask the participants questions such as "How did you feel doing this exercise?" and "What did you learn?" in order to allow discussion of the process. (45 minutes)

CLOSURE

Closure (5 minutes)

1. *(application)* Ask the participants "What might you do differently in your job as a result of what you learned?"

2. Make a transition to the next session.

13:00 – 14:00 Lunch

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DAY ONE

Session 2
Summary of Overheads

Objectives of Session 2. Importance of Priority Setting in Agricultural Research

4. Discuss the process of setting priorities in your organizations
5. Discuss the need to set priorities
6. Explain why formal priority-setting methods are necessary
7. Explain that a formal priority-setting process does not replace personal judgement, knowledge, and experience

1.2.1

Definition of Priority Setting

A process of choosing between alternative sets of research activities

1.2.2

Why Set Priorities?

- Make most effective use of resources
- Help in planning
- Help to reach consensus on objectives
- Renovate and modernize research agenda
- Provide guidance to management
- Increase credibility
- Control research agenda

1.2.3

Priority Setting: A Structured Analysis

- What is needed, in terms of
  - people
  - resources
  - information
  - time
- How is it done?
- What are the results?
- How are results used?

1.2.4

Why Use Structured Methods?

To help:

- Organize information to ensure logical consistency
- Resolve often-conflicting demands

1.2.5

However

- Does not substitute for judgement, but makes systematic use of experience
- Depends on quality of inputs

1.2.6

When to Use Priority Setting

- Before any planning is done
- Before re-planning
- Frequency must be weighed against costs

1.2.7

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Importance of Priority Setting in Agricultural Research (summary of presentation)

1. Note that:
   - Priority setting is a process.
   - The most appropriate process is specific to the research institute within which priority setting will occur.
   - An appropriate priority-setting process should be developed for each research institute.

2. Priority setting can be defined as "a process of choosing between alternative research activities." This definition emphasizes the different steps and actions that have to be undertaken to arrive at priorities rather than the methods used in the exercise.

3. The main aim of priority setting is to make the most effective use of available resources. Priority setting is also useful in planning since it facilitates a review of existing resource allocations. Consensus on objectives is achieved through the process as differences of opinions are clarified. The research agenda can also be renovated and modernized as new alternatives are considered. Resource allocation decisions become more transparent and unambiguous, and thus give clearer guidance. Finally, priority setting increases the credibility of an institution and helps it control a sound resource agenda in the face of conflicting external pressures.

4. An overview of the principles and process involved in a relatively structured analysis of agricultural research priorities will show who is involved in priority setting, how long it takes, what types of information are needed, what the basic principles and steps are, what resources are required, what outputs are produced, and how the results are used.

5. Why use a structured method? Here are two basic reasons:
   - to organize data and other information to help ensure logical consistency
   - to help resolve the often conflicting demands that producers, politicians, scientists, and other groups place on the research system

6. A formal priority-setting procedure is not a substitute for the judgement, experience and knowledge of researchers and research stakeholders. On the contrary, it makes systematic and explicit use of this experience by translating it into structured measures. Whatever formal priority-setting tool is used, the output results will not be better than the information input.

7. There is no rule as to when to conduct a priority-setting exercise, though it is advisable to do it before any planning exercise. Because priority setting can be an expensive undertaking, the frequency must be weighed against the cost of completing the exercise.

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Key References

Contant, R.B. and A. Bottomley. 1988. Priority Setting in Agricultural Research. Working Paper No. 10. The Hague: ISNAR.

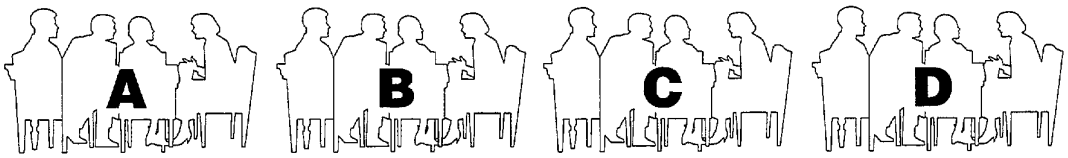
Janssen, W. 1994. Priority Setting as a Practical Tool for Research Management. The Hague: ISNAR.

Janssen, W. 1994. Priority Setting in Agricultural and Natural Resource Management: Following Hamlet's Dream or MacBeth's Plan? The Hague: ISNAR.

Exercise 2. Reflecting on priority setting as a tool for research management (group work)

Phase 1. Group work (50 minutes)

1. Form four groups. Each group elects a rapporteur.



2. Read J. Stewart, "Models of priority setting for public sector research" (handout 1.2.4).
3. Briefly outline the priority-setting models discussed by Stewart. You can use the worksheet (handout 1.2.3) for your responses.

   (a) How are resource allocation decisions currently made in your institute?
   (b) What formal priority-setting processes have your institutes undertaken?
   (c) Have the results of priority-setting exercises been effectively translated into resource allocation decisions?
   (d) What demands are there within your NARS for structured priority-setting exercises?

4. The rapporteurs write the results of their group's discussions on a flipchart.

Phase 2. Presentation and discussion

5. The rapporteurs present the groups results to the audience. Each group has five minutes for the presentation. (20 minutes)
6. The trainers will invite you to discuss the groups' responses and provide feedback on the content of the presentations. (45 minutes)

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Exercise 2. Worksheet

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Models of priority setting for public sector research[1]

Abstract

While the literature has discussed structural as well as thematic priorities, much policy-oriented thinking on national priorities for public sector research centers on the designation of preferred areas of science for emphasis. The paper puts forward the view that, at least at the national level, the utility of such benefit-cost approaches is limited. It is suggested that priority setting is best understood as a systemic process, with outcomes determined by the incentives and inter-relationships of choice rather than by ex ante calculation. Three systemic models, user-based, institutional and political, are advanced and their advantages and disadvantages discussed both in general and with reference to recent experience in Australia and New Zealand.

1. Models of priority setting for public sector research

In times of budgetary restraint, the need to make hard choices in publicly funded research has been much commented upon. There has been less consideration in the science policy literature as to the mechanisms which nation-states (or the science-funding institutions within them) might most productively use to help them make these choices.

When priority setting is looked at in a generic way, its interactive and systemic character is obvious. As an OECD report noted:

> ... the setting of science and technology priorities is essentially a complex political process involving many people who interact with one another. It is not a case of science-push or demand-pull, but a changing combination of the two which is impossible to break down precisely [11].

While the importance of structural priorities, that is, the relationship between key parts of the research system, is being increasingly acknowledged in the academic literature, there is a strong propensity among policy-makers to equate the activity of priority setting with the designation of preferred categories of scientific activity for expansion. Thus priority setting as a management task is identified with benefit-cost analysis, or with variations upon that theme.

This paper, by contrast, advances the proposition that it is possible and, indeed desirable, to approach research priority setting as a problem in system design. It is argued that the task of priority setting is best approached through an understanding of the way in which institutional systems, through their modes of operation, set priorities de facto. From this perspective, priorities in scientific research at both the national and organizational levels are best adjusted by changing aspects of the choice-making system, rather than by attempting to impose, from above, an a priori ranking.

2. The context of priority setting

Public sector scientific research (that is, research undertaken within organizations predominantly funded by government) can benefit the society which supports it only when products, services or techniques deriving (however indirectly) from such research

1. Reprinted from: *Research Policy, volume 24 number 1, Stewart, J. Models of Priority Setting for Public Research, January 1995.* With kind permission from Elsevier Science - NL, Sara Burgerhartstraat 25, 1055 KV Amsterdam, The Netherlands.

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receive some kind of general application. The benefits may be social (that is, improving the general quality of life) or economic (that is, improving living standards).

For any government, achieving such outcomes involves balancing the desires of scientists to work in the most exciting disciplinary fields with the wider interests of the national community. The marriage of research with planning must necessarily be an awkward one. In most countries at most times it is both convenient and inevitable that the true bases of choice are left vague and the range of possible options muddied by the cumulative effect of past decisions.

Certainly, if a nation has clearly stated goals, it is possible for scientists, as for others, to orientate their choices in conformity with those goals. But even in those countries (such as France and Japan) where research foresight techniques are deployed at the national level the process by which issues are defined is acknowledged to be as important as their content [9]. For nations with more pluralistic (or fragmented) and less centrally directed political systems, an understanding of the requirements of process may provide the key to better and more responsive priority setting.

3. What is a priority?

A priority is, literally, something one does first. If A has priority over B, all A's claims are met before any of B's are considered. In practice, priorities, even when explicitly articulated are no more than a guide, often at the margin, to choice-making. In complex systems, the notion of sequence implied by personal priorities (I will paint the house, then see if there is enough money for a holiday) does not apply, and priorities are more usefully considered as ways of highlighting significant issues for attention, rather than detailed methods for managing resource allocation. When funding outcomes are considered, however, (that is the relative amounts of resources going into particular types of research or related activities) priority setting is indistinguishable from resource allocation.

But if priority setting is about money going to objectives, the types of objective which are employed in the analysis inevitably involve one choice from the many available. When research priorities are set, it is usual to think in terms of categories: either disciplinary or, where strategic research is under consideration, socioeconomic objectives.

Such methods are clearly important in diagnosing where funds are going, and in relating research to classes of economic production. But their use should be accompanied by diagnosis of a systemic kind, which reveals thematic priorities of equivalent descriptive and prescriptive significance. Examples of thematic priorities are the relative influence of suppliers (that is, performers) of research as opposed to those who will make use of the results; the incentives within organizations which determine whether industrially relevant or other types of research are done; and political factors which allocate resources to particular groups on the basis of the relative power of their clients (e.g. scientists working on capital-intensive forms of agriculture may be better funded than those working on alternative farming methods).

The next section describes the category-based model and its variations, contrasting it with three quasi-normative system-based models, each of which can be used to identify and to adjust thematic priorities in public sector research. It is argued that category-based methods are necessarily based on a benefit-cost approach in that, within a notional overall allocation for public sector research, a ranking of projects is sought such that prospective net benefits are maximized.

3.1. The category-based (benefit-cost) model

In the formal sense, choosing between two competing alternatives involves determining which promises the better rate of return from the avail able resources. In choosing between a number of research projects, a research agency or company must attempt to quantify all the relevant variables affecting pay-offs

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from the research. Johnston [7] has listed these as being:

- the level and cost of resources to be committed to research, development and evaluation of the new technology;
- the cost saving associated with the use of technology in each industry;
- the international transferability of the technology;
- the probability of success;
- expected life of the technology;
- adoption rate and ceiling level of adoption;
- key economic parameters of the industries (elasticities, prices and quantities); and
- the existence of key external benefits or costs to be accounted for.

Attempting to make ex ante choices in this way is complex enough for a firm (and in practice must be backed up by constant monitoring and review). In the case of national science priorities, the desired benefits of research are not always economic or even necessarily quantifiable. By definition the projects undertaken will be further away from the marketplace than would be the case in industry-related decision-making. And while a firm has one person ultimately responsible for the choices that are made (in other words a uniform preference function) the allocation of resources to public sector science should represent as far as possible the preferences of society as a whole and not simply those of the members of the organization doing the research. In the strict sense, to apply a benefit-cost model to the selection of research priorities for science would involve:

(1) deriving a community preference function for trade-offs between social, economic and environmental objectives; and

(2) knowing which types of research were likely to contribute most to the achievement of those outcomes.

Comparing the objectives to which research might be applied is a little like comparing apples and oranges. Even where a monetary measuring stick can be applied, what weighting is to be given to $1 of health benefits as compared to $1 of improved industrial output or $1 of environmental benefits? These decisions can be made only if the preferences of individuals for different combinations of benefits are known, and if some mechanism has been found for aggregating them, the elusive social welfare function.

This is the familiar problem of social choice of course. But planning for research adds an additional level of complexity, in that the relationship between what is done now and the emergence of benefits in the future is, by definition, uncertain. As Salomon [12] has put it:

> While the research system can always be treated as one system of production among others, in which the promises of output are measured by the volume of input, it is nevertheless impossible to infer from scientific reasoning the criteria for a more rational distribution of resources.

Categorization of research programs constitutes another difficulty in itself. Strategic research (which can be expected to underpin a range of applications) fits poorly into a framework governed by economic objectives. And economic objectives themselves, particularly when expressed on an industry basis, are difficult to define unambiguously.

In practice, benefit-cost analysis in setting priorities is undertaken in a much looser and less formal way than is implied by a strict application of the concept and/or is done, not at the national level, but by specific research-performing and research-funding organizations operating within overall budgets. As the Australian Bureau of Industry Economics has pointed out, benefit-cost analysis in the pure sense is best applied at a late stage of research when more detailed analysis is needed to sup-

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port investment and is not well-suited to prospective direction setting of a general kind [4].

In practice, many institutions involved in priority setting use variations on the benefit-cost method which are less information-intensive and which compare objectives on the basis of predicted money-benefits alone. Research objectives are rated according to a number of criteria which capture both the general economic and strategic importance of research in that area, and the capacity of the organization for which priorities are being set to contribute to the desired outcome. The criteria are normally weighted in some way, to produce an overall 'score' for each research purpose.

This kind of approach is of most value in highlighting, in a defensibly objective way, which areas of research should be dropped or downgraded within an institutional (or, conceivably, national) portfolio of research investments. For institutions which have not previously attempted it, this exercise forces decision makers to examine both their own, and others' projects, in relation to an agreed rationale.

But there are shortcomings as well. If this method is the only one employed, it could lead to serious errors of judgment. Full information is never available, and ratings inevitably contain a strong subjective component. The priority-setting process may serve simply to vindicate existing power relations within the institution.

4. Systems theory and its application

It would be fair to say that the analytical use of systems theory in the policy sciences has fallen well short of its initial promise. Some principles of system design as applied to policy have been elucidated. In particular, the concepts of robustness, flexibility and feedback have been identified as contributing to the teaming potential of policy systems. The prescriptive implications of such work, however, remain unclear. The debate about the merits of relative centralization of decision making, in particular, and its relationship to teaming capacity remains unresolved [14].

In the present case, a systems approach can lend real cogency to the task of priority setting, precisely because the object of attention is not so much the designation of areas of research but rather the way in which such choices are made. From this perspective, three quasi-normative models can be discerned: the user-based model; the institutional model; and the political model.

Table 1 characterizes each of the models according to the identity of those choosing priorities; the incentives which determine their choices and the degree of centralization of decision making. The practical advantages and disadvantages of each model are discussed in the following sections.

Table 1. A Typology of Systematic Priority Setting

	User-based	Institutional	Political
Who chooses	Users (firms, citizens)	Scientists	Organized interests
Levels of decision making	Decentralized	Decentralized	Centralized or decentralized (pluralist)
Incentives to choosers	User needs	Rewards for research	Group benefits and costs

4.1. The user-based model

As suggested in Table 1, the user-based model (considered as an ideal type) substitutes the preferences of users of public sector research for those of performers and other interested parties in determining priorities. The rationale for deliberately designing a system in this way is that, as with other forms of production, a market-like arrangement is preferable to central planning in bringing demand for and supply of research into balance.

While research has a general 'public good' character, it is not the case that private interests have no incentive to fund it. Much health research, for example, is funded by charitable trusts. And where private interests are large enough (as in the case of major drug companies) they may fund research of a highly fundamental kind. It is necessary to distinguish carefully between those cases (such as agricultural research) where problems of free-riding

and economies of scale can be overcome by mechanisms such as compulsory research levies, and those where public sector funding through some sort of budgetary mechanism is unavoidable, either because groups of users cannot be clearly identified, or because the set of beneficiaries and the set of taxpayers are one and the same.

Provided (and it is a large proviso) users are themselves adequately funded to support research, there is no reason why their needs should not influence priorities in other fields of public sector research. This is particularly the case in those fields where the rationale for public funding is not the 'basicness' of the research but rather the fact that it is undertaken in support of activities which (for various reasons) are located within the public sector. Thus it is possible to imagine doctors and even patients having some influence on the direction of health-care research (particularly public-health research), and local people and authorities influencing environmental research.

In theory, it would be possible to fund all research through its users rather than its producers although to the extent that public money is involved, this simply restates the allocation problem all over again. Nevertheless, it is possible to orientate public sector research more closely to users' needs by a number of mechanisms, such as requiring public sector bodies to earn a proportion of their income from outside sources (the market solution), and/or by bringing users onto advisory boards (the political solution).

The great advantage of market-analogue arrangements is that they are both decentralized and bring to bear a much greater measure of 'demand pull' than would be possible using institutional and political arrangements. Those with an interest in the results of research, 'stakeholders' in the current jargon, have a practical perspective on costs and benefits which scientists themselves may lack. On the other hand, users are not usually in a position to understand the importance of long-term basic and strategic research, nor can they be expected to take into account the research training, teaching and infrastructural requirements of the research system as a whole.

Nevertheless, markets (in the sense of demand for products and skills) are known to exert a powerful influence on the structure of public sector research and development. Industries which are major sources of national income shape the pattern of public sector research because they employ skilled people (thereby influencing career choices by students) and the (generally) large firms involved place considerable pressure on governments to meet their needs. Many OECD countries have sought to improve the outcomes of public sector research by making these intrinsic linkages more explicit and by empowering groups of users (such as small businesses) whose priorities would otherwise be under-represented.

While there are clear problems in seeking to expand the influence of the private sector on priorities within the public sector, the transmission of market-based assessments of costs and benefits brings a clarity of perspective to public sector institutions and a problem-centered outlook which they might otherwise lack. Certainly in countries (such as Australia) with a public sector research structure which in key sectors has developed without significant industry involvement, problems of direction setting are particularly difficult to resolve because there are no industrial interests to give the necessary lead.

The user-based model also directs the attention of the policymaker to problems resulting from the varying capacities of different types of user to influence research. Such a perspective enables priorities to be rebalanced where (for example) industrial interests have an overwhelming influence on project choices, to the exclusion of consumer and environmental groups.

4.2. The institutional model

The institutional model derives its usefulness from its descriptive accuracy. Public sector research takes place, for the most part, within public sector organizations, each with its own

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internal controls and relationships with its environment. In planning their work, scientists are influenced by their personal values and objectives and by the incentives and disincentives offered by their institution. Different institutions perceive organizational and personal roles differently. It follows that certain kinds of priorities are set by these practices and relationships and can, in turn, be changed by altering them.

Frequent recourse to reorganization in public administration reflects the intuitive understanding that priorities are set and expressed by institutional relationships as much as by formal processes. Combining (say) marine science departments from a number of institutions within one dedicated institute changes the effective priority of marine science independently of the funds initially assigned to it, because the ability of marine science to win future funding increases will have improved relative to other research categories. (Of course, if the new environment proves less amenable to marine science interests than the old, effective priority will decline over time despite greater apparent salience.)

Institutional analysis often reveals latent priority-setting mechanisms which have no clear rationale. In many university systems, a notional proportion of the time of teaching staff is allocated to research. As teacher numbers reflect changes in enrolment patterns, over time there will be a tendency for research activity to follow student numbers when, from an overall perspective, there is no need for the two to be linked [2].

An institutional perspective also directs our attention to the incentives operating upon decision-makers within organizations. In the case of the researchers themselves, choice of project may be determined as much by the structure of rewards within their part of the research system as by external need for the results of the project or even its intrinsic scientific interest. If publication in academic journals confers advancement whereas testimonials from grateful clients or even the achievement of patents carry little weight, priorities will inevitably favor key problems within particular disciplines, rather than those whose solution might yield greater social or economic returns in the short-to-medium term.

Where priorities have been derived centrally, institutional analysis is vital to an understanding of implementation. Key decisions may be made at much lower levels in organizations than was thought, and be subject to incentives and constraints not apparent at head office. For example, where financial information is collected patchily or inconsistently, 'real' allocations of resources may be quite different from those which are claimed. Recruitment practices may not be matching nominated projects with personnel. Key people may be leaving the organization because of better opportunities elsewhere, or frustration with management.

The institutional perspective requires, firstly, that policy-makers have a clear understanding of the way in which existing arrangements are causing priorities to be set. To change priorities becomes as much a task of changing incentives as of designating particular objectives. And constant monitoring is needed to chart the effect of changed incentives.

4.3. The political model

Politics is often thought to imply a capricious or arbitrary cast to the direction of research. As Kemp [8] has pointed out (arguing for greater private sector involvement in the Australian R& D system) government is highly political, and the priorities of politics change all the time. Any set of institutions and activities which are highly dependent on government must expect there to be considerable change and disruption flowing from that area.

Certainly, the preferences (however formed) of those with the authority to dispense funds exercise a profound influence on the allocation of resources. Once we know who is doing the choosing, we have a fair idea of the outcome. This inevitable characteristic of the way in which political systems actually work can, however, be turned to positive account by

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consciously employing processes of consultation and bargaining in the setting of priorities. The wider the input (that is, the more interests that are organized and represented) the more closely should the necessary trade-offs approximate the community's true preferences.

The decision-making strategies employed within the political model will vary from country to country. Consensus may be achieved in a relatively centralized and rationalistic fashion (as in Japan) or as a result of compromises involving a wide variety of institutional and political agendas (as in the United States). In smaller countries (such as Sweden and Norway) a more explicit managerialist approach is used to co-ordinate research budgets, with the 'political' element represented by consultative and interactive processes involving scientists, interest groups and funding agencies.

At the interface between organizations and their environment, research advisory committees give planners access to the views of general community and special interest groups. Scientists, as with any professional group, are reluctant to involve outsiders too closely in decision-making about the work they do. Yet the power of pressure groups to frustrate (through regulation, for example) the best-laid scientific plans forces some attention to their claims.

Within organizations, consultation between the planners and those who do the research adds richness and precision to the information base used in setting priorities. Good research problems emanate from asking good questions, which have a habit of straying across fine-grained classificatory boundaries. Political or consultative models encourage the necessary balance, both ex ante and ongoing, between objectives and real research feasibility.

The political model has the obvious advantage that commitment to the decisions that are made by those who will be carrying them out overcomes the problem of substantial drift occurring between ostensible priorities and those which actually engage the attention of researchers. To use the current jargon, 'ownership' of decisions increases the likelihood of successful implementation.

5. Conclusion

Our understanding of priority setting (even though the practice is inevitably mixed) can be significantly advanced by attempting to sort out the principles according to which decisions about allocating resources are made, the basis for the four models put forward in this paper. The principal dividing-line, between system-based and benefit-cost methods, reflects two different ways of thinking about the problem, the first based on changing outcomes by changing processes, the second relying on centralized decision-making and hierarchy with a strong, often explicit, political component.

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DAY ONE

Session 3
Institutional Structures and Levels of Priority Setting

Instructions to Trainers

SESSION 3

14:00 – 15:30 Session 3. Institutional Structures and Levels of Priority Setting

RATIONALE

Priority setting involves all levels of an organization, each with specific information needed for resource allocation decisions. It is necessary to identify these levels and describe their specificities.

OBJECTIVES

By the end of this session, the participants will be able to do the following:

- Identify the existing structure and mechanisms for resource allocation within their institute.
- Discuss appropriate institutional structures and levels for priority setting.
- Assist in developing an internal priority-setting process for their institute.

Use overhead 1.3.1 to present the objectives.

PROCEDURE

Training techniques: presentation, pairs exercise.

PRESENTATION

(*experience*) Give a brief presentation on levels of priority setting. Eight overheads support the presentation: 1.3.2 through 1.3.9. At the end of the presentation distribute handout 1.3.1 and be sure to ask participants if they have any comments or questions, or if they need clarification. (15 minutes)

EXERCISE 3

Exercise 3. Institutional structures and levels of priority setting. (1 hour 10 minutes)

1. Distribute handouts 1.3.2, 1.3.3, and 1.3.4. Handout 1.3.2 gives clear instructions for the exercise. Go over the instructions with the participants step by step. Ask if clarification is needed. (5 minutes)

Phase 1. Working in pairs

2. *(experience)* All participants read handout 1.3.4 and 1.3.5. Then, pairs work together responding to the questions of phase 1 of the exercise. Responses can be written on the worksheet (handout 1.3.3). (35 minutes)

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Phase 2. Reporting and discussion

3. *(process)* Have a few rapporteurs report their pairs' results to the audience. Each rapporteur has three minutes. (15 minutes)

4. *(process)* Invite the participants to a discussion. Ask them to compare the results with their own experience. Discuss strengths and weaknesses. Provide feedback to enrich the results of the exercise. (15 minutes)

CLOSURE

Closure (5 minutes)

1. Ask the participants "What might you do differently in your job as a result of what you learned?"

2. Make a transition to the next session.

15:30 – 15:45 Tea/Coffee Break

DAY ONE

Session 3
Summary of Overheads

Objectives

Session 3: Institutional Structures and Levels of Priority Setting

8. Identify the existing structure and mechanisms for resource allocation
9. Discuss appropriate institutional structures and levels for priority setting
10. Assist in developing an internal process

1.3.1

External Versus Internal Priority-Setting Process

	Advantages	Disadvantages	Main constraints
External process	- Quick - Minimal human resources	- Lack of ownerahip - No learning	Funds
Internal process	- Ownerahip - Learning by doing	- Long process - Human resources intensive	Human resources

1.3.2

Priority Setting in Agricultural Research

Decision Level:		Guidelines:
cabinet	top down	national development goals
ministry of agriculture/research system		agricultural sector objectives Agricultural sector Operational Targets (programs)
research institute	bottom up	institute mandate
program		contribution to institute mandate

1.3.3

At Cabinet (Policy) Level

- Based on political dialogue
- Broad, noble and ambitious goals (development goals)

1.3.4

At Sectoral (Ministry) Level

- Priority based on contributions to national goals
- Priority gives clear indicative directive to research (operational targets)

1.3.5

At Program Level

- Priority based on contribution to institute mandate
- Influence of technical know-how and information
- Client constraints
- Potential for generation of adoptable technologies

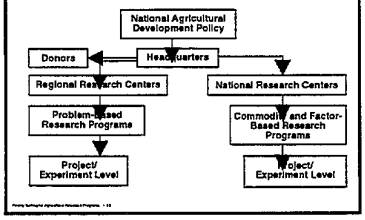
1.3.6

At Project/Institute Level

- Contribution to program priorities
- Technical soundness

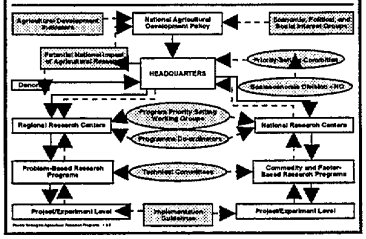
1.3.7

Structure of the Research Institute



1.3.8

Information Flows and Institute Structure



1.3.9

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Institutional Structures and Levels of Priority Setting (summary of presentation)

1. Priority setting is a process. The process can be external or internal to the institute. The external and internal priority-setting processes have advantages, disadvantages, and constraints.

	Advantages	Disadvantages	Main constraints
External process	– Quick – Minimal human resources	– Lack of ownerhsip – No learning	Funds
Internal process	– Ownership – Learning by doing	– Long process – Human resources	Human resources

2. Research priorities are set at several levels within a research system:
   - cabinet (policy) level—agricultural versus non-agricultural research
   - ministry (strategic) level—national, regional, and state level priorities are set among commodity and non-commodity research programs. The programs may represent disciplines such as plant breeding, entomology, or animal nutrition, or broader areas such as crop protection, agroforestry, natural resource management, and social sciences research
   - program level—within each program, priorities are set and resources are allocated among research projects
   - project level—within each project, priorities are set among experiments, studies, and other tasks

3. Priority setting at the cabinet level is usually not necessary, as decisions about agricultural research are based on policy considerations and negotiations. The outcome depends strongly on decision makers' expectations of impact of research on policy goals. These goals are usually broad, noble, and ambitious.

4. At the ministry level priority setting focuses on the relative importance of different research programs (commodity or non-commodity) as they contribute to national goals. The potential impacts of research in each program are compared. Priorities here give clear, indicative directives to research (operational targets).

5. At the program level, priorities are based on the likelihood of research to generate adaptive technologies to solve major client's problems. Technical assessment dominates this level, and projects within a program are compared on their technical soundness.

6. Once projects have been prioritized the stations decide which are long term and short term and, based on their inherent technical soundness, which should be executed and in what order.

7. How to diagnose an appropriate priority-setting process in your institute:

   - Identify levels for research planning and allocation in your institute. (KARI example)
   - Identify appropriate institutional structures for research priority setting. (KARI example)

Key References

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Exercise 3. Institutional structures and levels of priority setting (pairs exercise)

Phase 1. Working in pairs (35 minutes)

1. Pair up with a partner from your country and choose a rapporteur.

2. Read and discuss the main ideas presented in handout 1.3.4 (M. Dagg) and 1.3.5 (the KARI example).

3. Briefly analyze the 3 stages of research program planning in Dagg's paper and respond to the following questions. You can write your responses on the attached worksheet 1.3.3.

   (a) Identify the key levels for research allocation decisions in your institute.
   (b) What institutional structures exist for making resource allocation decisions?
   (c) At what levels should priorities be set?
   (d) What groups should be involved at each level?

4. Prepare a summary of your responses on a flip chart. Do not forget to write the name of your country on top of the page.

Phase 2. Reporting and discussion (30 minutes)

5. A few rapporteurs present their pairs' responses to the audience. Each rapporteur has three minutes to present. Time is limited, so be concise.

6. You will be invited to compare the results with your own experience, to discuss strengths and weaknesses, and to state lessons learned from this exercise.

7. The trainer provides feedback to enrich the results of this session.

Exercise 3. Worksheet

A general model for research program planning[1]

To effectively focus a national agricultural research system on clear needs and objectives, management in research organizations must conceive and arrange for coherent research programs in a manner which does not inhibit the creativity of researchers. A general model in which research program planning is carried out from top to bottom and review is carried out from bottom to top is presented here as a guide for managers involved in the research formulation process.

Planning: a top-down process

Research involves loosely defined goals and targets and processes that cannot be tightly or centrally controlled. While some central guidance can help to ensure that research staff are working towards predetermined development objectives, tightly centralized decision making regarding the research program details is counter-productive. The key task of those managing research program formulation is to ensure adequate guidance without stifling the creativity of the individual researchers.

One important distinction which research managers must make is that between the management of research program formulation and the management of resources. These two management activities are intrinsically different and thus must be approached from different angles, by different persons or units. Managing research program formulation requires interaction with people from outside the research system, while managing resources once priorities have been set is an internal task and should not involve outsiders. One of the first rules for research managers is thus to ensure that two types of decision-making bodies are in place: one for program formulation and the other for resource management.

Beginning with the highest, most general objectives for agricultural development, managers must devise a way to ensure first that research resources are allocated to the most important target programs and second that the resources are used on the best experiments and studies within those target programs. Two distinct levels of decision-making authority are responsible for these two tasks, as they must be decided not only at different stages in the program formulation process, but also from different perspectives. Allocation of resources to programs is made from the top down, and thus from a broad policy level, whereas decisions on expenditure for individual experiments are made from the bottom up, and thus more from the researcher or station manager's perspective.

The formulation of the detailed research program is actually accomplished through three separate stages, with the input of three authoritative bodies supplied with appropriate information and experience. These bodies are here called planning groups. The planning groups' composition at each of the three stages of the research program formulation process should reflect developmental objectives of the country. For example, if excellence in basic agricultural science is a high priority, the composition of the planning group will be quite different than if the top priority is the development of appropriate technology for on-farm use.

1. **Extract from:** Dagg, M. (1992). A General Model for Research Program Planning. In: Summary of Papers at the International Seminar on Agricultural Research Management, 25–27 May 1992, Beijing, China, The Hague: ISNAR.

Decisions at each of the three stages are made at increasingly decentralized locations from stage 1 to stage 3. In countries with a federal governmental structure all three stages must be carried out at each level of government. In China's case, for example, these levels are state, province, prefecture, county.

Also, at each of the three stages, appropriately processed information must be available to help the planning groups assess priorities and reach decisions. The kind of information required is different at each stage.

Three stages of research program planning

Stage 1

Broad national research priorities are stated from the broad perspective of the policy center. The planning group responsible for decision making among commodities or production factors at this stage must have policy-making, priority-setting, and resource-allocation authority. A selection of policymakers, ministry officials, scientists from universities and research institutes, senior extension officers, and marketing officers should be included.

The information required by this policy-level planning group concerns the economy, political objectives, and technical opportunities, as well as specific information about the country or region. It could include:

- area, production, and value statistics of main commodities by region;
- demand elasticities; comparative advantage of commodities at urban center and at farm gate; potential for expansion; regional agroecological characteristics;
- population figures; income distribution; nutritional status;
- scientific assessments and assessments of local knowledge regarding technical opportunities and limitations and appraisal of research staff capabilities.

Clearly, if this apex planning group consists of such senior scientists and officials, they cannot take as much time as is necessary to collect and analyze data. A technical secretariat, planning unit, or equivalent must therefore service this group, presenting the required information in a well-analyzed and usable form.

STAGE 1	Policy-making center, apex planning group	Sets broad priorities and objectives among commodities and/or factorrs of production to be examined by the national agricultural research system.	e.g., maize
STAGE 2	Agricultural research planning group	Decides on the specific constraints to be examined to best improve the production of the commodity or the efficiency of the factor of production named by the policy center above.	e.g., disease, yellow streak virus
STAGE 3	Institute, experiment stations, researchers	Makes proposals for specific experiments to examine the constraints selected by the management authority above.	e.g., how to reduce incidence of yellow streak virus; survey of alternative hosts of vector; field test of three planting dates at three sites; study of micropopulations of insect vector in four crop mixtures

Figure 1. The general framework for research program folumation

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Stage 2

The constraints which can be most effectively addressed to improve gains in the commodities or production factors identified in stage 1 are decided from the specialized perspective of a senior-level technical planning group.

Extension and agricultural development staff must be involved although the main members of the group will be research leaders with the authority and capability to prioritize constraints and correctly identify which can be most realistically tackled with the resources allocated.

The main information requirement for decision making at this stage is an overview of the technical and scientific possibilities for production improvements. Contact with foreign and international research institutions is helpful and the group's external members will bring knowledge of the capability of the national production system to bear on possible innovations resulting from proposed research thrusts.

Stage 3

The experiments and studies to be conducted, aimed at the priority constraints as selected in stage 2, are proposed and approved from the multidisciplinary perspective of the planning group at this stage. Socioeconomists, extension staff, and farmers' representatives should all be included. An important function of this stage 3 planning group will be to interpret national research priorities to research staff before they make their formal proposals.

At stage 3 information is brought to the planning meetings by individual members and should include details of the microeconomy and the circumstances, needs, and constraints of the research system's immediate clients — farmers, extensionists, planners, and fellow scientists. Some senior scientists should be available to monitor quality and realism in the design of experiments and studies.

At each of these three stages crucial decisions are made by planning groups. However, to reach consensus within such a group usually requires the use of a systematic priority-setting method or tool. When such a tool is used, the transparency of the decision-making process helps to convince actors in the system and outsiders alike of the decisions' appropriateness. This is especially important where resource allocation is involved. In managing the process of research program formulation, the use of priority-setting tools at all levels is an invaluable way to target all decisions on the stated developmental objectives. Examples of such objectives are as follows:

- efficiency — increase production, incomes, employment, and export earnings;
- equity — support some groups more than others;
- food security — reduce variability of production and increase food self-reliance;
- science and technology — develop scientific competence and to serve development;
- environmental sustainability — provide short- and long-term natural resource stability.

Review: a bottom-up process

After planning, a review of the research program formulated should take place following the three planning stages but in reverse order. The review process may vary widely among countries. Reviewing groups can be identical with the planning groups at each of the three stages, especially at the research institute/researcher level (stage 3) where the emphasis is on relevance and quality of experiments. At higher levels a major concern of the reviewing group is to ensure that the program formulated conforms with the resources available and with the planned allocations. In

general, at these higher levels the presence of extension staff and development experts is less crucial in the reviewing phase than in the planning phase.

Stage 3

At this first stage in the review process, each experiment proposal is reviewed for quality with questions such as "Is the design valid to yield reliable conclusions?" and "Is it efficient in its use of resources?" It is also reviewed for relevance with questions such as "Is it focused on the target constraint?" and "Will conclusions lead to improved farming practices?" It is generally impossible to review all experiments and studies in detail for quality and relevance at stage 2; if this is not done at the institute/researcher level (stage 3) it won't be done at all. In many developing countries, governments and donors underrate the overarching importance of this part of the review process.

Stage 2

At this middle stage of the review process, the agricultural research management agency examines the package of experiments approved at the institute/station/researcher level to ensure that they correspond to the planned balance of resource allocation to particular constraints and match the total resources available to the agency. Deleting or trimming proposed projects to bring them in line with priorities is generally necessary. Some optimism about expected resources is reasonable but putting forward proposals for two or three times the expected funds is not, as that would merely pass decision-making responsibility to a higher level but less-appropriate group.

Stage 1

This is the last stage of the bottom-up review process. Here, the policy center conducts a further and final review of the whole research program to ensure that the total collection of programs is in line with planned allocations to regions, commodities, factors and production systems and that the total claim matches the available resources.

Without exception, an essential beginning point in the whole process of program formulation is the careful documentation of proposed research and approved projects. This is important not only to amplify proposals and objectives clearly from level to level and from stage to stage, but also to provide a firm basis for program budgeting and a record for monitoring and evaluating progress.

Monitoring and evaluation

Monitoring and periodic evaluation are essential elements of good management in all areas of research. Managers at all levels need to have feedback on progress of implementation and on the potential of the plan to achieve its objectives. Only with such feedback are managers presented with the opportunities to take corrective action. The process of monitoring should include such activities as taking the minutes of meetings and including attendance lists to ensure that meetings are being held as planned, formally documenting plans along with the quantitative allocation of funds and researcher time, and documenting research proposals. While these are relatively easy to monitor, other aspects, such as the flow of appropriate information to planning groups, while just as important, present more monitoring and evaluation difficulty.

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Priority setting into the 21st century: a position paper by the priority-setting working group[1]

Executive Summary

In this paper we define priority setting as the process of combining institutional structures with information on the potential of research innovations, in order to allocate scarce research resources. Based on our analysis of the current institutional structures and methods for priority setting at KARI, we make the following recommendations.

1. **Institutional structures for priority setting:**

   - Priority-setting efforts will need to be undertaken at the institute, program, and project levels. A 'Priority-Setting Committee', composed of senior management will be charged with overseeing the co-ordination of these efforts.
   - An institute-level priority-setting effort, undertaken in 1996 or 1997, should draw mainly on information compiled at the program level.
   - Program-level priority-setting activities should form the basis for all priority-setting efforts and focus on evaluating the potential contribution of major program research themes to research evaluation criteria.
   - Project-level priorities are best set by technical specialists from programs, based on institute guidelines for the development and evaluation of research proposals.

2. **Criteria for priority setting:**

   - The Priority-Setting Committee will be charged with specifying the research evaluation criteria to be used in priority setting. These criteria should reflect the contribution of research to national development objectives.
   - The most commonly used criteria for priority setting are the following.

     a. Efficiency—the impace of research on national welfare.
     b. Equity—the distribution of research benefits.
     c. Foreign exchange earnings—the impact of research on the balance of trade.
     d. Food self-sufficiency—the contribution of research towards meeting all the country's food needs internally.
     e. Food security—the contribution of research towards reducing the variability of food availability.
     f. Sustainability— the contribution of research towards protecting the natural resource base for future generations.

1. **Extract from:** Kenya Agricultural Research Institute. 1995. Priority Setting into the 21st Century: A Positive Paper by the Priority-Setting Working Group: KARI.

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- The priority-setting working group makes the following specific recommendations on criteria.

a. The efficiency criterion and its consumer and producer surplus measures should form the basis of priority-setting efforts.

b. The equity criterion should also be included in priority-setting efforts and its measurement should be based on the distribution of efficiency benefits by target groups which will be designated.

c. If food security is determined to be an important component of national agricultural development objectives, a measure of this criterion should be included in priority-setting exercises. However, the weight given to the criterion should be determined by the quality of the information available on the contribution of research to food security objectives.

d. Since sustainability issues are vital to the long-term welfare of Kenyan society, methods and information bases for measuring the impact of research on the sustainability of agricultural production systems are under development. KARI must continue research efforts in this area.

3). Methods for national program priority setting

The specific methods used in priority-setting exercises will depend on the criteria specified by the Priority-Setting Committee. However, there are four crucial steps to all priority-setting exercises.

- Identification of " homogeneous" technology impact zones.
- Elicitation of assessments of the technical potential of research.
- Identification of the adoption potential of successful research.
- Evaluation of the economic impact of research through induced changes in commodity supply and demand.
- KARI is currently developing its capacity to undertake each of these steps through a number of program-based priority-setting efforts.

4. Plan of Action

The working group proposes the following plan of action to improve priority-setting efforts:

- A Priority-Setting Committee should be formed from senior management in the Headquarters, National Research Centers, and Regional Research Centers, (first quarter 1995).
- The Priority-Setting Committee should review this position paper and decide on the criteria and methods to be used in future priority-setting exercises, (first quarter 1995).
- The Committee should then oversee the development of an institutional structure to collect the necessary priority-setting information and implement the chosen method. However, matters regarding analytical methods and the assembly of relevant socioeconomic data will be managed by the socioeconomics division, drawing on INFORM data and ex-ante assessments of potential research impact formulated by technical specialists. As part of this effort, the specific responsibilities of individuals involved in priority-setting efforts must be outlined, (second quarter 1995).

- The socioeconomics division will inform programs with regard to the methods and the minimum information needs for program-level priority setting, (second quarter 1995).
- Programs are expected to complete their first major cycle of priority-setting exercises, in a continuing flow, by the end of 1996.
- These program-level exercises will be used as the basis for a comprehensive institute-wide priority-setting exercise by early 1997.

Key reference

Priority-Setting Working Group KARI. 1995. Priority Setting into the 21st Century: A Position Paper by the Priority-Setting Working Group. Nairobi: KARI.

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DAY ONE

Session 4
Basic Processes in Priority Setting

Instructions to Trainers

SESSION 4

15:45 – 17:00 Session 4. Basic Processes in Priority Setting

RATIONALE

It is important for participants to keep in mind some basic principles when analyzing research priorities, regardless of the particular method chosen to assist with the analysis.

OBJECTIVE

By the end of this session, the participants will be able to do the following:

- Identify key processes that should guide any priority-setting exercise.
- Use overhead 1.4.1 to present the objective.

PROCEDURE

Training techniques: presentation, modified "trip around the tables."

PRESENTATION

(*experience*) Give a brief presentation focusing on the basic processes of priority setting. Nine overheads support the presentation: 1.4.2 through 1.4.10. At the end of the presentation distribute handout 1.4.1 and be sure to ask participants if they have any comments or questions, or if they need clarification. (15 minutes)

EXERCISE 4

Exercise 4. Priority-setting analysis. (55 minutes)

1. Distribute handouts 1.4.2, 1.4.3, and 1.4.4. Go over the instructions with the participants step by step. Ask if clarification is needed. (5 minutes)

Phase 1. Group work

2. Divide the participants into four groups. Invite them to elect a rapporteur.
3. *(experience)* As the groups work, circulate from group to group to check progress. Clarify any concerns the groups may have while they are working. Be sure to remind the groups of the time remaining in this exercise.
   - Groups read, discuss, and respond to the questions assigned to them. Be sure that all participants read handout 1.4.4. (15 minutes)

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4. *(experience)* Invite the rapporteurs to make the "trip around the tables." Note that the rapporteurs of group A and B will **not** visit group C and D. The rapporteur has five minutes to visit the other table. Remain on time. (5 minutes)

5. *(process)* Rapporteurs return to their own group and discuss the responses including the inputs the rapporteur collected during the "trip." The rapporteur writes the results on a flip chart for presentation. (5 minutes)

Phase 2. Reporting and discussion

6. *(process)* The rapporteur presents the group's results to the audience. Each rapporteur has 3 minutes to present. Be aware that groups A-C and B-D will report similar contents. Take advantage of this to make a comparative study of these responses and promote learning. (15 minutes)

7. Let the groups participate in a discussion. (5 minutes)

8. *(process, generalize)* Provide feedback on the content of the presentations. Ask the participants questions, such as "How did you feel doing this exercise?" and "What did you learn?" in order to allow discussion of the process. (5 minutes)

CLOSURE

Closure (5 minutes)

1. *(application)* Ask the participants to tell one of their neighbors two things they might do differently in their job as a result of what they have learned. Ask volunteers to give examples.

2. Make a transition to the last session.

17:00 – 17:30 Feedback on the Day's Activities and PAPA

OBJECTIVES

By the end of this session participants will be able to do the following:

- Provide feedback on the day's activities.
- Consider possible actions they would like to implement in their own organizations.

PROCEDURE

Training technique: individual exercise.

Highlight positive and negative points of the day. Note areas that may need additional attention in the workshop. Participants can describe some strengths and weaknesses of this

day on handouts 1.4.5. and use handout 1.4.6 to facilitate their task. (15 minutes)

PAPA

(application) Ask the participants to take some time to jot down some "action ideas" they may have for themselves as a result of today's activities. They can use handout 1.4.7. (15 minutes)

DAY ONE

Session 4
Summary of Overheads

Objective of Session 4.
Basic Processes in Priority Setting

11. Identify key processes that should guide any priority-setting exercise

1.4.1

Principles of Priority Setting

Priority setting is a process

for improving resource allocation decisions

1.4.2

Developing a Priority-Setting Process

Identify:

1. objectives, at each level
2. options
3. information needed to measure contribution to objectives
4. methods for measuring contribution
5. ways to present results

1.4.3

1. Identify Research Objectives

- Research is one of many means for meeting societies' objectives
- Agricultural research contributes most effectively to sector production and efficiency

1.4.4

2. Identify Options for Research

- The level and scope of priority setting must be clearly defined;
  - commodities
  - locations
  - major research themes

1.4.5

3. Information Needs

- Objectives
  - research directors and policymakers
- Technical potential
  - scientists
  - extension workers
- Client constraints and adoption potential
  - baseline information
  - clients' opinions
- Economic analysis
  - economic information
  - priority-setting methods

1.4.6

4. Identify Methods to Measure Contribution

- Expected benefits are most common measure of research contributions
- Benefits can have economic as well as non-economic components

1.4.7

5. Translate Results into Decisions

The value of priority-setting analysis is greatly reduced if not directly tied to resource allocation decisions

1.4.8

Exact Method may vary, but Principles do not

- ☐ Do not treat research as only means of agricultural development
- ☐ Separate value judgements from technical and economic questions

1.4.9

Implementation Example

☐ Facilitator
- *identified benchmark data*
- *operated priority-setting applications*
- *ensures cross-program compatibility in priority-setting exercise*

☐ Working Group
- *key-program experts*
- *initial assumptions*
- *responsible for write-up of program exercise*

☐ Stakeholder Group
- *review/modify initial assumptions*
- *build program consensus*

☐ Data Needs

1.4.10

Basic Processes of Priority Setting (summary of presentation)

1. Priority setting is a process for improving resource allocation decisions.

2. The following five components should be kept in mind when developing a process for agricultural research priority setting:

   i identify research system objectives at each level
   ii identify the options for research (e.g., by location, themes, commodities)
   iii identify information needed to measure research contribution to objectives
   iv identify appropriate methods for measuring contribution
   v translate results into resource allocation decisions.

3. **Identify research system objectives**. Any society has a number of objectives and research can potentially contribute to several of them. Research, however, is not the only policy instrument for meeting societal objectives. Other policy instruments such as taxes, subsidies, and regulations are also available.

   Research can be an effective instrument for ensuring productivity and efficiency, but is often a blunt instrument when it come to meeting other objectives. A particular combination of taxes, subsidies, and regulations may be effective in meeting distributional or environmental objectives, but may be useless for meeting an efficiency objective.

4. **Identify the options for research** (e.g., by location, themes, commodities). Resource allocation decisions should be made across commodities, locations, and major research themes. The level of priority setting must be clearly defined.

5. **Information needs**. The appropriate sources of information on each type of question are usually different:

   (a) *Research directors* and *policymakers* are often the people with responsibility for making value judgments.
   (b) *Scientists* can provide information on technical factors such as the time required to complete the research, potential yield changes if the research is successful and adopted, and the probability of research success.
   (c) *Extension workers* and members of key *clientele groups* may be helpful sources on expected adoption rates for new technologies.
   (d) *Baseline information*—Researchable constraints or clients' needs
      - size and location of research target zones
      - price
      - factors influencing future production of population growth, area expansion price responsiveness.
   (e) *Economists* facilitate and guide the process by combining information provided by the other actors.

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6. **Measure the contributions of research alternatives to the objectives.** Expected benefits are the most common measure of research contributions. These measures will have economic as well as non-economic components

7. **Translate results into decisions.** A priority-setting analysis provides information that can feed into human resource development plans, facilitates investment decisions, and operating budgets. The value of the analysis is greatly reduced if it is not tied into planning efforts and decisions on hiring, training, building, etc.

8. The key conclusions to remember are the following:

   (a) The exact methods for priority setting may vary, but the basic principles do not.
   (b) Research is not the only policy instrument and is best for meeting efficiency objectives.
   (c) Separate value judgments from technical and economic questions and match questions with appropriate source of information.
   (d) Use economic value as a unit of measure of research contributions.
   (e) Translate results into decisions on people, facilities, and budgets.

9. A KARI example of key groups for implementing these processes.

   (a) Facilitator—identifies benchmark data, operates priority-setting applications, and ensures cross-program compatibility in priority-setting exercises.
   (b) Working group—key program experts provide initial assumptions and are responsible for write-up of program exercise.
   (c) Stakeholder group—reviews/modifies initial assumptions and builds program consensus.
   (d) Data needs.

Key Reference

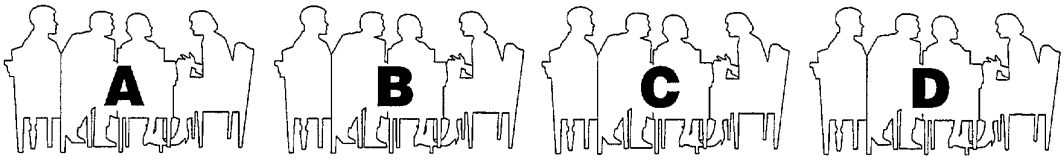
Norton, G.W. and P.G. Pardey. 1994. A Trainer's Guide to Strategic Priority Setting and Ex Post Evaluation. The Hague: ISNAR.

Mills, B.F. and D.D. Karanja. 1994. Processes and Methods for Research Program Priority Setting: the Experience of the Kenya Agricultural Research Institute Wheat Program. Nairobi: KARI.

Exercise 4. Priority-setting analysis (modified "trip around the tables" technique)

Phase 1. Group work (25 minutes)

1. Form four groups of participants.



2. Each group elects a rapporteur.
3. All participants read the introduction of handout 1.4.4 and discuss it among the group members. What are the key processes guiding the KARI priority-setting process?
4. Each group has fifteen minutes to respond to the questions assigned below, based on their own experiences.

   Groups A and C:
   - Who should be responsible for establishing the priority-setting process in your institute/national research system?
   - What groups should be involved in each of the five components of the priority-setting process discussed in handout 1.4.1.?

   Groups B and D:
   - How can information generated in priority-setting exercises be best translated into resource allocation decisions?
   - Does the type of information needed differ according to the level of priority setting?
5. The rapporteurs compile the groups' inputs on worksheets (handout 1.4.3).
6. Rapporteurs of group A and B switch tables. The rapporteurs of group C and D do the same. They have five minutes to present their group's inputs and collect contributions to improve their list of responses.
7. The rapporteurs return to their own group. They have five minutes to share the contributions collected during the "trip" and decide on three major responses to the assigned questions.

Phase 2. Reporting and presentation (25 minutes)

8. The rapporteurs write the results on the flip chart and present them to the audience. This should take three minutes each.
9. The trainer will make a comparative analysis of the responses, after which you will be invited to participate in a discussion.

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Exercise 4. Worksheet

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Processes and Methods for Research Programme Priority Setting: The Experience of the Kenya Agricultural Research Institute Wheat Programme[1]

Abstract

As funding for agricultural research in developing countries becomes increasingly scarce, national research institutes must develop efficient processes for targeting available resources to meet client needs. This paper presents the application of a process for setting national commodity programme research priorities both spatially and by major research theme. The exercise is conducted in three phases with the Kenya Agricultural Research Institute Wheat Programme. First, a working group of Wheat Programme scientists develops a consensus on programme target zones as well as the potential for the generation and adoption of technologies in those zones. Second, the working group assumptions are combined with available economic data to develop ex-ante economic surplus measures of programme impact. Third, the results are presented to a larger group of programme stakeholders in order to review the working group assumptions, establish research priorities, and then translate those priorities into guidelines for research managers on resource allocation decisions.

1) Introduction

Economists have developed an impressive toolkit of techniques for estimating the potential economic impact of agricultural research.[3] However, considerably less attention has been paid to how such techniques integrate with the general process for making resource allocation decisions in national agricultural research institutes. As a result, information generated in priority setting exercises has often had only a marginal influence on the actual resource allocation decisions made by research managers (Stewart 1995).

In an attempt to increase the usefulness of information generated in priority-setting exercises for resource allocation decisions, the Kenya Agricultural Research Institute, (KARI), and International Service for National Agricultural Research, (ISNAR), designed a collaborative research project to improve the institute processes, in addition to the methods, for agricultural research priority setting. The institutional structure, information flows, criteria, and methods for agricultural research priority setting at KARI were reviewed by a multidisciplinary priority setting working group (KARI 1994a). An important suggestion of the group was that priority setting must be undertaken at three separate, but related, levels: institute, programme, and project. Further, it was clearly stated that comparable programme level approaches must serve as the basis for the generation of information for institute-wide priority setting.

1. This paper is based on the authors' contribution to the KARI Wheat Programme Priority Setting Working Group. Bradford Mills is a Research Fellow with the International Service for National Agricultural Research. Daniel Karanja is an agricultural economist with the KARI Wheat Programme, Njoro. Particular thanks are extended to Stanley Wood and Phil Pardey for helpful inputs and comments.

3. Alston, Norton, and Pardey (1995) give a comprehensive overview of the current state of priority setting methods and their economic foundations.

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This paper reports the results of a programme level priority-setting exercise undertaken with a working group of KARI Wheat Programmme scientists. The process and methods established in the exercise, along with similar exercises conducted with the maize and millet/sorghum programmes, will serve as the basis for identifying a priority-setting framework to be used across KARI commodity programs. The major components of this process are: establishment of programme target zones; elicitation of potential research impact by target zone; characterization of commodity markets; calculation of potential consumer and producer economic surplus benefits from commodity programme research; and review of the exercise results with a programme stakeholder group.

The remainder of this section briefly describes Kenyan wheat production and consumption trends as well as the major research themes developed by the Wheat Programme. Section two presents a method for identifying programme target zones. Section three then discusses the elicitation of potential research impact within these target zones. Kenyan wheat markets are briefly discussed in section four. Section five then describes the combination of information from the previous three sections to generate total economic surplus estimates for major wheat programme research themes by target zone. Finally, section six concludes with a discussion of the research priorities identified by the programme stakeholder group as well as the coherence between those priorities and the current programme human resources.

The Wheat Programme, established in 1927, is one of the oldest crop research programmes in Kenya. Traditionally, the programme has concentrated on generating improved wheat technologies for large-scale production systems and breeding for higher yields. A good deal of success has been achieved over the years in these research areas, as documented by the release of 148 varieties between 1927 and 1990 (Karanja 1993).

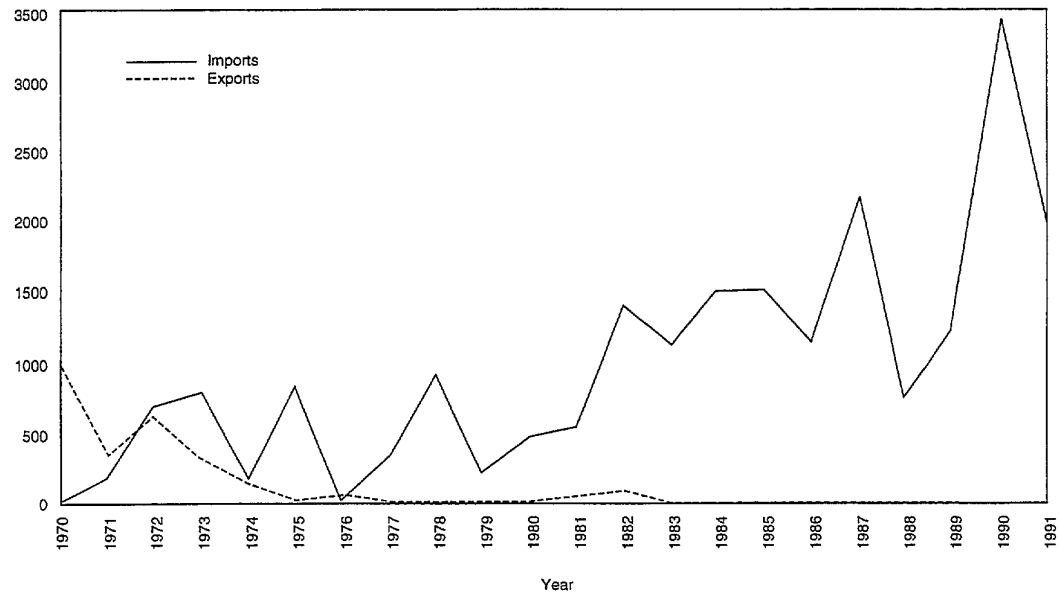
In recent years, the programme has devoted increased attention to the technological needs of small-scale wheat producers. This expanding research agenda has been accompanied by increased human resources, as the number of wheat scientists at the National Plant Breeding Research Centre in Njoro from 1978 to 1990 nearly tripled.[4] However, the same period saw dramatic funding cuts as programme expenditures decreased, in real 1990 Kenya pounds, from 445,490 per year average for 1980-81 to 114,950 per year average for 1989-90.

Despite this dramatic decrease in financial support, the Wheat Programme remains the second highest priority cereal crop at KARI on the basic of its high value of production.[5] Between 1989 and 1991 an estimated average of 148,390 hectares a year were planted to wheat and 288,717 metric tons a year were produced (Mills et al. 1994). However, long-term wheat production trends have not been favorable. Between 1972 and 1992 wheat production showed a sluggish growth rate of 0.9 percent per year while consumption of wheat products, spurred by population growth, urbanization and changing consumption habits, increased dramatically by 5.1 percent a year (FAO 1994). As figure 1 shows, this increased demand was met mainly through imports, which grew at a rate of 13.1 percent per year between 1972 and 1991. Thus, in a period of twenty years Kenya has gone from being self-sufficient in wheat production to being reliant on the world market to meet its consumption needs.

4. NPBRC has the national mandate for wheat research and most scientists at the station are associated with the Wheat Programme. The National Agricultural Research Programme identifies 17 scientists with at least MS degrees attached to the programme. An additional 5 scientists are currently away on training.

5. In the 1991 institution-wide KARI priority setting exercise, wheat was ranked 11th overall, but second among cereals behind maize (KARI 1991).

Figure 1: *Wheat imports and exports, 100 metric tonnes*



Source: F.A.O. 1994.

Research-induced productivity increases in existing wheat areas and the development of suitable technologies for potential expansion areas will be important factors in mitigating these trends. The Wheat Programme has four major research thrusts to meet these challenges.

Plant breeding to increase (maintain) either average yields or stability of yields in the light of major moisture, fertility, pest, and disease constraints found in Kenya wheat production systems.

Crop management to develop crop rotations, production operations, and soil and water management strategies which address crucial production constraints.

Plant Protection methods which reduce the magnitude of losses from pests and diseases, particularly pathogens.

Technology Dissemination to improve institutional linkages with farmers and extension and increase the flow of information on potential innovations to Wheat Programme clients.[6]

A more in-depth description of activities associated with these thrusts can be found in the programme's strategic plan (KARI 1994b). A further description of wheat production practices in Kenya and the potential for productivity growth is found in Hassan, Mwangi, and Karanja (1993).

Since programme funding and human resources are expected to remain constrained in the near future, the programme must carefully deploy its resources to research themes and zones that are likely to have the greatest impact. The remainder of this paper presents the rationale, assump-

6. The framework within which technology dissemination efforts translate into research benefits is arguably different than for the other research themes. However, the same structured elicitation process will be used to maintain compatibility across themes. Further, in order to minimize the overlap between technology dissemination and the benefits from other themes, the working group focused on the potential for increasing the flow of currently available technologies onto farmers fields.

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tions, and methods used by the Wheat Programme Priority Setting Working Group to help identify such themes and zones.[7] This strategic rationalization will guide the efficient deployment of current programme resources and, hopefully, attract longer term sources of support to priority areas.

2) Programme Target Zones

For efficient resource allocation, national commodity programmes must develop broad target zones for technology development. Within these target zones the application of new technologies arising from major research themes should have a relatively homogeneous bio-physical impact on production. Defining zones based on observable environmental characteristics creates a clearer basis for technical scientists to visualize the magnitude and spatial variation of the potential impact of major programme research themes. Further, these zones will often cut across regional research programme mandates and, thus, allow national programmes to strategically undertake technology development with regional research programmes. Finally, for priority setting, base production levels within target zones will have a major impact on the calculation of expected research benefits.

The Priority Setting Working Group identified the following key environmental determinants of wheat production.

Elevation: The traditional wheat growing zone occurs at elevations between 1800 and 2400 m, but wheat production is found up to 2800 m. A major focus of the wheat programme is to expand wheat production to lower elevations (higher temperatures), and lower moisture areas. However, 1000 m is the expected lower elevation limit for such expansion.

Temperature: Temperatures in traditional growing areas are 24-27 degrees Celsius mean monthly maximum and 7 degrees mean monthly minimum just before heading. However, this minimum is not a critical constraint on production. The highest mean monthly maximum possible for production is currently regarded as 32 degrees Celsius and this may well constrain wheat production at lower elevations.

Rainfall: Wheat is primarily grown during the first of Kenya's two major rainy seasons. In terms of rainfall, 500 mm during March to July period is seen as ideal. The lower limit for adequate production is 300 mm during the same period. At higher elevations the rains start later (May) and tend not to constrain production. Wheat is also sometimes grown during the October to December rains at elevations over 2400 m.

Rust: While not specifically an environmental factor, rust infestation severely effects wheat production in Kenya. Further, different varieties of rust respond differently to temperature and elevation, particularly for areas above and below 2400 m.

Soils: Soil fertility is also important for the classification of production zones. Wheat requires soils with high inherent fertility. Acidic soils also limit production, particularly in highland areas where such soils are prevalent. Unfortunately, given the site specific nature of soil classification, it is very difficult to incorporate this information into a relatively aggregate GIS classification scheme. Soil characteristics were, therefore, not included in the classification used in this programme level assessment, but soil related production constraints are addressed within the major research themes of affected zones.

7. The Working Group was composed of an agronomist, entomologist, pathologist, plant breeder, and socio-economist.

Based on the above environmental determinants and several mapping iterations using a geographic information system, the criteria shown in Table 1 were established as sufficiently accurate spatial representations of five target zones.[8] Appendix 1 presents a map of these zones.

Table 1: **Wheat Programme Agroecological Zones**

	Elevation (meters)	Rainfall (mm)	Temperature (degress Celsius)
Traditional			
High-Mid Altitude Moist	1800-2400	300-500 March-July	na
High-Mid Altitude Wet	1800-2400	500-750 March-July	na
Highland Long or short rains	2400-2800	300-500 May-July or 300-450 Oct.-Dec.	na
Target Expansion			
Mid-Altitude Moist	1000-1800	300-500 March-July	< 32° Mean Max. April and May
Mid-Altitude Wet	1000-1800	500-750 Mach-July	< 32° Mean Max. April and May

Note: na: not applicable

Zone areas and production estimates were then calculated based on Kenya Department of Resource Surveys and Remote Sensing average district level estimates for 1989-1991 wheat area and production levels during the long-rains. Further discussion of Kenya area, production, and yield data is found in Mills et al. (1994). Two assumptions were made in allocating district areas and production levels to zones: a) District area and production estimates are distributed in proportion to the areas of AEZs in each district and b) Target Expansion zones have no current area under wheat. Table 2 presents these derived area and production estimates for each zone. Zone yield estimates are calculated from the zone area and production figures.

Table 2: **Area under Wheat Production in Traditional Wheat Growing Target Zones**

	Total	High Mid-Alt – Moist	High Mid-Alt – Wet	Highland
% of area in traditional zone	100	48	41	11
Current area – hectares[a]	148390	54321	76148	17921
– % of total	100	37	51	12
Current production – tonnes[b]	288717	105595	148215	34907
– % of total	100	37	51	12
Estimate of yield[c]	1.95	1.94	1.95	1.95

Note: a - Based on district level area estimates; b - Based on district level production estimates; and c - Based on zone area and production estimates.

8. A more complete description of the geo-referenced climate data used for zonal classifications is found in Corbett 1994.

The High-Mid Altitude Moist Zone has the largest potential area for wheat of the traditional production zones. However, the High-Mid-Altitude Wet Zone has the largest estimated actual area under wheat production due to high levels of wheat production in districts with a large percentage of their land area in this zone. The Highland Zone is relatively small in terms of both potential area and actual production. Based on area and production estimates, there is little variation in current yield levels across zones. This result reflects the observed low variation in district-level yield estimates. Finally, the two target expansion zones are quite large. The Mid-Altitude Moist Zone covers an area 95 percent of the combined area in the traditional zones, while the Mid-Altitude Wet Zone covers an area equal to 58 percent of the traditional zones.

3) Potential for Generation and Adoption of Technologies by Major Research Theme and Zone

Once target zones are identified, the potential for the generation and adoption of technologies within the major programme research themes must be examined by zone. This section presents the Working Group assumptions on the potential for the generation and adoption of technologies. The assumptions are based on group members' knowledge of the research programme and target zones. The Programme Stakeholder Group also reviewed the assumptions and suggested modifications.

Potential for technology generation

Technology generation, by the nature of the research process, is uncertain and best represented as a distribution of possible outcomes. For commodities, outcomes are most commonly conceptualized in terms of yield increases (or avoided yield losses). However, such yield increases often require additional inputs, which lower the effective value of yield gains. Therefore, the Working Group specified research outcomes in terms of net yield gains, taking both yield increases and required additional input costs into account.

Net yield gains were specified in terms of minimum, most likely, and maximum possible outcomes (Table 3).[9] Benchmark district-level yield and area historical growth trends were also used to guide the Group in estimating these parameters. Further, for each major research theme, the Working Group defined the threshold yield net gain needed for technologies to be released for dissemination.[10] For simplicity, the potential net yield increases achieved by research were assumed to follow a triangular distribution, (see Box 1 for further details).

Two parameters were then calculated from the triangular probability density function: a) The probability of exceeding the net yield gain threshold for the technology to be released for dissemination, (commonly referred to as the 'probability of research success'), and b) The expected net yield increase conditional on the dissemination threshold being exceeded. Formulas for these calculations are given in Appendix 2.

9. The Working Group based these potential outcomes on continued current programme allocations of human and financial resources.

10. Dissemination thresholds are based on the criteria used by programme scientists to identify technologies for release to extension and farmers.

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Table 3: **Potential for Technology Generation**

Theme/Zone	% net yield gains				Probability of dissemination[a]	Conditional expected net yield increase[b] (%)
	Min.	Most Likely	Max.	Adoption threshold		
Plant Breeding						
High Mid Alt. - Moist	-3.00	4.50	19.45	10.00	0.27	12.77
High Mid Alt. - Wet	3.60	8.90	31.44	10.00	0.73	16.28
Highland	0.90	6.16	35.20	8.50	0.72	16.32
Mid Alt. - Moist	4.25	17.40	34.25	20.00	0.40	24.17
Mid Alt. - Wet	0.00	1.00	8.70	20.00	0.00	0.00
Plant Protection						
High Mid Alt. - Moist	0.00	2.50	3.75	2.50	0.33	2.87
High Mid Alt. - Wet	0.00	1.25	1.90	1.25	0.34	1.44
Highland	0.00	1.25	1.90	1.25	0.34	1.44
Mid Alt. - Moist	0.00	2.50	3.75	10.00	0.00	0.00
Mid Alt. - Wet	0.00	0.00	0.00	0.00	0.00	0.00
Crop Management						
High Mid Alt. - Moist	0.50	11.50	28.00	7.50	0.84	14.91
High Mid Alt. - Wet	1.50	11.10	29.50	15.00	0.41	19.25
Highland	-9.51	11.51	33.00	20.00	0.18	23.81
Mid Alt. - Moist	-1679	-2.00	13.00	10.00	0.02	10.88
Mid Alt. - Wet	-1590	-2.10	7.50	20.00	0.00	0.00
Technology Dissemination						
High Mid Alt. - Moist	8.00	15.00	20.00	10.00	0.95	14.58
High Mid Alt. - Wet	5.00	10.00	15.00	10.00	0.50	11.46
Highland	5.00	10.00	15.00	10.00	0.50	11.46
Mid Alt. - Moist	15.00	30.00	40.00	10.00	0.93	29.52
Mid Alt. - Wet	5.00	7.00	10.00	30.00	0.00	0.00

Note: a - $Pr(K > K^a)$, b - $E[K \mid K > K^a]$.

Potential adoption profiles

The actual commodity supply shift due to research will depend on the rate and extent of adoption of the technology. Thus, it is essential to include an assessment of the likely adoption pattern of the innovation in order to estimate potential impact reliably. Figure 3 shows a generic adoption profile. Several basic characteristics of the profile should be noted. These are labeled in the figure as: A) The research development lag, ending with the release of the new technology (at year 4 in the example); B) The initially increasing adoption rate as a growing number of farmers in the target area become exposed to the technology; C) The adoption plateau where most target farmers have been exposed to the technology and have decided whether or not to adopt; and D) The declining adoption rate as the technology becomes obsolete.

Combined, these components determine the speed and frequency with which research results are translated onto farmers' fields. However, the component parameters will also depend on the magnitude of the net yield gain embodied in the technology being disseminated. The Working Group used the expected net yield gains, conditional on the dissemination threshold being exceeded, as the basis for estimating potential adoption profiles.

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Box 1: Modeling the Probability Distribution of Research Outcomes

Let K represent the net yield gain of an innovation. In Figure 2 the minimum possible net yield gain is K_l; the most probable net yield gain is K_m; and maximum net yield gain is K_h. The minimum net yield gain necessary for an innovation to be released for dissemination is K^a, (a 3% net yield gain in this example). For every K there is a corresponding probability f(K) which is assumed to have followed a triangular probability distribution. The probability of achieving K^a, $Pr(KK^a)$ is given by the cumulative density function at the bottom of the example in Figure 2. In the example, the probability of a net yield gain from research above 3% is quite low, approximately 15%. The expected net yield gain is simply the expected value of K, conditional on K^a being achieved: E[K].

Figure 2: *The distribution of expected net yield gains*

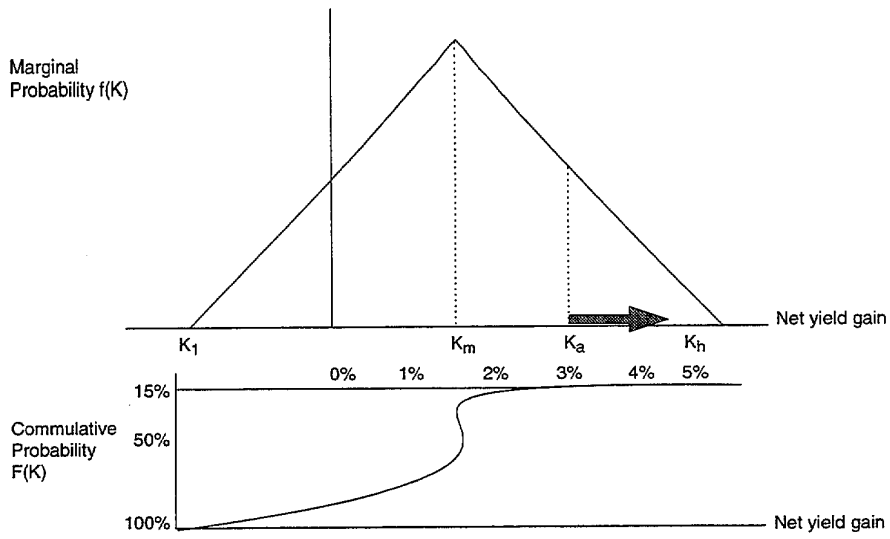
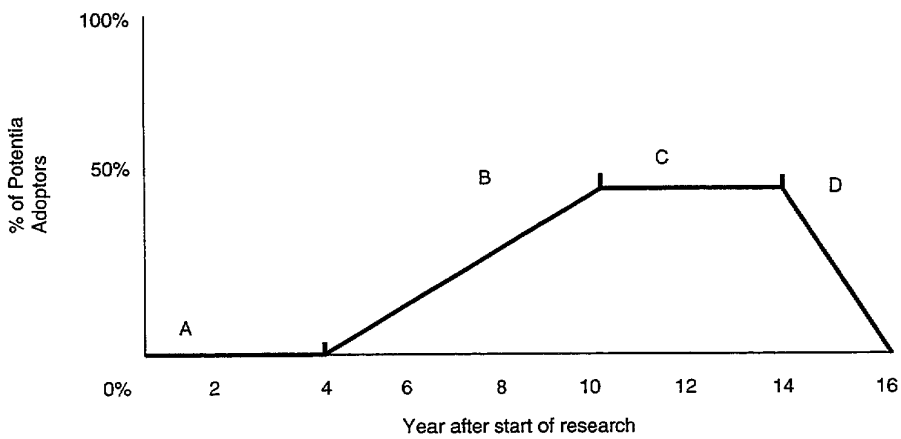


Figure 3: *Technology adoption profile*



Like the technical potential of research, the ex-ante specification of adoption profiles is based on expert opinions of the Working Group and the review of the Programme Stakeholder Group. The components of the profiles are presented in Table 4 by theme and zone.

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Table 4: **Predicted Adoption Profiles**

Theme/Zone	Research and Development Lag (yrs)	Maximum Adoption (yrs)	Maximum adoption Rate (%)	Start of disadoption (yrs)	Complete disadoption (yrs)
Plant Breeding					
High Mid Alt. - Moist	12	18	60	23	25
High Mid Alt. - Wet	12	18	60	24	30
Highland	12	17	70	22	24
Mid Alt. - Moist	8	16	30	24	32
Mid Alt. - Wet	13	20	20	29	37
Plant Protection					
High Mid Alt. - Moist	4	6	25	9	11
High Mid Alt. - Wet	4	6	7.5	9	11
Highland	4	6	25	9	11
Mid Alt. - Moist	5	7	50	10	12
Mid Alt. - Wet	–	–	–	–	–
Crop Management					
High Mid Alt. - Moist	9	14	50	na	na
High Mid Alt. - Wet	5	8	50	na	na
Highland	5	8	40	na	na
Mid Alt. - Moist	10	13	40	na	na
Mid Alt. - Wet	10	18	20	na	na
Technology Dissemination					
High Mid Alt. - Moist	3	8	60	18	23
High Mid Alt. - Wet	3	8	50	18	23
Highland	2	7	50	17	22
Mid Alt. - Moist	5	10	70	20	25
Mid Alt. - Wet	10	20	30	30	35

Note: a - Adoption potential extremely low; na - no significant disadoption is expected

4) Characteristics of the Wheat Market in Kenya

The change in economic surpluses (consumer surplus and producer surplus), is the most commonly used measure, whether by ex-ante or ex-post methods, of the economic benefits generated from agricultural research.[11] Consumer surplus measures the surplus value of a good to a consumer over the price paid. Producer surplus estimates the surplus of the price received for an article over the variable costs of production. The distribution of both measures is directly dependent on the structure of the market for the commodity.

In Kenya, there is a substantial amount of government intervention in wheat markets, including:[12]

- A legal monopoly on internal and external trading of wheat by the National Cereals Produce Board.
- Government controls consumer and producer prices with a minimum producer price set across Kenya based on import parity.

11. See Alston, Norton, and Pardey (1995 Chapter 2) for a discussion of economic surplus measures in agricultural research evaluation.

12. A more complete description of NCPB Wheat marketing system is found in Gitu and Sangori (1992).

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As discussed, despite efforts to promote domestic production, in the past twenty-five years Kenya has moved from being a net exporter of wheat to a net importer. Yet Kenya wheat imports account for only 0.2% of world trade and, therefore, have no significant impact on world prices.

At the same time, a number of studies have shown that wheat producers are very responsive to price changes and, therefore, to agricultural technologies which affect the profitability of wheat relative to other crops. Table 5 presents some of the available supply elasticity estimates for Kenya. For modeling the impact of technical change the relevant elasticity estimate is for the intermediate to long run. The Kirori and Gitu supply elasticity estimate of 0.50 is in the middle range of the presented long-run estimates and is, therefore is used in the calculation of research impact in the next section.

Table 5: **Supply Elasticity Estimates for Kenyan Wheat**

Study	Short run	Long run
Maitha (1974)	0.14 – 0.78	0.24 – 0.95
ECA (1983)	0.79	
Kirori and Gitu (1991)	0.10	0.50
Gitu and Sangori (1992)	0.429	0.661

5) An Economic Analysis of Expected Research Impact

Since internal demand does not affect world prices, the Kenya wheat market can be modeled as a small open economy. Box 2 discusses how the economic surplus generated from commodity research can be measured in a small open economy. Formulas for measuring research impact are given in the section and discussed in detail in Alston, Norton, and Pardey (1995). Estimates of the change in economic surplus due to research, by theme and zone, are also presented in the section.

The total economic surplus change at time t due to wheat research is calculated from two components: the proportional downward supply shift in each year, (K_t), and the change in total surplus arising from this proportional shift, (_TS_t).

The proportional downward supply shift for every period is simply calculated as the product of the probability of exceeding the dissemination threshold, the expected unit cost reduction, (conditional upon the dissemination threshold being exceeded), and adoption rate for the specific period divided by the supply elasticity.

$K_t = P_r(K \geq K^a)\, E[K \mid K \geq K^a] A_t/\varepsilon$ where:

A_t = The adoption rate at time t as determined by the trapezoid adoption profile and parameters in table 4; and
ε = the intermediate-run supply elasticity.

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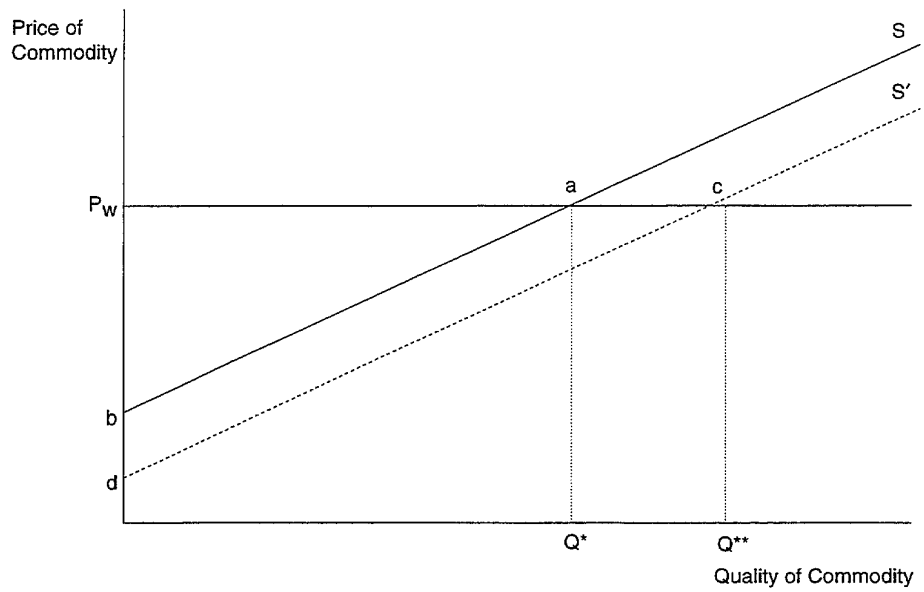
Box 2. Modeling Research Impact in a Small Open Economy

In a small, open economy the aggregate demand curve for wheat is horizontal (Figure 4). Consumers can get all the wheat desired without changing the world price of the commodity. However, the supply curve is upward sloping as producers are willing to devote additional resources to wheat production at higher prices or lower costs. The slope of the supply response curve is determined by the supply elasticity and, in the absence of any information to the contrary, the shift in supply due to research here (as in most similar applications) is assumed to be parallel.

When measuring the economic surplus gains from research, the impact of a unit cost reduction will increase the profitability of wheat production and shift the supply curve downward. In the 'without research' case producer surplus is represented by triangle $P_w$ab (the summation of the area above the supply curve and below the world price). With the research-induced supply shift, producer surplus increases to triangle $P_w$cd. Thus, producer surplus gains due to research is equal to the area $P_w$cd - $P_w$ab = acdb. Because the derived demand curve is horizontal, consumers neither gain or lose from the research-induced supply shift.

Figure 4: *The market consequences of technological innovation*



The change in total economic surplus is calculated as:

$$\Delta TS_t = K_t P_t Q_t (1+0.5K_t\varepsilon)$$

where:

P_t = the market price in Kenya; ($270 USD based on 1991 metric ton price); and
Q_t = Base quantity produced from Table 2, (this can be adjusted for exogenous change in each year).

Finally, the net present value of total surplus changes across all years is calculated based on real discount rates of three percent and five percent. Rates in this range are felt to reflect the long run real rate of borrowing for government funds. The results for the traditional wheat growing zones, by target zone and major research theme, are presented in Table 6. A sample spreadsheet explaining the calculations for plant breeding in the High-Mid Moist Zone is presented in Appendix 3.

In the High-Mid Moist Zone crop management and technology dissemination appear to be the research themes with the most potential. The estimated change in total surplus is large for these

themes because of the high probability of generating technologies with large expected net yield gains. Further, benefits from technology dissemination are higher than crop management due to a relatively rapid adoption profile. In the High-Mid Wet Zone crop management continues to show high economic surplus changes, in spite of a lower expected net yield gain from research. This is due to the large area under production and an increase in the speed of adoption relative to the High-Mid Moist Zone. At the same time, the estimated change in economic surplus from technology dissemination is small in the zone due to the lower potential for generating significant net yield increases. On the other hand, plant breeding has a high potential for generating higher yielding varieties in the High-Mid Moist Zone and, therefore, high surplus estimates. Finally, the Highland Zone has relatively small benefit estimates, partially due to the small quantity of wheat currently produced in the zone and to intensive past research efforts which limit the possibilities for further technical advance. It should also be noted that the relative ranking of total surpluses does not change under the three percent and five percent per annum real discount rate scenarios.

Table 6: Potential Economic Surplus Generated by Wheat Programme Research Themes, (100,000 US Dollars)

Discount rate = 3%			
Theme	High-mid moist	High-mid wet	Highlands
Plant breeding	60.5	376.4	77.6
Plant protection	11.0	1.4	0.9
Crop management	376.1	453.0	46.1
Technology dissemination	498.0	238.1	56.8
Discount rate = 5%			
Plant breeding	41.9	254.2	54.5
Plant protection	9.0	1.2	0.8
Crop management	257.3	329.0	33.5
Technology dissemination	393.8	188.0	46.6

In the target expansion zones it is difficult to model the impact of research because the current area under wheat production is negligible. Additional assumptions would need to be made with regard to the rate of area expansion and profitability of wheat relative to other crops that may be displaced. Such calculations would require moving towards an explicit multiple market framework for the modeling of research impact.

An examination of probability of research success and adoption profiles in the two target expansion zones reveals that none of the research themes in the Mid Altitude Wet Zone shows a positive probability of developing technologies for dissemination. In the Mid Altitude Moist Zone, by contrast, a research thrust in technology dissemination has a very high probability of producing rapid net yield gains. In fact only 25,000 hectares of wheat need to be brought into production in the zone in order for this theme to generate total benefits similar to that for technology dissemination in the High-Mid Wet Zone. Thus if the programme believes that significant expansion in the area under wheat is possible in the Mid-Altitude Moist Zone, it may wish to concentrate on disseminating available wheat technologies, particularly from the High-Mid Moist zone.

6. Linking the results to resource allocation decisions

Since priority setting is primarily a consensus building process, care must be taken not to make methods, models, and data the end goal of priority-setting exercises. There are no 'correct' priorities in terms of predicting agricultural research impact in future environments. There are, however, priorities which build a clear consensus on the direction of a programme or institute using expert opinion, data, and models as important tools in the process. As part of the consensus building process, economic methods for measuring potential research impact must be combined with effective institutional structures for setting programme guidelines on resource allocation decisions. Therefore, the working group results were presented to a larger group of programme research stakeholders where their assumptions were reviewed and modified.[13] The group then developed a consensus on high priority programme research themes and zones, Table 7. While the results of the priority-setting exercise were an important base for building a consensus on programme priorities, other considerations, particularly the stated national policy goal of expanding wheat production into the Mid-Altitude Moist zone, could be taken into account.

Table 7: A Comparison of Programme Priorities and Current Human Resource Allocations

	High-mid alt. moist	High-mid alt. wet	Highlands	Mid-alt. moist	Mid-alt. wet	Total[c]
Program priorities[a]						
Plant breeding						
Plant protection						
Crop management						
Technology dissemination						
Current allocation of program scientists (FTE)[b]						
Plant breeding	1.0	1.0	2.0	1.0	1.0	6(2)
Plant protection	2.0	2.0	2.0	0.0	0.0	6(1)
Crop management		2.0		2.0	0.0	4(1)
Technology dissemination		0.45		0.8	0.0	1.25(.75)

Note: a - Darkly shaded cells indicate high priority research themes within the zones.
b - Time allocation is in full-time researcher equivalents. Lightly shaded cells indicate an indivisible allocation of scientist time across the traditional wheat-growing zones.
c - Parentheses indicate researchers currently on training.

Finally, the Stakeholder Group compared high priority themes and zones with current human resource allocations within the Wheat Programme. Based on this comparison, several recommendations arose for adjusting the medium-term focus of the programme. These were:

- Reduce the previous programme emphasis on plant protection;
- Increase the programme focus on technology dissemination research themes, particularly in the moist rainfall zones;
- Concentrate crop management activities in the High Mid-Altitude Moist and High Mid-Altitude Wet zones; and

13. The Stakeholder Group was composed of farmer, extension, seed company, chemical company, and processing sector representatives, as well as a broader coalition of Wheat Programme scientists.

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- Concentrate wheat breeding activities in the High Mid-Altitude Wet and Moist Mid-Altitude zones.

Since stability is an important factor in programme performance, these recommendations do not necessary suggest an immediate reallocation of programme resources. Rather, they are guidelines for the further development of programme activities and human resources.

In conclusion, the goal of the priority-setting process described in this paper was to assist the KARI Wheat Programme in setting research priorities both spatially and by major research themes. The process was designed to minimize information, methodological, and human resource requirements without sacrificing conceptual rigor. At the programme level, such structured priority-setting exercises provide scientists with a better understanding of the environment for technology development. Target zones identify the area associated with key bio-physical parameters for production of the commodity. These zones also allow the programme to examine potential spill-overs in co-ordinating its work with regionally-based adaptive research centres. A review of the current production situation within zones, based on historical data sources, also improves the programme understanding of commodity trends to be addressed. Finally, a systematic analysis of the potential for the generation and adoption of research results within the current production environment improves programme understanding of potential impact.

Combined, this information can help the national commodity programmes to refine their research agendas and make coherent arguments on the potential contribution of those agendas to national agricultural development objectives. However, to have such an impact on the research agenda, the information must be effectively integrated into an institutional process for setting research priorities and then translating those priorities into resource allocation decisions. In order to achieve this objective, the priority-setting process formally constituted a stakeholder group to assist the Wheat Programme in establishing programme priorities and accompanying medium-term resource allocation guidelines.

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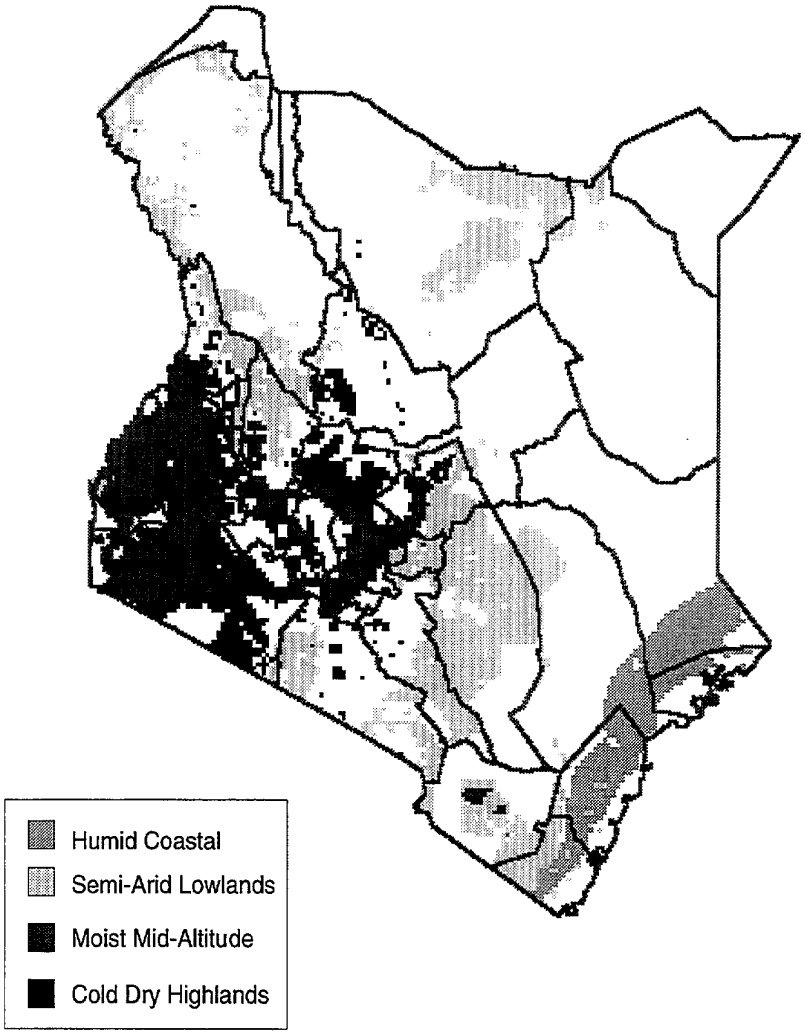
Appenix 1: KARI Sorghum Research Target Zones



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Appendix 2:

For a triangular probability density function the cumulative probability of producing an innovation with a net yield gain above K* is:

$$P_r K \geq K^* = 1 - \frac{(k^* - k_l)^2}{(k_h - k_l)(k_m - k_l)} \quad \text{if } k_l \leq k^* < k_m \text{ and}$$

$$P_r K \geq K^* = \frac{(k_h - k^*)^2}{(k_h - k_l)(k_h - k_m)} \quad \text{if } k_m \leq k^* < k_h \tag{1}$$

The expected net yield gain, E[K], given the threshold value for dissemination is reached can be calculated as:

$$E[K|K \geq K^*] = \frac{\left[\int_{K_*}^{K_m} \left(\frac{2}{(K_h - K_1)(K_m - K_1)}\right)(1/3K^3 - 1/2K^2 K_1)\right] + \left[\int_{K_m}^{K_h} \left(\frac{2}{(K_h - K_1)(K_h - K_m}\right)(1/2K^2 K_h - 1/3K_3\right]}{\left[\int_{K^*}^{K_m} \left(\frac{2}{(K_h - K_1)(K_m - K_1}\right)(1/2K^2 K_1)\right] + \left[\int_{K_m}^{K_h} \frac{2}{(K_h - K_1)(K_h - K_m)}(K_h - 1/2K_2)\right]} \tag{2}$$

For $K_1 \leq K^* < K_m$ and

$$E[K|K \geq K^*] = \frac{\left[\int_{K_*}^{K_m} \left(\frac{2}{(K_h - K_1)(K_h - K_m)}\right)(1/2K^2 K_h - 1/3K^3)\right]}{\left[\int_{K^*}^{K_h} \left(\frac{2}{(K_h - K_1)(K_h - K_m}\right)(K_h - 1/2K^2)\right]}$$

For $K_m \leq K^* < K_h$.

Appendix 3 KARI Wheat Programme Research

Zone:High-mid Moist
Theme:Plant Breeding

Year	(1) Supply Electricity	(2) Net Yield Gain (%)	(3) Dissemination Threshold Pr(K ³ K*)	(4) Adoption Rate (%)	(5) Net K Shifta	(6) Wheat Price USD	(7) Quality Metric Tonnes	(8) Change in Total Surplusb
1995	0.5	12.77	0.27	0	0	270	105595.1	0
1996	0.5	12.77	0.27	0	0	270	105595.1	0
1997	0.5	12.77	0.27	0	0	270	105595.1	0
1998	0.5	12.77	0.27	0	0	270	105595.1	0
1999	0.5	12.77	0.27	0	0	270	105595.1	0
2000	0.5	12.77	0.27	0	0	270	105595.1	0
2001	0.5	12.77	0.27	0	0	270	105595.1	0
2002	0.5	12.77	0.27	0	0	270	105595.1	0
2003	0.5	12.77	0.27	0	0	270	105595.1	0
2004	0.5	12.77	0.27	0	0	270	105595.1	0
2005	0.5	12.77	0.27	0	0	270	105595.1	0
2006	0.5	12.77	0.27	0	0	270	105595.1	0
2007	0.5	12.77	0.27	10	0.007	270	105595.1	197140.0
2008	0.5	12.77	0.27	20	0.014	270	105595.1	394958.6
2009	0.5	12.77	0.27	30	0.021	270	105595.1	593455.7
2010	0.5	12.77	0.27	40	0.028	270	105595.1	792631.3
2011	0.5	12.77	0.27	50	0.034	270	105595.1	992485.5
2012	0.5	12.77	0.27	60	0.041	270	105595.1	1193018.2
2013	0.5	12.77	0.27	60	0.041	270	105595.1	1193018.2
2014	0.5	12.77	0.27	60	0.041	270	105595.1	1193018.2
2015	0.5	12.77	0.27	60	0.041	270	105595.1	1193018.2
2016	0.5	12.77	0.27	60	0.041	270	105595.1	1193018.2
2017	0.5	12.77	0.27	60	0.041	270	105595.1	1193018.2
2018	0.5	12.77	0.27	30	0.021	270	105595.1	593455.7
2019	0.5	12.77	0.27	0	0	270	105595.1	0
2020	0.5	12.77	0.27	0	0	270	105595.1	0
2021	0.5	12.77	0.27	0	0	270	105595.1	0
2022	0.5	12.77	0.27	0	0	270	105595.1	0
2023	0.5	12.77	0.27	0	0	270	105595.1	0
2024	0.5	12.77	0.27	0	0	270	105595.1	0

Strengths and Weaknesses

- **Please list what you consider to be three strengths of day one**

1.
2.
3.

- **Please list what you consider to be three weaknesses of day one**

1.
2.
3.

- **Suggestions for improvements**

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Guidelines to Provide Feedback on the Workshop

1. **The Module**

   Content

   - usefulness/relevance
   - amount of information

   Structure

   - sequence
   - duration
   - balance between trainers' and trainees' participation
   - instructions to trainers
   - visual aids
   - handouts, exercises
   - extra readings
   - PAPA
   - evaluation

2. **Process: training techniques and direction**

   - usefulness/relevance/effectiveness
   - group interaction
   - clarity of questions/exercises instructions
   - opening and closure of the days

3. **Trainers', facilitators', and trainees' performance**

   - presentation/communication skills
   - interaction/effective participation
   - punctuality/interest/commitment/willingness to facilitate learning/willingness to participate
   - other attitudes

4. **Logistical support**

   - organization
   - accuracy
   - punctuality
   - willingness to assist participants
   - services provided in general

5. **Workshop environment**

- physical (training facilities, training material, hotel facilities in general)
- psychological (personal feelings such as self-motivation, interest, satisfaction, self-achievement)
- social (development of friendship, relaxed, comfortable among participants, etc.)

6. **Workshop results/outputs**

- personal and professional assessment
- recommendations

7. **General comments**

FIRST STAGE

PAPA - ideas for action items

Date : _____

Workshop title: SADC/ESAMI/ISNAR Workshop on Priority Setting for Agricultural Research Programs

Date/Venue : _____

Name : _____

Organization : _____

Ideas I would like to try out when I return to work at my research institute, based on what I have learned in this training workshop.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Note: You can use the workshop objectives, what you learn during the workshop, the handouts, conversations with participants and trainers, etc., to come up with ideas.

DAY TWO

Priority Setting for Agricultural Research Programs

DAY TWO — Overview

Objectives

By the end of the day the participants will be able to do the following:

1. Identify objectives that are operationally meaningful for priority setting.
2. Identify methods in priority setting.
3. List the criteria that should be considered in a choosing priority-setting method.
4. Describe methods for identifying research program target zones.
5. Identify key environmental determinants for research program target zones in national and regional programs.
6. Describe what a spreadsheet is and its possible uses.
7. Indicate how spreadsheets can be used in priority setting.

Handouts

2.5.1 Overview
2.5.2 Tentative Schedule
2.5.3 Identifying Research Objectives (summary of presentation)
2.5.4 Exercise 5. Identifying Research Objectives
2.5.5 Exercise 5. Worksheet
2.6.1 Methods to Define Research Priorities (summary of presentation)
2.6.2 Exercise 6. How to Choose Methods for Priority Setting
2.6.3 Exercise 6. Worksheet
2.6.4 Priority Setting in Agricultural Research (text)
2.6.5 Economic Consequences of Agricultural Research (text)
2.7.1 Research Alternatives: Identification of Research Target Zones (summary of presentation)
2.7.2 The Agroecological Dimension of Research Evaluation and its Role in Research Priority Setting (text)
2.7.3 Classifying Major Programme Research Themes and Target Zones (text)
2.7.4 Exercise 7. Identifying Research Target Zones
2.7.5 Exercise 7. Worksheet
2.8.1 Using Spreadsheets (summary of presentation)
2.8.2 Exercise 8. Setting up a Spreadsheet
2.8.3 Setting up a Spreadsheet (text)
2.8.4 Strengths and Weaknesses of Day Two
2.8.5 Guidelines to Provide Feedback on the Workshop
2.8.6 PAPA Form — First Stage

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Priority Setting for Agricultural Research Programs

DAY TWO — Tentative Schedule

08:30 - 09:00	**Opening of the Day's Activities**
09:00 - 10:30	**Session 5. Identifying Research Objectives** (Presentation and exercise 5)
10:30 - 10:45	Tea/Coffee Break
10:45 - 13:00	**Session 6. Methods to Define Research Priorities** (Presentation and exercise 6)

13:00 — 14:00 Lunch

14:00 - 15.30	**Session 7. Research Alternatives: Identification of Research Target Zones** (Presentation and exercise 7 - part 1)
15:30 - 15:45	Tea/Coffee Break
15:45 - 16:15	**Session 7. (Continued)**
16:15 - 17:00	**Session 8. Using Spreadsheets in Priority Setting** (Presentation and exercise 8)
17:00 - 17:30	**Feedback on the Day's Activities and PAPA**

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Priority Setting for Agricultural Research Programs

DAY TWO — Checklist for Trainers

Handouts

		Yes ✔	No ✔
2.5.1	Overview	❒	❒
2.5.2	Tentative Schedule	❒	❒
2.5.3	Identifying Research Objectives (summary of presentation)	❒	❒
2.5.4	Exercise 5. Identifying Research Objectives	❒	❒
2.5.5	Exercise 5. Worksheet	❒	❒
2.6.1	Methods to Define Research Priorities (summary of presentation)	❒	❒
2.6.2	Exercise 6. How to Choose Methods for Priority Setting	❒	❒
2.6.3	Exercise 6. Worksheet	❒	❒
2.6.4	Priority Setting in Agricultural Research (text)	❒	❒
2.6.5	Economic Consequences of Agricultural Research (text)	❒	❒
2.7.1	Research Alternatives: Identificatioin of Research Target Zones (summary of presentation)	❒	❒
2.7.2	The Agroecological Dimension of Research Evaluation and its Role in Research Priority Setting (text)	❒	❒
2.7.3	Classifying Major Programme Research Themes and Target Zones (text)	❒	❒
2.7.4	Exercise 7. Identifying Research Target Zones	❒	❒
2.7.5	Exercise 7. Worksheet	❒	❒
2.8.1	Using Spreadsheets (summary of presentation)	❒	❒
2.8.2	Exercise 8. Setting up a Spreadsheet	❒	❒
2.8.3	Setting up a Spreadsheet (text)	❒	❒
2.8.4	Strengths and Weaknesses of Day Two	❒	❒
2.8.5	Guidelines to Provide Feedback on the Workshop	❒	❒
2.8.6	PAPA Form — First Stage	❒	❒

Overheads

2.5.1	Objectives of Day Two	❒	❒
2.5.2	Schedule of Day Two	❒	❒
2.5.3	Objectives of Session 5. Identifying Research Objectives	❒	❒
2.5.4	Identifying Research Objectives	❒	❒
2.5.5	Six Steps in Priority Setting	❒	❒
2.5.6	Step 1: Identify Objectives	❒	❒
2.5.7	Step 1: Identify Objectives	❒	❒

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		Yes	No
2.5.8	Translate Stated Objectives into Underlying Objectives	❒	❒
2.5.9	Developmental Objectives	❒	❒
2.5.10	Research Evaluation Criteria	❒	❒
2.5.11	National Agricultural Development Objectives	❒	❒
2.5.11a	(Continued)	❒	❒
2.5.12	Criteria	❒	❒
2.5.12a	(Continued)	❒	❒
2.6.1	Objectives Session 6. Methods to Define Research Priorities	❒	❒
2.6.2	Types of Priority-Setting Methods	❒	❒
2.6.3	Priority-Setting Methods	❒	❒
2.6.4	Congruence Analysis	❒	❒
2.6.5	Economic Surplus Model	❒	❒
2.6.6	Scoring Models	❒	❒
2.6.7	Mathematical Programming	❒	❒
2.6.8	Checklist Method	❒	❒
2.6.9	Criteria for Selecting Methods	❒	❒
2.6.10	No Right or Wrong Tool	❒	❒
2.6.11	Consensus on Priorities	❒	❒
2.6.12	Information for Decision Making	❒	❒
2.7.1	Objectives of Session 7. Research Alternatives: Identification of Research Target Zones	❒	❒
2.7.2	Research Target Zones	❒	❒
2.7.3	Environmental Criteria		
2.7.4	Agroecological Characterization	❒	❒
2.7.5	Solution to Characterizing Environments in Ranges	❒	❒
2.7.6	GIS	❒	❒
2.7.7	Databases	❒	❒
2.7.8	Zones	❒	❒
2.7.9	Zones	❒	❒
2.7.10	Inter Alia	❒	❒
2.7.11	Selection of Methods	❒	❒
2.7.12	Some Approaches to Agroecological Zoning in the CGIAR System	❒	❒
2.7.13	Some Approaches to Agroecological Zoning in the CGIAR System	❒	❒
2.8.1	Objectives of Session 8. Using Spreadsheets in Priority Setting	❒	❒
2.8.2	What is a Spreadsheet?	❒	❒
2.8.3	Advantages of Spreadsheet	❒	❒
2.8.4	Spreadsheet is Divided in Cells	❒	❒
2.8.5	Press the HELP Key (Usually F1)	❒	❒
2.8.6	Spreadsheets	❒	❒
2.8.7	Always remember	❒	❒
2.8.8	Microsoft Excel as a Spreadsheet	❒	❒

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Materials

	Yes	No
Overhead projector	❒	❒
Projector screen	❒	❒
Flipchart stands (minimum two)	❒	❒
Flipchart paper/pads (about 10 per day)	❒	❒
Markers for writing on newsprint	❒	❒
Markers for writing on transparencies	❒	❒
Blank transparencies	❒	❒
Stapler	❒	❒
Tape (strong masking tape and regular tape)	❒	❒
Push pins	❒	❒
Glue	❒	❒
Pencils/note pads/pens	❒	❒
Pencil sharpeners	❒	❒
Extension cords	❒	❒
Certificates	❒	❒
Photocopying facilities	❒	❒
Spare bulbs for overhead projector	❒	❒
Extra notepads and pens	❒	❒
Scissors	❒	❒

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DAY TWO

Session 5
Identifying Research Objectives

Instructions to Trainers

PRE-SESSION

08:30 – 09:00 Opening of the Day's Activities
– Review of the previous day's activities.
– Summary of the evaluation of the previous day.
– Overview of the day's activities.

OBJECTIVES

By the end of the pre-session the participants will be able to do the following:

- Assess the progress of the workshop.
- List the objectives and describe the agenda for the day's activities.

OPENING

Invite a volunteer to review the previous day's activities. (10 minutes)

Summarize the evaluation of the previous day. (10 minutes)

Distribute the overview and the schedule for day two (handouts 2.5.1 and 2.5.2) to the participants. Review the objectives and schedule, using overheads 2.5.1 and 2.5.2. Ask if clarifications are needed. (10 minutes)

SESSION 5

09:00 – 10:30 Session 5. Identifying Research Objectives

RATIONALE

Agricultural research systems frequently have multiple objectives. This session suggests a possible means for identifying those objectives so that they can be used in a priority-setting analysis.

OBJECTIVE

By the end of this session, the participants will be able to do the following:

- Identify objectives that are operationally meaningful for priority setting.

Use overhead 2.5.3 to present the objective.

PROCEDURE

Training techniques: presentation, modified panel.

PRESENTATION

(*experience*) Give a brief presentation focusing on identifying research objectives. Nine overheads support the presentation: 2.5.4 through 2.5.12. At the end of the presentation distribute handout 2.5.4 and be sure to ask the participants if they have any comments or questions, or if they need clarification. (15 minutes)

EXERCISE 5

Exercise 5. Identifying research objectives. (1 hour 10 minutes)

1. Distribute handouts 2.5.4, 2.5.5, and 2.5.6. Handout 2.5.4 outlines the exercise. Go over the instructions with the participants step by step. Ask if clarification is needed. (5 minutes)

Phase 1. Group work

2. Divide the participants into four groups.

3. (*experience*) Groups select rapporteurs. They then work on the task and prepare their presentations. As the groups work circulate from group to group to check progress. Clarify any concerns the groups may have while they are working. Be sure to remind the groups of the time remaining. (30 minutes)

Phase 2. Reporting and discussion

4. *(process)* Groups report for exercise 5. Facilitate the presentations. Approximately three minutes is available for each group. (15 minutes)

5. To follow through on the modified panel technique, first allow a short discussion of the results among the rapporteurs. Then open the discussion to the audience and, finally, provide your view on the results of the exercise. (15 minutes)

6. *(process, generalize)* At the end of the exercise provide feedback on the content of the presentations. Ask the participants questions such as "How did you feel doing this exercise?" and "What did you learn?" (5 minutes)

CLOSURE

Closure (5 minutes)

1. (*application*) Ask the participants "What might you do differently in your job as a result of what you learned?"

2. Make a transition to the next session.

10:30 – 10:45 Tea/Coffee Break

DAY TWO

Session 5
Summary of Overheads

Objectives of Day Two

1. Identify objectives that are operationally meaningful for priority setting
2. Identify methods in priority setting
3. List criteria to consider when choosing a priority-setting method
4. Describe methods for identifying research program target zones
5. Identify key environmental determinants for research program target zones in their national and regional programs
6. Describe a spreadsheet and what the possibilities of spreadsheets are
7. Indicate how spreadsheets can be used in priority setting

2.5.1

Schedule of Day Two

08:30 – 09:00	Opening of the Day's Activities
09:00 – 10:30	Session 5. Identifying Research Objectives
Tea/Coffee Break	
10:45 – 13:00	Session 6. Methods to Define Research Priorities
Lunch	
14:00 – 15:30	Session 7. Research Alternatives: Identification of Research Target Zones
Tea/Coffee Break	
15:45 – 16:15	Session 7. (Continued)
16:15 – 17:00	Session 8. Using Spreadsheets in Priority Setting
17:00 – 17:30	Feedback on Day's Activities and PAPA

2.5.2

Objectives

Session 5: Identifying Research Objectives

1. Identify objectives that are operationally meaningful for priority setting

2.5.3

Identifying Research Objectives

- Who sets research objectives?
  - National agricultural development policies
  - Institute mandate
  - Clients
  - Senior management

2.5.4

6 Steps in Priority Setting

6 Approve & implement priorities (discuss, refine results)
5 Compare measurements (process information)
4 Predict performance (compile information) Identify information needs, sources
3 Derive measurement standards (choose measures of research contributions)
2 Define alternatives (define programs, agroecologial zones)
1 Define objective (identify research system objective)

2.5.5

Step 1: Identify Objectives

Research System Objectives

Published sources:
- mission statements

Interview with:
- research directors
- policymakers
- client groups

2.5.6

Step 1: Identify Objectives

Research system objectives
↓ ↑
Analysis
↓ ↑
Means and measures

2.5.7

Translate *Stated* Objectives into *Underlying* Objectives

Stated Objectives	Underlying Objectives
- Increased agricultural productivity	- Increased economic and physical well-being for all citizens
- Increased foreign exchange	
- Improved nutrition	- Increased economic and physical well-being of the poor

2.5.8

Developmental Objectives

- Economic growth (efficiency)
- Equity
- Security
- Ecology (resource sustainability)

2.5.9

Research Evaluation Criteria

Criteria should measure KARI contribution to agricultural sector stakeholder development

National Agricultural Development Objectives
KARI Technology Generation
Other Agricultural Development Bodies
Agricultural Sector Stakeholder Development

2.5.10

National Agricultural Development Objectives

Sessional Paper No. 1 of 1986	Sessional Paper No. 1 of 1994
to:	
- ensure the nation's food security - contribute to export earnings - promote higher farm incomes through off-farm employment	- self-sufficiency in basic foods - increasing food production and inter-district trade
Achieved by:	Achieved by:
- reallocation of land activities with higher returns per hectare	- development and diffusion of technical innovations to enhance yields
- increased productivity through better seeds and cultivation techniques	- increased availability and efficient use of labor, fertilizer, and other inputs

2.5.11

National Agricultural Development Objectives

Development Plan 1994-1996
- agricultural development = growth

Required areas of growth
- basic foods (and strategic reserves)
- exports
- vertical industries
  - primary processing
  - agroindustry

2.5.11a

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Criteria

The KARI Priority Setting Committee reviewed the following objectives:

Efficiency	Impact of research on aggregate welfare
Equity	Distribution of research benefits
Foreign exchange earnings	Impact of research on balance of trade
Food self-sufficiency	Contribution of research to meeting all the country's internal food needs
Food security	Contribution of research to reducing the variance in food availability
Sustainability	Contribution of research to the protection of the natural resource base for future use

2.5.12

Criteria

The KARI Priority Setting Committee recommends:

- The efficiency criterion and its consumer and producer surplus measures should form the basis of priority-setting efforts
- The equity criterion can be included in priority-setting efforts based on the distribution of efficiency benefits. However, target groups must be clearly defined

2.5.12a

Handout - Overview of Day Two

Priority Setting for Agricultural Research Programs

Objectives

By the end of the day the participants will be able to do the following:

1. Identify objectives that are operationally meaningful for priority setting.
2. Identify methods in priority setting.
3. List the criteria that should be considered in choosing a priority-setting method.
4. Describe methods for identifying research program target zones.
5. Identify key environmental determinants for research program target zones in national and regional programs.
6. Describe what a spreadsheet is and and its possible uses.
7. Indicate how spreadsheets can be used in priority setting.

Handouts

2.5.1 Overview
2.5.2 Tentative Schedule
2.5.3 Identifying Research Objectives (summary of presentation)
2.5.4 Exercise 5. Identifying Research Objectives
2.5.5 Exercise 5. Worksheet
2.6.1 Methods to Define Research Priorities (summary of presentation)
2.6.2 Exercise 6. How to Choose Methods for Priority Setting
2.6.3 Exercise 6. Worksheet
2.6.4 Priority Setting in Agricultural Research (text)
2.6.5 Economic Consequences of Agricultural Research (text)
2.7.1 Research Alternatives: Identification of Research Target Zones (summary of presentation)
2.7.2 The Agroecological Dimension of Research Evaluation and its Role in Research Priority Setting (text)
2.7.3 Classifying Major Programme Research Themes and Target Zones (text)
2.7.4 Exercise 7. Identifying Research Target Zones
2.7.5 Exercise 7. Worksheet
2.8.1 Using Spreadsheets (summary of presentation)
2.8.2 Exercise 8. Setting up a Spreadsheet
2.8.3 Setting up a Spreadsheet (text)
2.8.4 Strengths and Weaknesses of Day Two
2.8.5 Guidelines to Provide Feedback on the Workshop
2.8.6 PAPA Form — First Stage

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Handout - Tentative Schedule of Day Two

Priority Setting for Agricultural Research Programs

08:30 - 09:00	**Opening of the Day's Activities**
09:00 - 10:30	**Session 5. Identifying Research Objectives** (Presentation and exercise 5)
10:30 - 10:45	Tea/Coffee Break
10:45 - 13:00	**Session 6. Methods to Define Research Priorities** (Presentation and exercise 6)

13:00 — 14:00 Lunch

14:00 - 15:30	**Session 7. Research Alternatives: Identification of Research Target Zones** (Presentation and exercise 7 - part 1)
15:30 - 15:45	Tea/Coffee Break
15:45 - 16:15	**Session 7. (Continued)**
16:15 - 17:00	**Session 8. Using Spreadsheets in Priority Setting** (Presentation and exercise 8)
17:00 - 17:30	**Feedback on the Day's Activities and PAPA**

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Identifying Research Objectives (summary of presentation)

1. It is important to know who sets the research objectives and through what institutional mechanism. Those who implement priority-setting exercises will probably not set the objectives, but they do advise senior management on the technical aspects of measurement.

2. There is no single correct process for a priority-setting analysis. However, a series of six basic steps have been tested and found useful. This does not mean that the suggested steps can be generally applied across all institutes and levels.

3. The first step is to *identify research system objectives*. These objectives can be obtained from mission statements, other documents, and discussions with research directors, policy-makers, and clientele groups. These should be distinguished from *means* and *measures* of achieving objectives at any given level. While many objectives are possible, virtually all countries wish to increase agricultural productivity and efficiency to raise incomes and foreign exchange. Other common objectives are related to distribution of research benefits, for example, increasing the well-being of people on small farms, and improving the environment.

4. Stated objectives may need to be translated into underlying objectives. For example, the objectives of increasing agricultural productivity and foreign exchange may imply an underlying objective of increased economic and physical well-being for all citizens. Or, an objective of improved nutrition may imply an underlying objective of increased economic and physical well-being for the poor (at least in developing countries).

5. Often the directors and policymakers state *means* and *measures* e.g., increasing production and employment is a measure the improving standard of living; then it is necessary to identify the fundamental and analytically more meaningful objectives. Means and measures at one level may be objectives at another.

Translation of development objectives

Resources are scarce. They need to be allocated in such a way as to maximize the contribution of research to achieving the development objectives of the country. National development objectives can usually be grouped in four categories: efficiency, equity, food security, and ecology.

(a) *Efficiency (or economic growth).* Economic growth is a measure of the absolute size of the benefits of research, that is, how a certain research activity helps to increase the national income. This can be measured directly, by the expected contribution to GDP (gross domestic product), but may also be assessed indirectly, by means of the contribution to growth-promoting strategies such as export enhancement or import substitution.

(b) *Equity.* Equity relates to the distribution of benefits across society. Benefits are distributed differently, for example, between producers and consumers, among groups of producers, among regions, and among consumer groups. Equity may also include gender aspects, that is, the distribution of research benefits among men and women.

The results of successful research tend to increase supply. If this causes a large price reduction, consumers benefit most. If prices do not change much, producers benefit most. However, it should be kept in mind that in many African countries producers account for a large share of consumption. Those producers who adopt new technology and do so most rapidly, reap the highest benefits. If production is spread over several regions but a new technology is only adopted in one region, that region will benefit, probably at the cost of the others. Finally, some products are consumed mainly by poor people, others mainly by rich people. If the price of a product important to the poor is reduced, they will reap more benefits than the rich, and vice-versa.

If equity criteria are included in the priority-setting exercise, the target group for equity considerations must be clearly defined.

(c) *Food security.* Food security is the ability of a country to feed its population in times of climatic variability or unstable world market prices. Food security concerns lead countries to favor research on food crops rather than export crops, and to prefer research on products with low production variability across years. The cost of such a food security strategy in foregone economic growth may be quite high. Food security may conflict with foreign exchange concerns that favor export crops. In times of structural adjustment, resolving this conflict is critical.

(d) *Ecology (or resource sustainability).* Ecology refers to a range of topics from agricultural resource management and nature conservation, to health considerations. Two concerns are primary:

1. Production increases are not desirable at any cost, but only as long as the quality of the natural resource base and the health of the population is maintained.

2. Short-term production increases should be balanced with long-term production potential. If production capacity is increased at the cost of future production potential, the present generation benefits at the cost of later generations. As with food security and equity, it is easy to understand that a wealthy country may be willing to exchange economic growth for improved environment.

These developmental objectives are generally broad, thus difficult to translate into research objectives unless they are prioritized. Research objectives should answer the question: What is the potential contribution of national research to the attainment of each agricultural development objective?

Example of KARI's criteria

- The KARI priority-setting committee reviewed the following criteria:
  a. Efficiency—the impact of research on national welfare.
  b. Equity—the distribution of research benefits.
  c. Foreign exchange earnings—the impact of research on the balance of trade.

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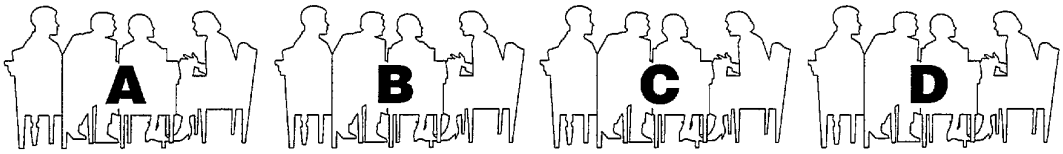
d. Food self-sufficiency—the contribution of research was to meeting all the country's food needs internally.
e. Food security—the contribution of research to reducing the variability of food availability.
f. Sustainability—the contribution of research to protecting the natural resource base for future generations.

- The priority-setting working group makes the following specific recommendations on criteria.
  a. The efficiency criterion and its consumer and producer surplus measures should form the basis of priority-setting efforts.
  b. The equity criterion can be included in priority-setting efforts based on the distribution of efficiency benefits; however, target groups must be clearly defined.

Exercise 5. Identifying research objectives (modified panel technique)

Phase 1. Group work (30 minutes)

1. Form four groups.



2. Each group elects a rapporteur.

3. All four groups use the attached worksheet (handout 2.5.5) to do the following:

   (a) Identify three objectives of your research system.
   (b) How did the system arrive at these objectives?
   (c) Translate the stated objectives into operationally meaningful efficiency, equity, and other criteria.

4. Rapporteurs write the groups' results on a flip chart.

Phase 2. Reporting and discussion (35 minutes)

5. The rapporteurs present the results of the groups' discussions to the audience. Each rapporteur has approximately three minutes to report.

6. First the results are discussed among the rapporteurs. Then the discussion is opened to the audience. Finally, the resource persons provide their views on the results of the exercise.

Exercise 5. Worksheet

(a) Identify three objectives of your research system.

(b) How did the system arrive at these objectives?

(c) Translate the stated objectives into operationally meaningful efficiency, equity, and other criteria.

DAY TWO

Session 6
Methods to Define Research Priorities

Instructions to Trainers

SESSION 6

10:45 – 13:00 Session 6. Methods to Define Research Priorities

RATIONALE

There is no "right" tool for priority setting in all circumstances.

OBJECTIVES

By the end of this session, the participants will be able to do the following:

- Identify methods in priority setting.
- List the criteria that should be considered in choosing a priority-setting method.

Use overhead 2.6.1 to present the objectives.

PROCEDURE

Training techniques: presentation, individual and group exercise.

PRESENTATION

(*experience*) Give a brief presentation focusing on methodologies to define research priorities. Eleven overheads support the presentation: 2.6.2 through 2.6.12. At the end of the presentation distribute handout 2.6.1 and be sure to ask the participants if they have any comments or questions, or if they need clarification. (15 minutes)

EXERCISE 6

Exercise 6. How to choose methods for priority setting. (1 hour 55 minutes)

1. Distribute handouts 2.6.2, 2.6.3, 2.6.4, and 2.6.5. Handout 2.6.2 gives clear instructions for the exercise. Go over the instructions with the participants step by step. Ask if clarification is needed. (5 minutes)

Phase 1. Individual practice

2. Ask participants to read handout 2.6.4 and 2.6.5 and to respond to the questions in the first phase of the exercise. Responses can be written on the worksheet (handout 2.6.3). (30 minutes)

Phase 2. Group work

3. Divide the participants into four groups. Ask them to elect a rapporteur.
4. *(experience)* Groups respond to the questions of the second phase of the exercise (45 minutes).

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5. As the groups work, circulate from group to group to check progress. Clarify any concerns the groups may have while they are working. Be sure to remind the groups of the time remaining.

Phase 3. Reporting and discussion

6. *(experience, process)* Invite the rapporteurs to present the groups' results. Each rapporteur has five minutes to present. (20 minutes)

7. *(process, generalize)* At the end of the exercise provide feedback on the content of the presentations. Ask the participants questions such as "How did you feel doing this exercise?" and "What did you learn?" (15 minutes)

CLOSURE

Closure (5 minutes)

1. *(application)* Ask volunteers to list the major things they learned from this exercise. These should be things that will improve their performance of project identification tasks in their jobs.

2. Make a transition to the next session.

13:00 – 14:00 Lunch

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DAY TWO

Session 6
Summary of Overheads

Objectives

Session 6: Methods to Define Research Priorities

2. Identify methods in priority setting
3. List the criteria that should be considered in choosing priority-setting methods

2.6.1

Types of Priority-Setting Methods

- Single-criterion methods
  - checklist
  - congruence analysis
  - economic surplus model
- Multiple-criteria methods
  - scoring model
  - mathematical programming model
  - checklist

2.6.2

Priority-Setting Methods

Framework for analysis:

1. Identify research alternatives:
   - what are the target zones?
   - what research alternatives (commodities/ disciplines/themes) are to be analyzed?
   - what is the potential of each alternative for contributing to identified research objectives?

2.6.3

Congruence Analysis

- Single-criterion method
- Allows budget allocation
- Simple, cheap, transparent
- Poor theoretical logic - doubtful results

2.6.4

Economic Surplus Model

- Powerful method
- Economic-based information
- Data intensive
- Strong assumptions
- Expensive and complicated

2.6.5

Scoring Models

Advantages
- Time
- Transparent
- Can rank all research areas
- Multiple goals and objectives

Disadvantages
- Easy to abuse
- Lack of discounting
- Crude estimates of efficiency and distributional effects of research

2.6.6

Mathematical Programming

- Rather complicated
- Multiple-criteria method
- Select best but no ranking
- Not transparent

2.6.7

Checklist Method

- Simplest
- Cheap
- Historically-based
- Understanding of agriculture not necessary

2.6.8

Criteria for Selecting Methods

- Data
- Skill level
- Time and resources
- Rigor
- Transparency

2.6.9

No Right or Wrong Tool

Only the right tool for specific context

Choice depends on:
- Accuracy of available data
- Time for making decisions
- Resources available
- Degree of participation required and other factors

2.6.10

"Consensus on priorities is more desirable than rigorous results on which interested parties do not agree"

2.6.11

Information for decision making more important than methods for priority setting

2.6.12

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Methods to Define Research Priorities (summary of presentation)

1. A number of priority-setting tools are available. These can be grouped as single-criterion methods —those that use one indicator/criterion reflecting the objective for which priorities are being set, or multiple-criteria methods —those that recognize several overall objectives and develop a combined measure. Some of the commonly used priority-setting methods include the following:

   Single criteria methods: – congruence analysis
   – economic surplus model

   Multiple criteria methods: – checklist
   – scoring model
   – mathematical programming model

2. All priority-setting methods are based on the following framework for analysis.

   i. What are the target zones of the research alternatives?
   ii. What research alternatives (themes connected with programs) will be addressed?
   iii. What is the potential impact of these alternatives to contribute to research objectives.

3. **Checklist**. This is the simplest of all tools. A list of criteria for project selection is elaborated. Then each project is checked against each criterion. Examples of criteria used are the following:

   Adoption: will the technology developed by researchers be accepted and put into use by producers or other end users?

   Will the project increase food security?

   Will the project help increase exports? (or decrease import?)

   Will the project require resources that are not available at present?

   Will the technology adversely affect the environment?

4. In **congruency analysis** the importance of a research subject depends on the size of one indicator. The indicator may be value of production, area planted, or number of people earning income from a product. If commodity A has double the value of commodity B, the amount of research resources allocated to A would be double the amount to B. Congruency analysis delivers not only a priority but also a budget allocation. Congruency analysis is transparent, simple and cheap to apply, but its theoretical logic is poor. Though, in principle, the discriminating potential is clear, it is very doubtful that people will accept the outcome immediately. Rather, it becomes the basis for discussion.

5. **Economic surplus methodology.** This method tries to predict the economic benefits of research. For each activity, it estimates the physical impact of research (e.g., an increase in yields by 10%, at the same costs per ha as before) and translates this into a shift of the supply

function. Afterwards the effect of the supply shift on the market equilibrium (price and quantity) is calculated and economic welfare theory is used to calculate total research benefits. Benefits are then compared to human or financial resources allocations.

6. **Scoring.** Scoring methods represent a more sophisticated version of the checklist. They also start with a list of criteria, but the answers to questions are assigned numerical values and weights. This enables planners to calculate a project score and rank projects according to their score. Scoring allows for consideration of multiple objectives, including equity.

7. **Mathematical programming.** This chooses the best research portfolio through mathematically optimizing a multiple-goal objective function, given the resource constraints. To set priorities among research projects, mathematical programming identifies the projects that maximize the research program goals, given budget, human resources, state of knowledge, and other constraints in the system. This procedure uses the same information as the cost-benefit analysis, but selects an optimal research portfolio rather than ranking projects. Like scoring models, it has the advantage of being able to consider multiple objectives, including those related to equity.

8. These methods vary considerably in terms of data requirements; skill level required; analysts; time and resources needed; the rigor of results, and the transparency of calculations. Checklists are the least demanding, in terms of data, analysts' skill level, and time. They are also the least rigorous, but the most transparent. By contrast, mathematical programming and economic surplus models require reliable and detailed data, highly skilled analysts, and ample time to produce results. The calculations are not easy to follow for noneconomists and require computer spreadsheets.

9. There is no right or wrong tool; only a tool appropriate to each circumstance. The choice of a priority-setting tool should be based upon the following:

   - the accuracy of available data
   - the time available to make decisions
   - the resources available, including the skill of available analysts
   - the degree of participation desired
   - transparency
   - simplicity
   - theoretical logic
   - discriminating potential

10. Participation is quite important. Because the objective of a priority-setting exercise is to get researchers and research stakeholders to agree on priorities, it is important to involve them throughout the process. It is not enough to consult them at the beginning and present them with numbers at the end. There is little point in obtaining rigorous results from the priority-setting exercise, if the main interested parties will not agree with them.

11. Methods are often overemphasized. It is the information brought to the decision-making process that is most important.

Exercise 6. How to choose methods for priority setting (individual and group exercise)

Phase 1. Individual practice (30 minutes)

1. Read handouts 2.6.4 and 2.6.5. Respond to the following three questions. You can write your responses on the attached worksheet (handout 2.6.3).
   - If your organization uses priority-setting methods, which are commonly used?
   - List a few advantages and disadvantages of these methods.
   - Which method would you recommend to your organization to be more effective in setting research priorities?

Phase 2. Group work (45 minutes)

2. Form four groups of participants.

3. Elect rapporteurs to record the groups' results.

4. Compare the individual responses of the participants in the group.

5. List the methods that were commonly used by the participants' organizations and decide on the major ones.

6. Evaluate the effectiveness of using these methods (pros, cons, level of accuracy, conflicts that might develop, and so on).

7. The rapporteurs summarize the responses on flip charts for presentation purposes.

Phase 3. Reporting and discussion (35 minutes)

6. The rapporteurs present the results of their group to the audience. Each rapporteur has five minutes to present.

7. The trainers will invite you to discuss the groups' responses and provide feedback on the content of the presentations.

Exercise 6. Worksheet

Phase 1: Individual practice

Phase 2: Group work

Priority Setting in Agricultural Research[1]

Priority-setting methods

In introducing the proposed quantitative methodologies for priority setting, it should be stressed that these have many imperfections, and that it is the systematic thinking which they require, as much as the precise outcome, which matters. Their purpose is to inject more objectivity and clarity into what is usually an intuitive exercise.

Any methodology for research priority setting and resource allocation ideally should be easy to understand, have costs in line with the size of the research program, demand as little data as is reasonable, be compatible with existing widely used priority-setting techniques in other sectors of the planning process, and be capable of achieving as "correct" a ranking for research resource allocation as the imprecisions of the situation allow. The techniques involved must be largely based upon plausible hypotheses, supplemented by whatever relevant data may be available.

There are seven methodologies, of varying degrees of sophistication, which can be used to establish research priorities:

1. Congruence
2. Checklists
3. Scoring
4. Domestic resource cost ratios
5. Benefit/cost analysis (economic surplus)
6. Mathematical programming
7. Systems analysis and simulation analysis.

Methods 1, 2, and 3 are the simplest, and are already in experimental use. However, method 1, congruence, is really no more than a starting point in the priority-setting exercise. Methods 2 and 3, checklists and scoring, are more comprehensive. They have much to recommend them, especially for institutes currently using no formal methods whatsoever.

Methods 4, 5, 6, and 7 represent the more quantitative formal methods seldom used in research at present. Method 4, domestic resource cost ratios, is just as complex as method 5, without being as informative. The most informative, but at the same time the most difficult to apply among the more formal approaches, is likely to be method 5, benefit/cost analysis. Because of their high levels of sophistication, data needs, and skill requirements, methods 6 and 7 are unlikely to be widely used by national agricultural research systems in developing countries in the foreseeable future.

Each of the methods 1 through 5 attributes the entire net return of an innovation to the research which brought it about. Other inputs, such as fertilizer and water, are assumed to be available at cost. The justification of this point of view as far as priority setting is concerned is that research findings alone activate these inputs in a new and more productive way.

1. **Extracted from**: Contant, R.B. and A. Bottomley. 1988. Priority Setting in Agricultural Research. Working Paper No. 10, pages 9-16. The Hague: ISNAR.

Given their higher costs and greater demands on staff time, three important points should be borne in mind when applying any of the more formal methods:

- Time and money can be saved by using a common sense approach. Some programs so obviously have low priority that they can be eliminated in an initial screening process. But there may be other, highly desirable programs for which the requisite staff are simply not available. While these programs should be retained as priorities, their implementation must wait until external collaboration has been secured and the necessary recruitment and training completed.[2]
- Formal methods require more precise data over a wider range of subjects than do informal ones, but there is a trade-off between the accuracy of data and the cost of obtaining it. In the absence of reliable data, it is essential to use hypotheses generated by experienced scientific staff whose objectivity and judgement can be trusted.
- Even when the conditions for applying a formal method are far from ideal, it may still be worthwhile applying it. This is because formal methods impose systematic thinking by a group of people, in a process which can give rise to new insights for all involved. Although the final results of the priority-setting exercise may remain imperfect, a better understanding is gained through the exchange of ideas. This will be equally true whether the choice is being made at level 1 or at level 2 discussed above. It is even possible that these methods may be applied to certain research topics at level 3.

The rest of this section outlines methods 1 through 5, briefly discussing the advantages and disadvantages of each.

Method 1: Congruence

Congruence simply means that, assuming other things are equal, total available research funds should be allocated to commodities in the same proportions as their existing contribution to the agricultural domestic product. If, for example, maize represents 10% of the total value added in agriculture, it should get 10% of the resources allocated to research. Congruence can be applied directly only to programs based on commodities.

The congruence concept is expressed by the formula:

$$C = 1 - \sum_{i=1}^{n} (A_i - S_i)^2$$

where A_i is the share of a particular commodity in the research budget, and S_i is the share of that commodity in agricultural value added. Perfect congruence arises when $C = 1$ for n commodities.

This approach has serious shortcomings. Unless applied to planned rather than current production levels, congruence favors commodities that are already well established, discriminating against new ones and those with low current value. Financial outlays might justifiably be lower than congruence dictates for commodities heavily researched elsewhere, and for those with

2. At decision-making level 1, referred to above, research priorities should first be identified without reference to manpower availability. At level 2, however, manpower considerations must come into play, with any severe problems referred back to level 1, where the necessary resources should either be made available or the priorities altered.

limited research needs. For these reasons, fund allocation by congruence is not a good general approach, although it is a useful starting point in an allocation exercise, and can be used for checking whether current research is broadly in line with planned development.

As a matter of insurance, few countries would be willing to do without research on their most vital commodities, even if today's research needs were minor and use could be made of results obtained elsewhere. The notion of congruence may therefore be used as a basis for high-level decisions on the retention of a minimum research capacity for the main staple foods and export products.

Method 2: Checklists

Checklists, though the least sophisticated of all the priority-setting techniques, can greatly improve the quality of priority setting at little extra cost. For national research systems which currently rely entirely on historical allocations and personal judgement, use of a checklist is probably the most appropriate initial approach to formal priority setting. The planner uses a list of the criteria and associated questions which he or she must consider and answer in deciding on priorities. The technique is simple to apply, but it does require much understanding of both agricultural research and development.

The usefulness of this approach is closely related to how well the questions are developed and how relevant they are to the matters under review. Most of the questions on checklists revolve around three areas: the impact of research, its cost, and its feasibility.

One question every checklist should raise is whether the scientific manpower for a given program is available. But if appropriate scientific expertise is not immediately available for a particular program, this should not prevent it from being placed on the initial priority list (see footnote on page 10). The program must then be postponed until technical assistance has been secured and recruitment and/or training undertaken. In the meantime, a lower-priority program may be put in its place.

The checklist method does not include any quantification of what is important and what is not, but the experience and perspicacity of the checklist-user may safeguard against major errors.

The checklist concept can be expanded into a 'scoring model" by attaching weights and scores to the criteria it lists. In this case special care is needed in choosing criteria. When a more sophisticated technique is used, such as the benefit/cost analysis outlined further on, a checklist can and should still be used to insure against the omission of important considerations. In fact, whatever formal method they use, planners should never wholly abandon the concept of a checklist.

Method 3: Scoring

Scoring methods represent a more sophisticated version of the checklist technique. They have been tried more often than any other formal method for ranking research priorities. The scoring matrix is really no more than a checklist with the answers to questions assigned numerical values and weights. Criteria weights are multiplied by the values which a particular research program merits under each criterion to produce a final score. Programs can then be ranked in order of priority according to their scores.

There are practical problems connected with attempting to rank programs dealing with aspects of the natural resource base along with those on commodities. Whereas the benefits from a commodity research program can be expressed directly, those from research on a factor such as

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soils can only be derived from assumptions regarding increased productivity over a range of commodities. In some cases, even this approach is impractical. Because of these problems, some analysts have chosen to treat commodity research programs differently from factor research programs. But the results do not then inform the decision maker as to where priorities should lie *between*, as opposed to *within*, the two categories of research. In this case, informed discussion between all concerned is the only way to reach a consensus; direct comparison of quantitative results will be extremely difficult.

There is always the possibility that the personal judgements which lie behind the determination of weights and scores may result in misleading conclusions, as is the case, in varying degrees, with the other methodologies dealt with here. For example, decision makers tend to weight program costs high because of the constraints of the national budget within which they must work. In so doing, they may overlook the likelihood that the returns on any reasonably successful research program often dwarf its costs.

When looking at final scores, decision makers may conclude that they do not accord with common sense. If this happens, they may wish to adjust the values, and sometimes the weights, until a result emerges which is more reasonable to them. Scores may be adjusted either by an individual decision maker or by group interaction, but preferably by the latter. In either case, the process of adjustment should not be carried too far: results should not be manipulated until they merely reflect existing prejudices.

Scoring has significant advantages over the use of checklists. Not only does it force the research planner to consider all the significant factors which may bear upon prioritization, but it also compels him or her to try to assess their relative importance. The approach is straightforward and can be applied without any special training. As with checklists, data requirements are very modest, but experience and knowledge, both broad and deep, are essential.

Economic Consequences of Agricultural Research[1]

$$Q_t = q(X_t, W_t, H_t, P_t, Z_t, R_{t-r}, E_{t-e}) \quad \text{for} \quad r, e = 0 \text{ to } \Diamond \tag{2.6}$$

Equation 2.6 captures the essence of most of the approaches used to measure the economic consequences of agricultural research. Two broad alternatives have been used. *Econometric approaches* have estimated equations of the form of 2.6 directly. Then, using the estimated equation, economic benefits from research have been calculated as the value of the additional output attributable to the lagged research expenditures (holding other inputs constant) or the value of the savings in inputs due to the lagged research expenditures (holding output constant).

An alternative approach is to go beyond the *production function* to look at research impact on the firm and industry *supply functions. An economic surplus approach* can be used to evaluate the benefits from a shift in supply due to a change in productivity (as could be measured, for instance, by equation 2.6). When it changes the relationship between inputs and outputs, a technical change also affects relationships between production costs and output and thus between supply and price. In this way the consequences of research and changes in technology can be assessed by looking at the relationship between research investments and a commodity's industry-level supply function. Indeed, this has been the most popular and fruitful approach used to assess the consequences of investments in agricultural research.[2]

The Basic Supply-and-Demand Framework

Figure 2.1 is a conventional, comparative-static, partial-equilibrium model of supply and demand in a commodity market.[3] The supply curve under the original technology is denoted by S_0, and the demand curve by D. The original price is P_0, and the quantity supplied and demanded is Q_0. Adoption of new technology shifts the supply curve to S_1, resulting in a new equilibrium price and quantity of P_1 and Q_1. This model can be used to show the effects of research on a number of other variables in addition to the quantity produced, the price paid by consumers, and the price received by producers. For instance using economic surplus measures, the model can be used to identify the effects on industry revenue and to measure total increases in economic efficiency (total social benefits) as well as the distribution of benefits between producers and consumers.

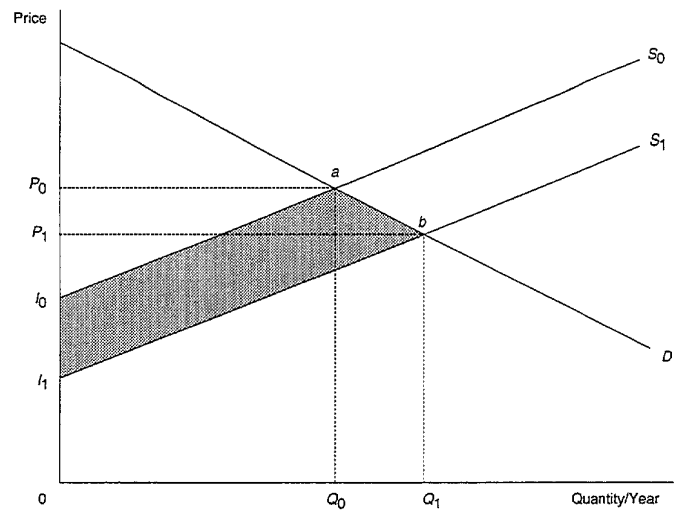
1. **Extracted from**: Alston, J.M., Norton, G.W. and P.G. Pardey. (1995). Science Under Scarcity: Principles and Practice of Agricultural Research Evaluation and Priority Setting. Published for ISNAR by Cornell University Press: Ithaca.

2. In some senses the econometric approach in practice is a variant of the economic surplus approach under some extreme elasticity assumptions. In any event, the economic surplus approach provides the theoretical support for the econometrically obtained measures of research benefits.

3. This is called a partial-equilibrium model (as opposed to a general-equilibrium model) because it focuses on part of the economy (e.g., agriculture or the maize industry) and treats most other economic variables as being constant (exogenous) in the analysis. The exogenous variables that are being held constant in the analysis are sometimes referred to as *ceteris paribus* conditions. It is a comparative-static model in that two (static) equilibrium situations — before and after a change or with and without a policy - am compared. Little attention is paid to the more difficult issue of the process or the path of the transition.

This model can be used to consider security objectives, too, so long as those objectives can be expressed in terms of market variables, and it can be modified to incorporate trade effects, demand shifts, and pricing policies, among other things. Here, it is used mainly to illustrate the economic surplus effects of research-induced technical changes. Gross annual research benefits are measured (using economic surplus measures) as the shaded area between the two supply curves and beneath the demand curve, area I_0ab_I, in Figure 2.1. This is the annual flow of economic benefits due to the supply shift from S_0 to S_I.

Figure 2.1: *Gross annual research benefits*



Lags in Research and Adoption

The comparative-static model in Figure 2.1 is the cornerstone of most of what follows. It is static, however, and abstracts from some important dynamic issues. In particular, there are long, variable, and uncertain lags in the interval between commencing a research activity and generating useful knowledge, as well as between generating new technology and seeing it adopted. Further, once research leads to an increment in the stock of knowledge or an improvement in technology, that increment to knowledge or improvement in technology yields a stream of future benefits that continues until the knowledge or new technology becomes obsolete. The flow of gross annual benefits in Figure 2.1 is a snapshot of only one year's worth of benefits. A successful research investment generally yields a sustained stream of such flows. The complete evaluation of a particular research investment must therefore take account of the dynamic relationships between investments in research that lead - after some, possibly long, lags to a sustained change in the stock of productive capital and thus to a stream of future benefits. These ideas are illustrated in Figures 2.2 and 2.3.

Figure 2.2 shows the hypothetical relationship between the adoption of new technology and the same after the initial investment in research. It includes a research lag (shown as five years) between the initiation of the research and the generation of pretechnology knowledge, followed by a development lag (shown as a further four years). During this time the results from pretechnology research are incorporated into useful agricultural technology, followed by an adoption lag (say a further six years) between the release of the agricultural technology and maximum adoption by producers. These assumptions about lag length are illustrative. Some projects may begin with the results from previous pretechnology research or they may begin even later in the overall process (say, by transferring in results from overseas), leading to much shorter lags between investment and adoption. On the other hand, some projects involve

extremely long lags. More applied agricultural research work, typical in developing countries, is likely to involve shorter lags than the more fundamental research that is typically carried out elsewhere.

Figure 2.2: *Research, development, and adoption lags*

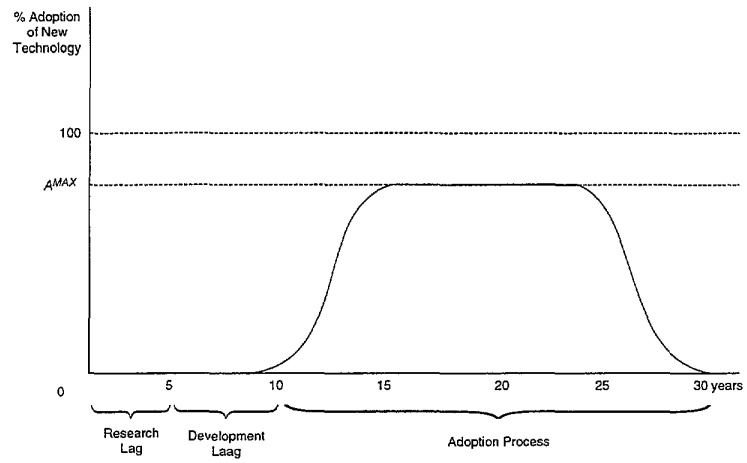
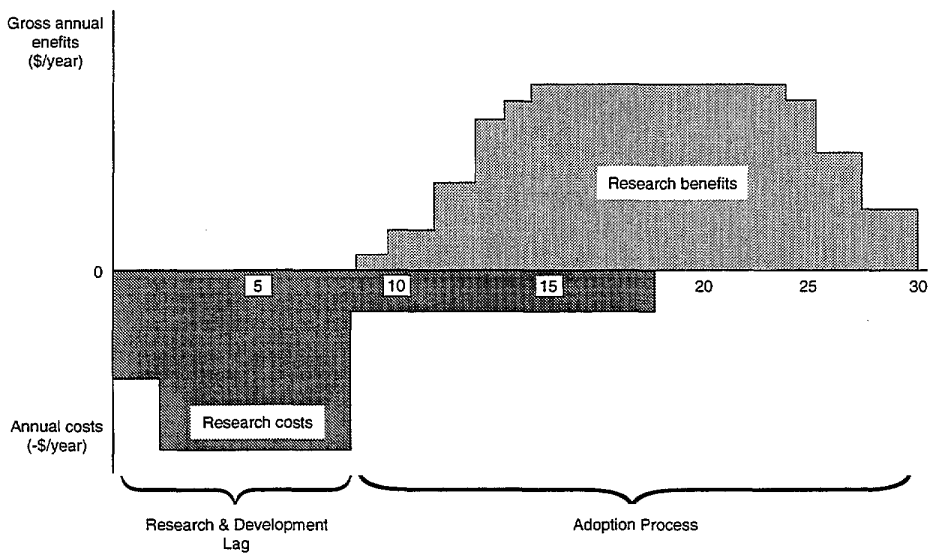


Figure 2.3: *Net research benefits over time*



Some further features of the diagram are notable. First, adoption is drawn as an S-shaped curve, which is common practice following Griliches (1958) who used a logistic curve. In empirical work, simpler linear functions (e.g., Edwards and Freebairn 1981), polynomial lags (e.g., Cline 1975 and Davis 1979), or trapezoidal lags (e.g., Huffman and Evenson 1992) have often been used. Second, the maximum adoption rate, A^{MAX}. is shown as less than 100 percent of the total potential adoption. Third, eventually the curve turns down when the technology depreciates or becomes obsolete and is progressively abandoned by the industry.

In practice, a discrete time approximation to a continuous adoption curve is used to develop a stream of annual flows of benefits. Figure 2.3 shows the annual flows of costs and benefits corresponding to the research investment represented in Figure 2.2. It combines the information from Figure 2.1, on flows of benefits for a given research-induced supply shift (the shaded area),

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and the information from Figure 2.2 on the time path of adoption (and hence the size of the industry-level supply shift), with other information on R&D costs. In the early years there are no benefits. Once people in the industry begin to adopt the technology, there will be a supply shift of the type depicted in Figure 2.1 and a corresponding flow of benefits. As the extent of adoption increases, the size of the supply shift and the corresponding flow of annual benefits also increases. Thus, the flow of benefits over time follows the shape of the adoption curve in Figure 2.2. In the early years there are costs of research, development, and adoption. Even after the research results have been fully adopted, the stream of costs and benefits reflects the costs of further research undertaken to maintain the value of the technology.

Depreciation and Maintenance Research

As with most forms of capital, the economic contribution of a particular component of the stock of knowledge (i.e., a specific piece of technology or information generated by agricultural research) erodes over time because of depreciation and obsolescence. Research-based information depreciates when circumstances change in a way that makes the information less productive; it becomes obsolete when it is replaced with better information for the same conditions. Maintenance research may be needed to compensate for the inherent depreciation of information, technology, and materials. Clear examples arise with pesticides or resistant varieties that are made obsolete by the development of new chemicals or new resistant varieties and which depreciate as pests evolve to resist the chemicals or overcome natural resistance. The timing and extent of depreciation and obsolescence vary greatly among different types of research, production environments, and types of knowledge. The results of basic research are likely to depreciate more slowly than the results of very applied research because the value of basic research is usually less sensitive to changing circumstances.

The comparative-static approach compares situations with and without research, but time-subscripted data are often used for that comparison — ie., 'before and after' rather than "with and without." The hazard in such work is that the comparison will be inappropriate unless the analyst has controlled properly for variation other than that due to research. This is clearly important in the context of maintenance research. To evaluate maintenance research that succeeds in preventing yields from falling, the appropriate comparison is not between current and previous yields but rather between current yields and what yields otherwise would have been. Recent work shows that a significant fraction of agricultural research in the U.S. has been maintenance research.[4] As a consequence studies may have underestimated the initial effect of particular research investments but overstated the longevity of the contributions. This is an example of the more general point that it is important to maintain the integrity of the *ceteris paribus* assumption when conducting comparative-static analysis. This point arises in many ways in the analysis of research benefits.

Summary Measures of Economic Effects

There are several options for evaluating a stream of benefits and costs associated with a particular research program, such as the one illustrated in Figure 2.3. These options are drawn from the literature on capital budgeting and benefit-cost analysis. Mostly, they entail calculating summary statistics such as the internal rate of return (IRR), the net present value (NPV), or the benefit-cost ratio, which can be used to rank programs or projects and set priorities. The NPV of a program

4. Evidence for the United States suggests that maintenance research represents about one-third of production-related agricultural research. See Adusei (1988) and Adusei and Norton (1990)

of research undertaken in time t is calculated as the sum of the stream of future benefits, B_k, minus the costs, C_{t+k}, associated with the program, discounted at an appropriate rate, r (here, for simplicity, assumed to be a constant), as follows:

$$NPV_t = \sum_{k=0}^{\infty} \frac{B_{t+k} - C_{t+k}}{(1+r)^k} \tag{2.7}$$

The IRR is calculated as the discount rate at which the NPV is exactly zero.

$$0 = \sum_{k=0}^{\infty} \frac{B_{t+k} - C_{t+k}}{(1+IRR)^k} \tag{2.8}$$

Further details on these alternative methods and their advantages and disadvantages can be obtained from a number of sources (e.g., Mishan 1981).

For most purposes, the NPV method is preferred. In this approach, any program with a positive net present value is profitable. The disadvantage of this method is that it does not provide a convenient ranking of alternatives because, although the scale of benefits is measured, the scale of the investment is not revealed. Concern over scale of investment is not an issue when funds are unlimited: all programs with a positive NPV are profitable. When funds are limited, an alternative is to express the net present value per unit of constrained input (e.g., per unit of research investment or per scientist and rank programs accordingly. The IRR method does rank programs clearly in terms of their profitability, but it does not reveal either the scale of the investment or the value of the programs. According to this criterion, programs are profitable if the IRR is greater than the opportunity cost of funds. One criticism of IRR is that it assumes that the stream of benefits can be reinvested at the computed rate of return, which is implausible in many cases of agricultural research where very high rates of return are obtained. Often, a combination of IRR and NPV calculations can be used as complementary approaches to summarize the relevant information on the total returns to research. Typically, IRRs have been used in ex-post evaluation studies, while NPVs (per scientist or per unit of investment) have been used in ex-ante evaluation and priority-setting studies.

Two important, related questions transcend the choice of method: What is the appropriate rate of discount (a required rate of return either for use in NPV calculations or for comparison to calculated IRRs)? How should uncertainty surrounding the estimated stream of benefits and costs be handled? Some people try to deal with both questions by requiring conservatively large rates of return. In our view (with the support of the mainstream of the literature on project appraisal), it is not appropriate to deal with uncertainty by adjusting the rate at which the streams of benefits and costs are discounted. In addition, some have argued, especially recently, that we should be using low discount rates so as to encourage research into technology that conserves natural resources (Cline 1992).[5] Underlying this is an implicit belief that we should attach greater weight to the welfare of future generations and that biasing the pattern of agricultural research is an appropriate way to achieve an intergenerational redistribution of welfare (Birdsall and Steer 1993). Ad hoc reduction of the discount rate is, however, unlikely to be a good way to account for externalities or to incorporate (intergenerational) distributive weights into research evaluations.[6] In most situations, there are likely to be less costly means of achieving environmental objectives, (or intergenerational transfers) than biasing the pattern of agricultural research specifically towards environmentally friendly projects.

As a final note on this topic, sometimes it is helpful and important to distinguish between marginal and average effects of research and rates of return to research. It is often suggested that the research production function is characterized by diminishing returns. Indeed, if this were not

the case, it might well be better to specialize much more in a smaller number of research programs or projects within programs. With diminishing returns, the. marginal return to increasing the budget for a particular program will be smaller than the average return to the total investment in the program. When the relevant decision is whether to continue a program or close it down, the average return is the appropriate measure. When the relevant decision is how to allocate an increase in the total research budget among programs (or, more realistically in the current environment, how to distribute a budget cut among programs), the appropriate measure may be the marginal rate of return. Sometimes programs will be ranked differently according to marginal returns rather than according to average returns. Often both marginal and average rates of return are useful for providing a more complete picture of the opportunity costs of program alternatives.

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5. Ruttan (1994) points out that the impact of lowering the discount (or interest) rate on the rate of exploitation of natural resources is not entirely clear and the relationships are not simple. Lipton (1991) discusses the effects of low and high interest rates on sustainability. See also Ptaroe, Barbier and Markandya (1990).

6. Mikeseil (1991) suggests taking explicit account of resource depletion in project analysis, instead.

DAY TWO

Session 7
Research Alternatives: Identification of Research Target Zones

Instructions to Trainers

SESSION 7

14:00 – 15:30 Session 7. Research Alternatives: Identification of Research Target Zones

15:30 – 15:45 Tea/Coffee Break

15:45 – 16:15 Session 7. (Continued)

RATIONALE

A clearly defined scope of a research program is the basis for any type of evaluation.

OBJECTIVES

By the end of this session, the participants will be able to do the following:

- Describe methods for identifying research program target zones.
- Identify key environmental determinants for research program target zones in national and regional programs.

Use overhead 2.7.1 to present the objectives.

PROCEDURE

Training techniques: presentation, group exercise.

PRESENTATION

(*experience*) Give a brief presentation. Emphasize that this presentation is based on handout 2.7.1, 2.7.2, and 2.7.3. Twelve overheads support the presentation: 2.7.2 through 2.7.13. At the end of the presentation distribute handouts 2.7.1, 2.7.2, and 2.7.3 and be sure to ask the participants if they have any comments or questions, or if they need clarification. (20 minutes)

EXERCISE 7

Exercise 7 (part 1). Identifying research-target zones. (1 hour 35 minutes)

1. Distribute handouts 2.7.4 and 2.7.5. These handouts give clear instructions for the exercise. Go over the instructions with the participants step by step. Ask if clarification is needed. (5 minutes) Make sure that the participants understand that this exercise will be carried out in two parts. This is part 1 and session 9 exercise 9 will cover part 2.

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Phase 1. Forming groups

2. **Important!** Divide the participants into four groups. Participant groups should be mixed, different countries/institutes. These groups will work together in a number of sessions through-out the workshop to work through a complete sample priority-setting exercise.

Phase 2. Developing a new table of research target zones

3. *(experience)* Groups read the handouts and work on two questions. Circulate from group to group to check the progress of the groups. Clarify any concerns the groups may have while they are working. Be sure to remind the groups of the time remaining. (60 minutes)

4. Collect the new tables and select one to explain how these data will be processed in the computer. (30 minutes)

5. Explain the participants that this exercise will continue tomorrow, when all data have been processed in the computer.

CLOSURE

Closure (5 minutes)

1. *(application)* Ask the participants to tell one of their neighbors two things they might do differently in their job as a result of what they learned in this exercise. Choose some volunteers to give samples.

2. Make a transition to the next session.

DAY TWO

Session 7
Summary of Overheads

Objectives

Session 7: Research Alternatives: Identification of Research Target Zones

4. Describe methods for identifying research program target zones
5. Identify key environmental determinants for research program target zones in their national and regional programs

2.7.1

Research target zones will form the basis for evaluation of potential research impact

2.7.2

Environmental criteria are often the basis for defining research target zones

2.7.3

Agroecological Characterization

- The fundamental difficulty in agroecological characterization is the trade-off between scale and accuracy.

2.7.4

Solution to Characterizing Environments in Ranges

(a) Appropriate to the natural resource variability within the geographical area of interest.

e.g. group all areas having similar thermal and moisture regions

(b) Appropriate to the specific use of land for which the charaterization is being made.

e.g. delineation of areas physically suited to smallholder coffee production

2.7.5

GIS give user much greater choice about *when* and *how* to classify — including the option not to classify at all.

2.7.6

There are a growing number of widely available, spatially referenced, global and regional databases of topography, climate, land resources, and vegetation.

2.7.7

Zones can be readily redefined to correspond to current foci of a research program.

2.7.8

Zones that are likely to exhibit a homogeneous *physical* response to the application of a new technology.

2.7.9

For this reason, INTER ALIA is becoming more usual for incorporating adoption-related characteristics into the spatial zoning process.

i.e. Attempting to deliniate combined ecologic-economic zones.

2.7.10

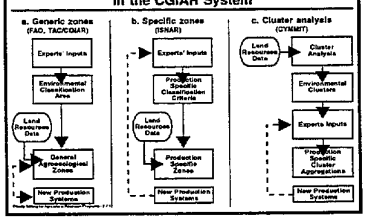
Selection of Methods

These are several approaches to agroecological classification and zoning, but for application at the regional level, four specific methods are:

1. Generic zones
2. Specific (Dynamic) zones
3. Cluster analysis

2.7.11

Some Approaches to Agroecological Zoning in the CGIAR System



2.7.12

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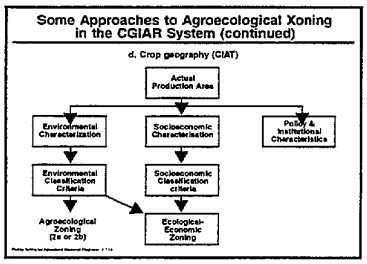
Some Approaches to Agroecological Xoning in the CGIAR System (continued)
d. Crop geography (CIAT)
Actual Production Area
Environmental Characterization
Socioeconomic Characterisation
Policy & Institutional Characteristics
Environmental Classification Criteria
Socioeconomic Classification criteria
Agroecological Zoning (2x or 2b)
Ecological-Economic Zoning

2.7.13

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Research Alternatives: Identification of Research Target Zones (summary of presentation)

1. In order to set priorities, the geographic areas of potential interventions must be clearly defined.

2. Environmental and social variables can be an important basis for the establishment of research target zones.

3. Often a trade-off must be made between accurate representation of the variation in agricultural production systems and the establishment of a limited number of zones of practical use. Classification is often based on either geographic areas with similar environmental criteria or areas with similar suitability for specific commodities.

4. Previous zonation schemes are often available to assist in establishment of research target zones. Geo-referenced data can assist in development of program specific classifications. Finally statistical techniques can be used to identify zones based on minimum variance over selected criteria.

The Agroecological Dimension of Research Evaluation and its Role in Research Priority Setting[1]

3. AGROECOLOGICAL CHARACTERIZATION

There are some fundamental difficulties with agroecological characterization, particularly at the regional level of analysis. Given that optimum land management and production methods can change on a field-by-field basis in agroecologically diverse areas, how is it possible to delineate meaningful zone boundaries at a regional or even a national scale? This trade-off between scale and accuracy is not a new problem either to information science or to natural resource specialists, and historically the solution has been to characterize environments in ranges: (a) appropriate to the natural resource variability within the geographical area of interest e.g., group together all areas having similar thermal and moisture regimes, or (b) appropriate to the specific use of land for which the characterization is being made, e.g., delineation of areas physically suited to smallholder coffee production. At high levels of aggregation, it is customary to identify and group repeating spatial patterns of resource characteristics, as in soil science where soil mapping units frequently represent complexes or associations of different physiographic units and/or soil types. Since these associations are usually quantified in proportionate terms, precise spatial definition is lost, but information on the heterogeneity occurring within each mapped unit is retained for subsequent analysis.[2] Another important principle involved is that of compatibility between the hierarchical (aggregation) levels of natural resource characterization and production system characterization. Thus, it could be very misleading to match the well defined environmental requirements of a specific crop cultivar against an agroecological zoning scheme (or an aggregated resource database) designed for a regional scale, a scheme in which zones are likely to be highly heterogeneous from the perspective of the cultivar.

Two important technologies have rapidly changed perceptions and practices with respect to spatial analysis — geographical information systems (GIS) and remote sensing. Much of the historic need for classification related to the constraints of manual analysis and mapping whereby early classification (reduction) of the information content was essential to make the analysis tractable. Classification of agroecological variables results in the decision of a number of more spatially contiguous zones and, thus, a simplified mapping process and a comprehensible map legend. GISs give users much greater choice about when and how to classify — including the option not to classify at all, i.e., retain all of the richness of the primary data set and interpret it in different ways for different applications (although there are differences between vector and raster-based systems in this regard).

Furthermore, there are a growing number of widely available, spatially referenced, global and regional databases of topography, climate, land resources, vegetation etc. Combine the availability of more and better georeferenced data, with low-cost GIS technologies that support spatial

1. **Extracted from**: Wood, S. 1994. Regional Priority-Setting Round Table ISNAR April 18-20, 1994. Paper 9, The Agricultural Dimension of Research Evaluation and its Role in Research Priority Setting.

2. For example, the mapping unit 'Bh12-3c' delineated on the FAO UNESCO soil map is made up of three proportional elements; soil type Humic Cambisol with heavy textures and steep slopes for 60% of the unit, soil type Orthic Acrisol with medium texture and medium slopes for 30% of the area, and soil type Dystric Fluvisol with medium texture and gentle slopes for 10% of the area.

interpolation of point information, proximity and buffer zone analysis, "transport" costs based on anisotropic forces and frictions, drainage patterns and hydrological network analysis, rapid and intelligent reclassification etc., and it is not difficult to envisage the wealth of spatial analysis possibilities that can be brought to bear on the research evaluation problem. No less dramatic is the change in perception of the role of maps that GIS development has engendered. The relative ease with which datasets can be edited, new thematic overlays included, and classification assumptions changed has rendered (non-cartographic standard) mapmaking an almost "on-demand" activity. In the context of our interest this means that the concept of "zoning" is also less static, and that zones can be readily redefined to correspond to the current foci of a research program e.g., fragile ecosystems, germplasm groups, production systems and research activities/disciplines. In the case of a raster based GIS it is conceivable that a single pixel (typically representing an 8–15 km grid size on a regional scale database) could define a single unique "zone".

The economic-ecologic research evaluation framework that ISNAR is developing tries to make maximum use of these new analytical opportunities. One way in which we do this is to use multiple sets of zones within a single research program, each of which corresponds to the specific perception of agroecological space associated with a major research program component. We then use the GIS to assist in spatial aggregation of component-specific research effects for input to the market level analysis.

A final general issue concerns the extent to which zones can really be considered as delineating areas of relatively homogeneous research effect. Agroecological analysis can only delineate zones that are likely to exhibit a homogeneous *physical* response to the application of new technology. However, the actual (or realized) response is limited by the infrastructural, institutional, cultural, and other socioeconomic conditions governing technology adoption and use. If only agroecological zoning criteria are used, then the research evaluation analysis must use other means to estimate *actual* effects likely to occur within AEZs of uniform *potential* effect. For this reason, inter alia, it is becoming more usual to incorporate adoption-related characteristics into the spatial zoning process, i.e., attempting to delineate combined ecologic-economic zones.

3.1 Selection of characterization variables

A primary concern in the characterization process is to identify those agroecological factors that influence potential production or natural resource conservation. Thermal and moisture regimes are perhaps the most important, but beyond these the selection is more specific to individual species and sub-species, and localized environmental phenomena. Typically, an agroecological characterization at anything other than a megascale would also include one or more of the following factors;

- Existing land use and vegetation cover
- Physiography, land form and slope (and often elevation as a proxy for temperature)
- Soil type (including key characteristics, e.g., pH, texture, soil depth)
- Climatic hazards e.g., probability of drought, frost, flood, typhoon

Many factors, not least the availability of data, influence the selection of variables, but perhaps the most important ones are the time dependency of the underlying variables e.g., the relative stability of soils versus the dynamics of vegetation cover. Also of concern is the extent to which

sparse or incomplete data may be reliably interpolated. Thus, climatic hazards are generally suited for spatial interpolation, whereas soil type is not.[3]

Although measures of agroecological risk, e.g., the probability of occurence of a climatic hazard, are not common, their importance has been recognized as conditioning factors with regard to farmer attitudes and teh application of production technologies. Clearly such probabilistic must be based on often scarce time series data but it appears that much more could be done in this regard. Examples of such variables being used include typhoon probability overlays in the Philippines (Cabrido 1994) and the classification of year-to-year growing season patterns in Kenya (FAO 1993).

3.2 Selection of method

Issues of scale, purpose, and the availability of such technologies as GIS and remote sensing have all influenced the approaches taken to agroecological characterization. Furthermore, the complexity of characterization increases in proportion to the number of defining criteria (i.e., spatial overlays). Early work, such as FAO's AEZ study (FAO 1981) used relatively few thematic layers to delineate the agroecological boundaries of production potential. But clearly many other spatially varying factors influence production potential, natural resource degradation, and technology adoption and, hence, would warrant incorporation into the characterization process. We have seen that this tendency is supported by (and partly a consequence of) the improved spatial data handling and analytical capacities provided by GIS.

A related but separate issue from the number and type of variables used to delimit zones is that of the particular zoning method adopted. There are several approaches to agroecological classification and zoning (Young 1987) but for application at the regional level four specific methods, summarized diagrammatically in Figure 1, are considered most relevant:

(a) Generic Zones — *Figure 1a*

On the basis of an expected range of potential production systems and natural resource degradation hazards a general set of agroecological classification criteria are defined. When applied to the land resources database of an area, the criteria translate into spatial boundaries that delineate zones. These zones are fixed regardless of the actual production systems and commodities that are eventually tested. The FAO AEZ methodology adopts this fixed approach to zones.[4] Because ACIAR's and TAC/CGIAR's approaches to research priority setting both use FAO's AEZs, the generic zoning approach is inherent in their research evaluation methodologies.

(b) Specific (Dynamic) Zones — *Figure 1b*

Here adaptability and degradation criteria are identified separately for each potential production system. Thus, a different spatial definition of zones, e.g., a new zonal map, is produced for each individual or group of production systems. This approach is used by ISNAR in its collaborative ex-ante research evaluation projects (Wood and Pardey forthcoming).

3. A closer approximation to this objective could also be obtained by including appropriate variables in any of the other methods.

4. The fixity of zones is not inherent in FAO's AEZ concepts, but represents the way in which the concepts have been implemented in the original global study and in various subsequent country level studies.

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(c) Cluster Analysis — *Figure 1c*

Here the starting point is not potential production systems, but the land resource database. Although conditioned by the selection of characterization variables and statistical control parameters, an otherwise unhindered statistical grouping of agroecologically similar clusters is obtained. Once defined, these clusters can be interpreted by scientists to assess their relevance to specific production systems.

(d) Production Geography — *Figure 1d*

In this approach the starting point is the actual distribution of production. This distribution can be characterized from a number of perspectives including agroecology, socio-economics, and the institutional and policy environment. The characteristics so identified can then be used to delineate zones in other geographic areas.

All of the above methods have their strengths and weaknesses. The generic and specific (dynamic) zone methods are conceptually similar. An extremely disaggregated set of generic zones — i.e., many classification criteria and, hence, zone boundaries — could conceivably be aggregated into different sets of zones for each new production system. In practice, however, classification boundaries for generic zone systems tend to be oriented to general cartographic needs, and seldom coincide with the requirements of any individual commodity or production system. By contrast, the criteria used in dynamic zoning correspond with the agroecological thresholds most relevant for the specific ongoing or planned research on a given production system.

Before the advent of computer-based GIS, zones were delineated manually in map format. Generic zones then had the distinct advantage that zoning was performed only once, regardless of the number and type of production systems. The significant disadvantage, however, is that the zones so delineated often have considerable spatial mismatch with the actual requirements or tolerances of specific production systems. The dynamic method overcomes this problem, since it redefines zones for each production system (or group) to match its precise requirements,[5] but it does have the disadvantage of requiring a capability to update zones as new production systems are analyzed (i.e., it is only practical using a GIS). Updating often involves the addition of new delimiting criteria by digitizing or spatial interpolation. Dynamically defined zones, by virtue of their more precise criteria, should not only provide better spatial definition, but should also display greater homogeneity in their response to research.

Cluster analysis takes a fundamentally different approach by not predefining classification boundary values *a priori,* but by defining only a set of characterization *variables* from which statistically significant environmental "cluster" boundaries (i.e., the characterization criteria values) are deduced. Expert judgement is then used to match defined clusters with production system requirements or tolerances. This is not always easy. Experts are required to make judgements in a multi-variable domain (compared with fixed and dynamic zones where variables are treated independently),[6] secondly, there is not necessarily a close correspondence between the statistically determined cluster boundaries and the specific requirements of production systems. There are also some theoretical and practical difficulties in the statistical analysis itself,

5. The limits of precision are defined by (a) the extent to which the production system requirements or tolerances are known, and (b) the level of aggregation inherent in the underlying environmental data.

6. This is not to say that the independence *(ceteris paribus)* assumption is more scientifically defensible — rather than it has proved a more practical way of eliciting expert opinion on crop requirements or tolerances.

such as the choice of "distance" algorithm and the user specification of the number of clusters, both of which affect the clustering results.

Cluster analysis is somewhat like the generic zones approach if analysis for a new production system is made by a reinterpretation of existing cluster groupings, rather than by totally redefining cluster boundaries. It provides a systematic and reproducible means of aggregating agroecological space. However, the only way in which the clustering process is related to any production system is if the selection of cluster variables is production-system biased. In this case there is scope to redefine cluster variables and, hence, the resulting clusters on a production-system basis.

The production geography approach is manpower intensive but does (theoretically at least) allow for the complete characterization of production. In this sense it comes closest to the ultimate goal of identifying areas of homogeneous technology effect including adoption.[7] However, the approach is by definition limited to current practices, practices that do not necessarily provide reliable indicators of the likely effect of new technologies. For example, research may seek to significantly shift the environmental adaptability range of a crop or to improve its tolerance to geographically specific pests and diseases. In this case the new technology my have the potential to define a different production geography. Overall, the crop geography approach may be seen as a relatively rigorous scientific attempt to determine productivity, adoption and, to some extent, sustainability criteria that could be used in any of the ways described above to help delineate zones beyond the current areas of production.

The analytical choices faced between generic, specific, and cluster approaches to zoning, when those choices must be made, and how they are conditioned by the particular GIS technology (vector or raster) used, are summarized diagrammatically in Figure 2. This diagram also serves to underline some specific classification issues — a fundamental one being that ALL approaches rely upon expert scientific judgement. Since not all agroecological characteristics are amenable to computer-based spatial interpolation,[8] the manual-interpolation-then-digitize approach is widely practiced. it is also clear that the vector-based GIS approaches tend to force a higher degree of classification than raster systems since there are practical, operational limits on the maximum number and minimum size of poygons for analysis, plotting, and labelling purposes. The raster domain is more flexible, and pixel data can be stored in an unclassified form (i.e., with no loss of information). Furthermore, for display and plotting purposes, there is no minimum contiguous area requirement — in the limit a "zone" could be represented by a single pixel.

When making a classification in the raster domain one major choice faced is whether to directly classify each pixel in turn, or whether to make a cluster analysis of pixels and then classifying the clusters. This choice is largely determined by the extent of knowledge on the agroecological tolerances/requirements of a given species (or sub-species). For most agricultural plant species, particularly those found in research programs, it is most likely that adaptability limits and tolerances are fairly well known. In this case the preferred approach is direct classification of each pixel based on these criteria and the generation of a (sub) species specific classified image ("zone map"). If, on the other hand, relatively little apart from existing geographic distribution is known as appears to be the case with many forest and agroforestry species (e.g., the provenances of certain qualities of seed), then cluster analysis provides a powerful means of

7. A closer approximation to this objective could also be obtained by including appropriate variables in any of the other methods.

8. And there may be good technical reasons why manual interpolation may sometimes be more reliable, even in cases when computer-based interpolation is a feasible option.

identifying agroecologically homologous areas and, in that process, can help to better define agroecological characterization criteria. Figure 2 also indicates those points at which data is available for agroecological modeling, and highlights the multiple sets of commodity/production system specific zones that are used in ISNAR's research evaluation studies.

Figure 1: *Some approaches to agroecological zoning in the CGIAR system*

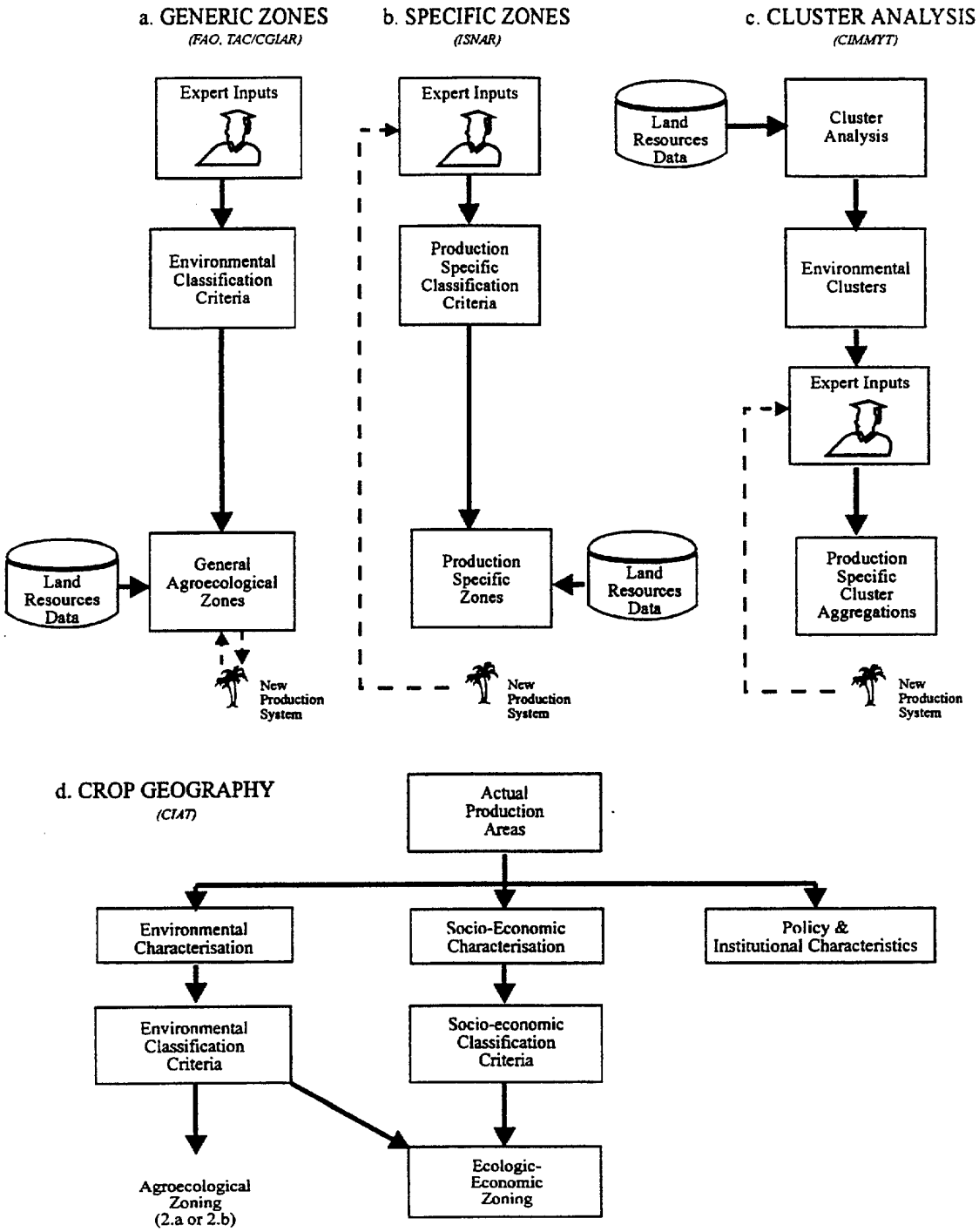

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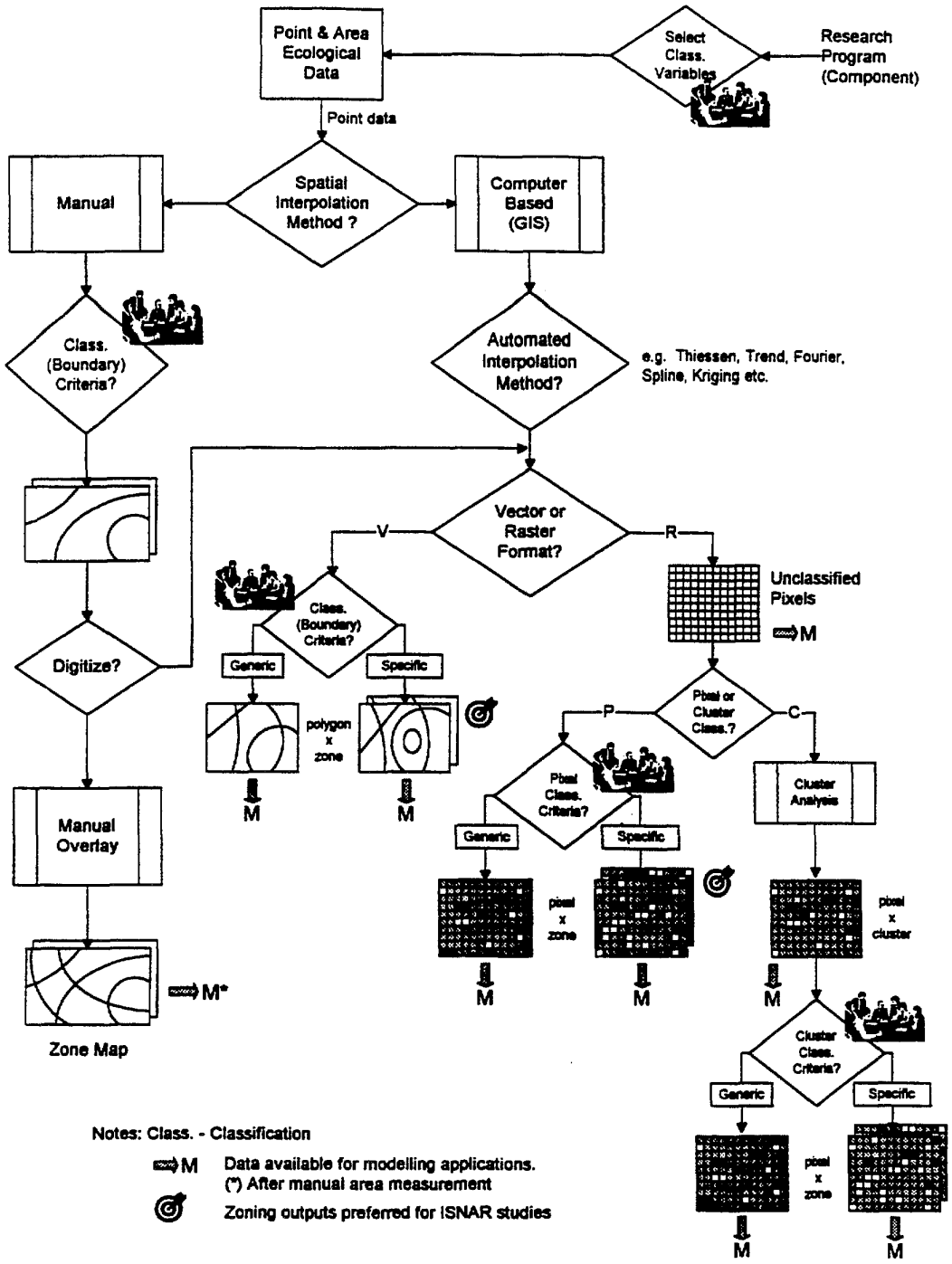
Figure 2: *Some GIS-related options involved in agroecological characterization*



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Classifying Major Programme Research Themes and Target Zones[1]

The priority setting process was guided by a Priority Setting Working Group composed of key programme scientists from different disciplines and regions of Kenya.[2] The Working Group identified four major programme research themes to be reviewed in the priority setting exercise: varietal development; crop management; technology development and dissemination; and processing, utilization, and storage.

Varietal development research activities focus on improving (or maintaining) the yields and/or stability of sorghum through the manipulation of genetic material.

Crop management research activities focus on improving agronomic practices. This theme is broadly defined to cover crop protection and soil fertility management research activities.

Technology development and dissemination research activities are relatively more complex. A limited specification of these activities focuses on improving the flow of existing technologies to extension agents and farmers as well as increasing the flow of information back to technical scientists on client needs for new technologies. From a broader perspective, the potential set of activities includes research on the policy environment within which technology transfer takes place. Sorghum and Millet Programme activities reviewed under this theme lie within the more narrow definition. However, KARI, particularly the Socio-Economics Division, has a mandate to participate in the wider policy forum on improving the environment for the dissemination of research technologies.[3]

Processing, utilization, and storage research activities attempt to increase the quality of processed gain and the range of food products. Research activities also attempt to reduce the level of key inputs, particularly labor, in the processing of grain as well as post-harvest losses.

For efficient resource allocation, national commodity programmes must also develop broad target zones for technology development . Within these target zones the application of new technologies arising from major research themes should have a relatively homogeneous bio-physical impact on production. Defining zones based on observable environmental characteristics creates a clearer basis for technical scientists to visualize the magnitude and spatial variation of the potential impact of major programme research themes. Further, these zones will cut across regional research programme mandates and, thus, allow national programmes to strategically integrate technology development within regional research programme research agendas. Finally, for priority setting, base production levels within target zones will have a major impact on the calculation of expected research benefits.

1. **Extracted from**: Kenya Agricultural Research Institute. 1995. Sorghum Research Priorities at the Kenya Agricultural Research Institute. The Sorghum Priority Setting Working Group, pages 2-4. Nairobi: KARI.

2. The Working Group consisted of a regional distribution of agronomists, extension officers, plant breeders, socio-economists, as well as plant protection and post-harvest processing specialists.

3. The framework within which technology dissemination efforts translate into research benefits is arguably different than for the other research themes. However, the same structured elicitation process will be used to maintain compatibility across themes. Further, in order to minimize the overlap between technology dissemination and the benefits from other themes, the working group focused on the potential for increasing the flow of currently available technologies onto farmers fields.

For the development of sorghum technologies, the Priority Setting Working Group identified the four target zones: Humid Coastal; Semi-Arid Lowland; Moist Mid-Altitude; and Cold Dry Highlands. The three agroclimatic determinants (elevation, rainfall, and temperature) and the criteria used to define relevant sorghum agroecologies are given in table 1.

Table 1. **Sorghum Target Zones**

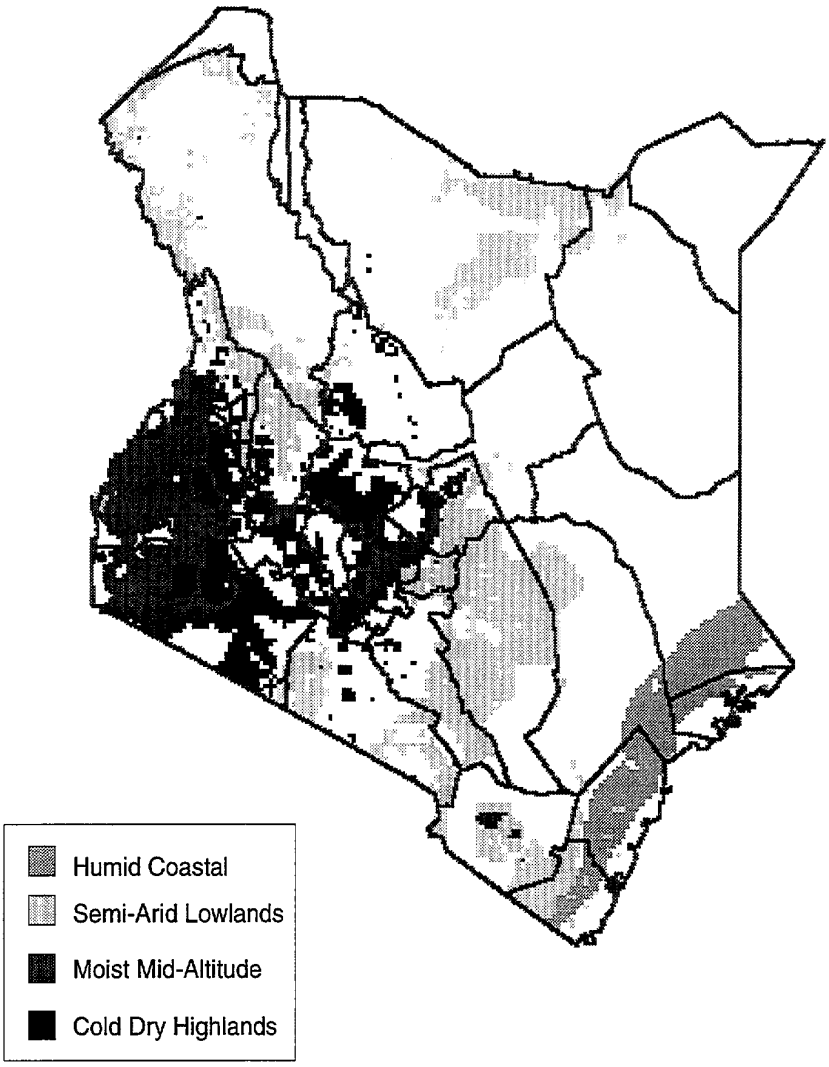
	Elevation (meters)	Rainfall (mm)	Temperature (degrees Celsius)
Humid Costal	0-250	225-500 March-June, 50 March-April, & 40 June	na
Semi-Arid Lowlands	250-1150	250-525 March-July or October-December	>°11 Ave. Min for July
Moist-Mid. Altitude	1150-1750	500-1250 March-July	na

Elevation: While the traditional major sorghum production zone (Moist-Mid Altitude) lies between 1150 and 1750 meters, a major focus of sorghum research is to expand production to the Semi-Arid Lowland Zone between 250 and 1150 meters. A limited amount of production also occurs near the Coast, between 0 and 250 meters. Finally, some sorghum is produced for both human consumption and livestock feed at higher elevations of 1750 to 2300 meters.

Temperature: Low temperatures can significantly retard the growth of sorghum plants. Varieties in the Cold-Dry Highland Zone have some resistance to cold, but production is reduced dramatically in areas where the July average minimum temperature is below 5 degrees Celsius. Varieties in the Semi-Arid Lowlands are less cold tolerant than those in the Cold-Dry Highlands and yields will be significantly reduced if the July minimum average temperature falls below 11 degrees Celsius.

Rainfall: Sorghum varieties are well adapted to low rainfall conditions if necessary. In the Mid-Altitude Moist Zone rainfall is rarely limiting and varieties are adapted to conditions of between 500 and 1250 mm average rainfall during the first rains from March to July. The Cold-Dry Highlands, by contrast, need only a little rainfall during the early part of the growing season (40 mm average total between March and April) to ensure the success of the crop, given the cloudy conditions and low rates of evapo-transpiration later in the season. In the Semi-Arid Lowlands sorghum is often grown during the second rains (October-December), which tend to be more reliable in low-elevation areas east of Mt. Kenya. However, an average of 250 to 525 mm in either the first rains (March - July) or second rains (October - December) are sufficient for sorghum production. Finally, in the Humid Coastal Zone 225 to 500 mm of average rainfall between March and June, with 50 mm falling between March and April and 40 mm at heading in June, are sufficient for Sorghum production.

All zones are mutually exclusive in terms of combinations of criteria and the resulting zones are depicted in figure 1.



Sorghum area and production estimates for each zone were then calculated based on district level averages of 1990 to 1993 Central Bureau of Statistics first and second rain estimates (table 2).[4] Based on the elevation, temperature, and rainfall criteria, the Semi-Arid Lowlands Zone spans the largest area of all the zones. However, when area and production statistics are allocated to zones, the Moist Mid-Altitude Zone ranks first in terms of both area and production (accounting for 63 percent of the area and 78 percent of the production of sorghum). The Semi-Arid Lowlands Zone ranks a distant second in terms of both area and production and shows a far lower estimated yield per hectare than the Moist Mid-Altitude Zone. The Cold-Dry Highlands, despite its size, has low imputed area and production estimates. Finally, districts lying within the Humid Coastal Zone show extremely low levels of estimated sorghum production and, thus, imputed areas and production levels of sorghum within the zone are very low.

4. The estimated area under sorghum production in each district is allocated in proportion to the district area falling within each zone. A detailed discussion of the available sources of district level production data is found in Mills et al. 1994.

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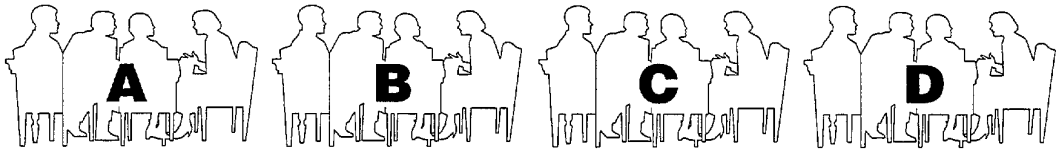
Table 2: **Sorghum Area, Production, and Yield by Agroecological Zone**

	Humid Costal	Semi-Arid Lowlands	Moist Mid-Altitude	Cold-Dry Highlands	Total
% of total zone zrea	12.69	46.79	16.32	24.20	100
Estimate of area currently under sorghum (1000 ha)	0.06	71.56	142.51	10.88	225.01
%	0.03	31.80	63.30	4.80	100
Production estimate (1000 mt)	0.02	13.85	61.20	3.53	78.60
%	0.02	17.62	77.87	4.49	100
Estimate of yield (mt/ha)	0.25	0.19	0.43	0.32	0.35

Exercise 7. Identifying research target zones (group exercise)

Phase 1. Forming groups (5 minutes)

1. Form four groups. These groups will work together in a number of sessions through-out the workshop through complete sample priority-setting exercises.



2. Elect a rapporteur.

Phase 2. Developing a new table of research target zones (1 hour 30 minutes)

3. Read handouts 2.7.2 and 2.7.3.

4. Respond to the following questions:

   - Identify two new zones for sorghum production.
   - Fill out the attached chart (handout 2.7.5) based on elevation, rainfall, and temperature criteria.

5. The trainer collects the new tables and uses one group's results to demonstrate how the data will be processed in the computer.

Note: This exercise will continue when the trainer has processed all the data. This will be in session 9 tomorrow.

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Exercise 7. Worksheet

Sorghum Target Zones			
	Elevation (meters)	Rainfall (mm)	Temperature (degrees Celsius)
Zone 1			
Zone 2			

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DAY TWO

Session 8
Using Spreadsheets in Priority Setting

Instructions to Trainers

SESSION 8

16:15 – 17:00 Session 8. Using Spreadsheets in Priority Setting

RATIONALE

In order to understand how spreadsheets are used in priority setting, the participants should have some basic knowledge of computers and spreadsheets.

OBJECTIVES

By the end of this session, the participants will be able to do the following:

- Describe what a spreadsheet is and its possible uses.
- Indicate how spreadsheets can be used in priority setting.

Use overhead 2.8.1 to present the objectives.

PROCEDURE

Training techniques: presentation, group work.

PRESENTATION

(*experience*) Give a brief presentation focusing on the principles of spreadsheets. Seven overheads support the presentation: 2.8.2 through 2.8.8. At the end of the presentation distribute handout 2.8.1 and be sure to ask the participants if they have any comments or questions, or if they need clarification. (15 minutes)

EXERCISE 8

Exercise 8. Working with spreadsheets. (25 minutes)

1. Distribute handout 2.8.2. This handout gives an outline of the exercise. Review the instructions with the participants step by step. Emphasize that you will give a demonstration of the spreadsheet you use during the exercise.
2. Divide the participants into four groups. Each group works on one computer.
3. *(experience)* Give a demonstration of how the participants can realize the tasks in the exercise with your spreadsheet program. Then, as the participants work on the tasks themselves, circulate from group to group to check progress. Clarify any concerns the groups may have while they are working. Be sure to remind the groups of the time remaining.

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CLOSURE

Closure (5 minutes)

1. *(application)* Ask the participants if they understand the advantages of spreadsheets. Ask volunteers to give examples.
2. Make a transition to the last session.

17:00 – 17:30 Feedback on the Day's Activities and PAPA

OBJECTIVES

By the end of this session participants will be able to do the following:

- Provide feedback on the day's activities.
- Consider possible actions they would like to implement in their own organizations.

PROCEDURE

Training technique: individual exercise.

Highlight positive and negative points of the day. Note areas that may need additional attention in the workshop. Participants can write some strengths and weaknesses of this day on handout 2.8.4., and use handout 2.8.5 to facilitate their task. (15 minutes)

PAPA

(application) Ask the participants to take some time to jot down some "action ideas" they may have for themselves as a result of today's activities. They can use handout 2.8.6. (15 minutes)

DAY TWO

Session 8
Summary of Overheads

Objectives of Session 8.
Using Spreadsheets in Priority Setting

6. Describe what a spreadsheet is and its possible uses
7. Indicate how spreadsheets can be used in priority setting

2.8.1

What is a Spreadsheet?

- An electronic version of an accountant's ledger book
- Used to record figures and other information
- A computer program and has great advantages over an old-fashioned ledger

2.8.2

Advantages of a Spreadsheet

- Spreadsheet size
- Automatic calculation
- Easy editing
- Instant graphs

2.8.3

Spreadsheet is Divided in Cells

- Each cell can contain a separate value
- Use the arrowkeys to move the highlighted cell selector around the spreadsheet
- Move the selector to the cell, then type the information
- The characters you type are displayed above the spreadsheet on the input line
- To enter the data into the spreadsheet, press "Enter" or any of the arrow keys

2.8.4

Press the HELP Key (usually F1)

- Any time you are confused or
- Need assistance

2.8.5

Spreadsheets

- Offer hundreds of commands for manipulating and displaying data
- If you are not sure what a command does, highlight it
- A short description of the command on a status line below the spreadsheet
- Press HELP key for further details

2.8.6

Always remember

to save all your work from the computer's memory to a file on disk before you exit the program.

OTHERWISE, all information will be lost!

2.8.7

Microsoft Excel as a Spreadsheet

- Start the examples and demos in the HELP menu to see demonstration of the program
- HELP menu explains HOW TO work with Excel. Then, USE IT. It is the guideline to this session

2.8.8

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Using Spreadsheets (summary of presentation)

1. What is a spreadsheet? A spreadsheet is an electronic version of an accountant's ledger book. You use it to record figures and other information. Of course, because it is a computer program, it has a great many advantages over an old-fashioned ledger, just a few of which are the following:

   - *Spreadsheet size.* What you see on the screen is actually only a fraction of the entire spreadsheet. You can scroll the spreadsheet by pressing certain keys (arrows, PgUp, PgDown, and others).
   - *Automatic calculation.* You can enter formulas in the spreadsheet to automatically calculate values—for example, to total figures in a column or to calculate the average in a range of entries. You can even use formulas to access, or link to, values in a different spreadsheet.
   - *Easy editing.* It is simple to change a spreadsheet. Other entries affected by the change are automatically updated.
   - *Instant graphs.* You can instantly create and print graphs to help analyze your spreadsheet data. You can display the graph separately or as a part of the spreadsheet.

2. A spreadsheet is divided in *cells*. Each cell can contain a separate value. To enter information in a cell, use the arrow keys to move the highlighted *cell selector* around the spreadsheet. Move the selector to the cell in which you want to enter data, then type the information. The characters you type are displayed above the spreadsheet on the *input line*. When you are ready to enter the data you typed into the spreadsheet, press "Enter" or any of the arrow keys.

3. Any time you are confused or need assistance, press the Help key (usually F1). The program will provide information that will help you solve the problem.

4. Spreadsheets offer hundreds of commands for manipulating and displaying data. If you are not sure what a command does, highlight it; you will see a short description of the command on a status line below the spreadsheet. For further details, press the Help key, and the program will display more in-depth information.

5. Always remember that you need to save your work from the computer's memory to a file on disk before you exit the program. Otherwise, all your information will be lost.

6. If you use "Microsoft Excel" as a spreadsheet, you can start the *Examples and Demos* in the Help menu to see a demonstration of the program.

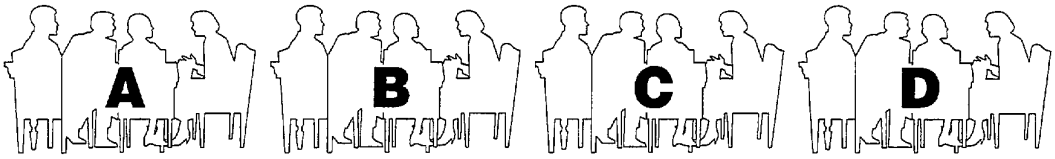
Key reference

Quattro Pro manual, Getting started.

Exercise 8. Setting up a spreadsheet

Phase 1. Group work

1. Form four groups. Each group works on one computer.



2. a. Start the spreadsheet program.
   b. Create headings to label the rows and columns.
   c. Adjust the heading display so the spreadsheet is easy to read (adjust the width of a column and align the labels in cell).
   d. Save your spreadsheet in a file.

3. a. Enter data, such as dates and dollar amounts.
   b. Copy information from one part of the spreadsheet to another.
   c. Enter formulas to calculate data in the spreadsheet.
   d. Change the spreadsheet display (numeric format, draw boxes, shade cells, lock headings, insert and delete extra lines, etc.).

4. As you work, do not hesitate to ask the trainer questions.

Phase 2. Discussion

5. The trainer will invite the groups to share how they have performed this first exercise using the computer together.

6. The participants are expected to provide feedback on this exercise, and point out its strengths and weaknesses, including the instructions and approach used for this exercise.

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Setting up a spreadsheet

I. INTRODUCTION

Excel is a spreadsheet program.

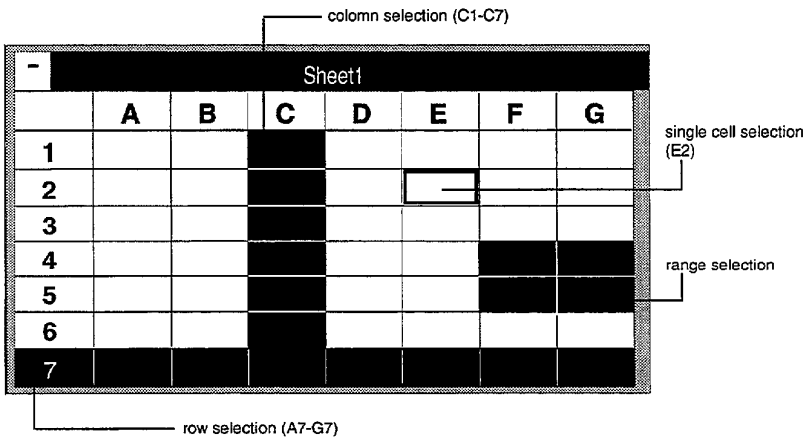
Microsoft Excel is an automated tool for calculations, projections, and data analysis as well as a presentation tool for report the results. The program can be subdivided into five areas:

Worksheets	You can store, manipulate, calculate and analyze data such as text, numbers and formulas on a worksheet.
Databases	You can manage data on a worksheet using standard database operations (not covered here).
Charts	You can present your data visually in a chart. A chart can be created directly on a worksheet or as a separate document in a separate windows.
Macros	Frequently performed tasks can be automated using the macro facility and are stored on a separate macro sheet (not covered here).
Templates	This is a document you create as the basic pattern for other similar documents (not covered here).

Getting started

Double clicking on the Excel icon in the office manager toolbar will bring you into Excel, that is always opening with a new untitled workbook. In a workbook you can keep several worksheets, chartsheets, and visual basic modules.

Worksheet is made up of cells arrayed in rows and columns. A cell can be made active by clicking on it with the left mouse-button.



(An Excel worksheet consists of 256 columns (indicated A through IV) and 16384 rows (indicated 1 through 16384).

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Entering data

You can enter two basic types of data in a worksheet cell:

constant value:	data that you type directly into a cell; it can be a numeric value, including a date or time, or it can be text.
formula:	a sequence of constant values, cell references, names, functions or operators that produces a new value from existing values. Formulas always begin with an equal sign (=).

2. FUNCTIONS

A function is a prewritten formula built in Excel. Formulas are used to perform both simple and complex calculations using data from other cells in your worksheet.

A range in a function is represented by the upper left cell reference and the bottom right cell reference, separated by a colon (:).

Sum-function:	This function returns the total of a range specified between the brackets. The general format is: =SUM(range) or =SUM(upper-left-cell-reference:bottom-right-cell-reference) example: =SUM(A3:D3)
Average-function:	This function returns the average value of a range =AVERAGE(range)
Max-and Min-function:	This function returns the maximum value of a range, the minimum function returns the minimum value of a range. The general format of these two functions =Max(range) or =Min(range)
If-function:	This function returns a value which is the result of a test. This test may be a comparison between two cells. It will either return value X if the test is successful (true) or value Y if the test fails (false). The general format of the IF-function: =IF(logical_TEST,value_if_TRUE,value_if_FALSE)

3. EDITING A WORKSHEET

Copying data

Copying data is duplicating cells and pasting them into another location. If a cell contains a formula, Excel doesn't copy the result of that formula, but the formula itself.

You can copy and paste from the edit menu:

- Select the cells to be copied (the source)
- Choose Edit, copy.
- Select destination.
- Choose Edit paste (or press enter).

When the right mouse-button is pressed a pop-up menu appears into the worksheet.

You can copy with edit fill down/right:

- Select the range, incl. the cells containing data and the cells where you want it to be copied
- Choose Edit, Fill Down or Edit, Fill Right

Moving data

- Select a range to be moved
- Choose Edit, Cut
- Select the upper left corner of the destination
- Choose Edit, Paste

Erasing the cell content

- Select a range to be deleted
- Press the Delete-key

Insert and delete cells, rows and columns

If you try to delete a cell which is referred to by a formula somewhere else in your worksheet, that formula will display #REF, indicating that one or more references in the formula are no longer valid. Formulas referring to cells outside the range to be deleted will be adjusted automatically.

3. FORMATTING A WORKSHEET

Changing the way a worksheet looks is called formatting.

The general principle of formatting is: Always select the cell(s) you want to format first.

Formatting characters

Formatting characters is changing the way characters look, this can be done by using the toolbar or the menus (with the right mouse-button). Changing the font or the font style or size, or the alignment - the position of the text into the cells.

Formatting numbers

To change the way results and values are shown, first select the cells you want to affect and then choose Format Number and select the format you want from the list, or create your own.

General

The following symbols are used in the structure of number formats

0 (Zero)	Indicates a position of a number, if that number is zero, a 0 will be displayed
#	Any number other than zero will be displayed (zero suppression)
.	Decimal period
_	Skip the width of the character
*	Repeat the next character enough times to fill the column width

A few examples:

	Results of format			
Entry	**0**	**0.00**	**###0;(#,##0)**	**#,##0_):(#,##0); "zero";"error"**
2	2	2.00	2	2
-3	-3	-3.00	(3)	(3)
1.45	1	1.45	1	1
105.55	106	105.55	106	106
-2876.85	-2876	-2876.85	(2,877)	(2,877)
0	0	0.00	0	zero
test	test	test	test	error

Currencies

Default format is available in US dollars ($). By replacing the $-sign you can create a format for any currency you want

	Results of format		
Entry	$#,##0; (#$#,##0)	\f*#,##0; (\f*#,##0)	_(\f*#,##0_); (f*#,##0)
2	$2	f 2	f 2
-3	($3	(f 3)	(f 3)
1.45	$1	f 1	f 1
105.55	$106	f 106	f 106
-2876.85	(2,877)	(f 2,877)	(f 2,877)

Changing the column width and row height

Select the columns or rows that need to be adjusted, choose Format Column Width or Format Row Htype the wanted number in and click on OK.

4. FILE HANDLING

It is recommended that you save your work frequently during a session so that your work is not completely lost in the event of a power failure or a hardware problem.

Opening files

- Choose file Open, select the correct file, click on OK, double-click on that filename or press enter.

Saving files

- Choose file save, click on OK or press Enter.

Save as

- Choose file Save As.
- Enter a new name, other than the name of an opened file.
- Click on OK or press Enter.

You can also save it as a different format (eg Lotus 1-2-3 format).

- Choose File Save As.
- Click on the arrow button Save File as Type.
- Select a different file format. Click on OK or press Enter.

Printing

From the Page Setup command you can control printer and page settings such as portrait (vertical paper orientation), landscape (horizontal paper orientation), alignment or margins, headers and footers.

Strengths and Weaknesses

- **Please list what you consider to be three strengths of day two**

1.
2.
3.

- **Please list what you consider to be three weaknesses of day two**

1.
2.
3.

- **Suggestions for improvements**

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Guidelines to Provide Feedback on the Workshop

1. **The Module**

   Content

   - usefulness/relevance
   - amount of information

   Structure

   - sequence
   - duration
   - balance between trainer's and trainee's participation
   - instructions to trainers
   - visual aids
   - handouts, exercises
   - extra readings
   - PAPA
   - evaluation

2. **Process: training techniques and direction**

   - usefulness/relevance/effectiveness
   - group interaction
   - clarity of questions/exercises instructions
   - opening and closure of the days

3. **Trainers', facilitators', and trainees' performance**

   - presentation/communication skills
   - interaction/effective participation
   - punctuality/interest/commitment/willingness to facilitate learning/willingness to participate
   - other attitudes

4. **Logistical support**

   - organization
   - accuracy
   - punctuality
   - willingness to assist participants
   - services provided in general

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5. **Workshop environment**

- physical (training facilities, training material, hotel facilities in general)
- psychological (personal feelings such as self-motivation, interest, satisfaction, self-achievement)
- social (development of friendship, relaxed, comfortable among participants, etc.)

6. **Workshop results/outputs**

- personal and professional assessment
- recommendations

7. **General comments**

FIRST STAGE

PAPA - ideas for action items

Date : _____

Workshop title: SADC/ESAMI/ISNAR Workshop on Priority Setting for Agricultural Research Programs

Date/Venue : _____

Name : _____

Organization : _____

Ideas I would like to try out when I return to work at my research institute, based on what I have learned in this training workshop.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Note: You can use the workshop objectives, what you learn during the workshop, the handouts, conversations with participants and trainers, etc., to come up with ideas.

DAY THREE

Priority Setting for Agricultural Research Programs

DAY THREE — Overview

Objectives

By the end of the day the participants will be able to do the following:

1. Discuss the maps of research target zones.
2. Report on the new tables developed by the working groups during exercise 7 (session 7 in the previous day).
3. Implement a congruency model which prioritizes by magnitude of production.
4. Identify major constraints and then allocate those constraints to major research themes.

Handouts

3.9.1 Overview
3.9.2 Tentative Schedule
3.9.3 Exercise 9. Identifying Research Target Zones (part 2 of exercise 7)
3.9.4 Exercise 9. Worksheet
3.10.1 Application of Congruency Methods (summary of presentation)
3.10.2 Exercise 10. A Congruency Analysis of Sorghum Target AEZ Areas (1,000 ha)
3.10.3 Exercise 10. Spreadsheet
3.10.4 Exercise 10. Worksheet
3.10.5 CIAT's Commodity Evaluation Approach (text)
3.11.1 Defining a List of Program Research Themes (summary of presentation)
3.11.2 Exercise 11. Defining a List of Program Research Themes
3.11.3 Exercise 11. Worksheet
3.11.4 Farmer Participation in Priority Setting (text)
3.11.5 Strengths and Weaknesses of Day Three
3.11.6 Guidelines to Provide Feedback on the Workshop
3.11.7 PAPA Form — First Stage

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Priority Setting for Agricultural Research Programs

DAY THREE — Tentative Schedule

08:30 - 09:00	**Opening of the Day's Activities**
09:00 - 10:30	**Session 9. Maps: Identifying Research Target Zones (part 2 of exercise 7)** (Exercise 9)
10:30 - 10:45	Tea/Coffee Break
10:45 - 11:00	**Session 9. (Continued)**
11:00 - 13:00	**Session 10. Application of Congruency Methods** (Presentation and exercise 10)
13:00 — 14:00 Lunch	
14:00 - 15:30	**Session 11. Identification of Major Research Themes through Constraints Analysis** (Presentation and exercise 11)
15:30 - 15:45	Tea/Coffee Break
15:45 - 17:00	**Session 11. (Continued)**
17:00 - 17:30	**Feedback on the Day's Activities and PAPA**

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Priority Setting for Agricultural Research Programs

DAY THREE — Checklist for trainers

Handouts

		Yes ✔	No ✔
3.9.1	Overview	❒	❒
3.9.2	Tentative Schedule	❒	❒
3.9.3	Exercise 9. Identifying Research Target Zones (part 2 of exercise 7)	❒	❒
3.9.4	Exercise 9. Worksheet	❒	❒
3.10.1	Application of Congruency Methods (summary of presentation)	❒	❒
3.10.2	Exercise 10. A Congruency Analysis of Sorghum Target AEZ Areas (1,000 ha)	❒	❒
3.10.3	Exercise 10. Spreadsheet	❒	❒
3.10.4	Exercise 10. Worksheet	❒	❒
3.10.5	CIAT's Commodity Evaluation Approach (text)	❒	❒
3.11.1	Defining a List of Program Research Themes (summary of presentation)	❒	❒
3.11.2	Exercise 11. Defining a List of Program Research Themes	❒	❒
3.11.3	Exercise 11. Worksheet	❒	❒
3.11.4	Farmer Participation in Priority Setting (text)	❒	❒
3.11.5	Strengths and Weaknesses of Day Three	❒	❒
3.11.6	Guidelines to Provide Feedback on the Workshop	❒	❒
3.11.7	PAPA Form — First Sage	❒	❒

Overheads

3.9.1	Objectives of Day Three	❒	❒
3.9.2	Schedule of Day Three	❒	❒
3.9.3	Objectives of Session 9. MAPS: Identifying Research Target Zones	❒	❒
3.9.4	Note to the Trainer	❒	❒
3.10.1	Objectives of Session 10. Application of Congruency Methods	❒	❒
3.10.2	Congruency	❒	❒
3.10.3	A Congruency Example	❒	❒
3.10.4	What is in a Criterion?	❒	❒
3.10.5	Resource Allocations	❒	❒
3.11.1	Objectives of Session 11. Identification of Major Themes Through Constraints Analysis	❒	❒
3.11.2	Define a List of Alternatives	❒	❒

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	Yes	No
3.11.3 Client Needs, Adoption, Technology Generation	❒	❒
3.11.4 Problem Tree Analysis	❒	❒
3.11.5 Problem Tree Analysis	❒	❒
3.11.6 Low Milk Yields	❒	❒
3.11.7 An Example of Research Theme Identification	❒	❒

Materials

• Overhead projector	❒	❒
• Projector screen	❒	❒
• Flipchart stands (minimum 2)	❒	❒
• Flipchart paper/pads (about 10 per day)	❒	❒
• Markers for writing on newsprint	❒	❒
• Markers for writing on transparencies	❒	❒
• Blank transparencies	❒	❒
• Stapler	❒	❒
• Tape (strong masking tape and regular tape)	❒	❒
• Push pins	❒	❒
• Glue	❒	❒
• Pencils/note pads/pens	❒	❒
• Pencil sharpeners	❒	❒
• Extension cords	❒	❒
• Certificates	❒	❒
• Photocopying facilities	❒	❒
• Spare bulbs for overhead projector	❒	❒
• Extra notepads and pens	❒	❒
• Scissors	❒	❒

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DAY THREE

Session 9
Exercise 9 Maps: Identifying Research Target Zones (Part 2 of Exercise 7/Session 7)

Instructions to Trainers

PRE-SESSION

08:30 – 09:00 Opening of the Day's Activities
– Review of the previous day's activities.
– Summary of the evaluation of the previous day.
– Overview of the day's activities.

OBJECTIVES

By the end of the pre-session the participants will be able to do the following:

- Assess the progress of the workshop.
- List the objectives and describe the agenda for the day's activities.

OPENING

Invite a volunteer to review the previous day's activities. (10 minutes)

Summarize the evaluation of the previous day. (10 minutes)

Distribute the overview and the schedule for day three (handouts 3.9.1 and 3.9.2) to the participants. Review the objectives and schedule, using overheads 3.9.1 and 3.9.2. Ask if clarification is needed. (10 minutes)

SESSION 9

09:00 – 10:30 Session 9. Exercise 9 (part of exercise 7)

10:30 – 10:45 Tea/Coffee Break

10:45 – 11:00 Session 9. (Continued)

OBJECTIVES

By the end of this session the participants will be able to the following:

- Discuss the maps of research target zones.
- Report on the new tables developed by the working groups during exercise 7/Session 7 (previous day).

Use overhead 3.9.3 to present the objectives.

PROCEDURE

Training techniques: presentation of new maps, brief discussion and group exercise. The trainer reports and explains steps that were used to design the new maps. **Note**: make overheads of the new maps to support your presentation.

EXERCISE 9

Exercise 9 (part 2 – exercise 7). Presenting and discussing the research target zones (maps). (2 hours and 35 minutes)

1. Distribute handouts 3.9.3 and 3.9.4. Handout 3.9.3 gives clear instructions for the exercise. Go over the instructions with the participants step by step. Ask if clarification is needed. (5 minutes)
2. **Important!** Divide the participants into the *same groups as in exercise 7*. Ask them to select a rapporteur.

Phase 1. Presentation of maps (5 minutes)

3. Present the maps of research target zones and facilitate a discussion for clarification.

Phase 2. Group discussion and report preparation

4. *(experience)* The groups discuss the results and prepare a report to the audience. As the groups work, circulate from group to group to check progress. Clarify any concerns the groups may have while they are working. Be sure to remind the groups of the time remaining. (45 minutes)

Phase 3. Reporting groups' results and discussion

5. *(process)* Invite the rapporteurs to present the groups' results. Facilitate a brief discussion after each presentation. Each rapporteur has five minutes to present. (35 minutes)
6. *(process, generalize)* At the end of the exercise provide feedback on the content of the discussion and summarize the main issues. Ask the participants questions such as "How did you feel doing this exercise?" and "What did you learn?" (5 minutes)

CLOSURE

Closure (5 minutes)

1. *(application)* Ask volunteers to list the major things they learned from this exercise. These should be things that will improve their performance of priority-setting tasks in their jobs.
2. Make a transition to the next session.

DAY THREE

Session 9
Summary of Overheads

Objectives of Day Three

1. Discuss the maps of research target zones.
2. Report on the new tables developed by the working groups during exercise 7 (Session 7 in the previous day).
3. Implement a congruency model which prioritizes by magnitude of production.
4. Identify major constraints and then allocate those constraints to major research themes.

3.9.1

Schedule of Day Three

08:30 – 09:00	Opening of the Day's Activities
09:00 – 10:30	Session 9. Maps; identifying research target zones (part 2 of exercise 7)
	Tea/Coffee Break
10:45 – 11:00	Session 9. (Continued)
11:00 – 13:00	Session 10. Application on Congruency Methods
	Lunch
14:00 – 15:30	Session 11. Identification of Major Research Themes through Constraints Analysis
	Tea/Coffee Break
15:45 – 17:00	Session 11. (Continued)
17:00 – 17:30	Feedback on the Day's Activities and PAPA

3.9.2

Objectives

Session 9: MAPS: Identifying Research Target Zones

1. Discuss the maps of research target zones.
2. Report on the new tables developed by the working groups during exercise 7 (Session 7 in the previous day).

3.9.3

Note to Trainers

Make overheads of NEW MAPS to support presentation

3.9.4

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Handout - Overview of Day Three

Priority Setting for Agricultural Research Programs

Objectives

By the end of the day the participants will be able to do the following:

1. Discuss the maps of research target zones.
2. Report on the new tables developed by the working groups during exercise 7 (session 7 in the previous day).
3. Implement a congruency model which prioritizes by magnitude of production.
4. Identify major constraints and then allocate those constraints to major research themes.

Handouts

3.9.1 Overview
3.9.2 Tentative Schedule
3.9.3 Exercise 9. Identifying Research Target Zones (part 2 of exercise 7)
3.9.4 Exercise 9. Worksheet
3.10.1 Application of Congruency Methods (summary of presentation)
3.10.2 Exercise 10. A Congruency Analysis of Sorghum Target AEZ Areas (1,000 ha)
3.10.3 Exercise 10. Spreadsheet
3.10.4 Exercise 10. Worksheet
3.10.5 CIAT's Commodity Evaluation Approach (text)
3.11.1 Defining a List of Program Research Themes (summary of presentation)
3.11.2 Exercise 11. Defining a List of Program Research Themes
3.11.3 Exercise 11. Worksheet
3.11.4 Farmer Participation in Priority Setting (text)
3.11.5 Strengths and Weaknesses of Day Three
3.11.6 Guidelines to Provide Feedback on the Workshop
3.11.7 PAPA Form — First Stage

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Handout - Tentative Schedule of Day Three

Priority Setting for Agricultural Research Programs

08:00 - 09:00	**Opening of the Day's Activities**
09:00 - 10:30	**Session 9. Maps: Identifying Research Target Zones (part 2 of exercise 7)** (Exercise 9)
10:30 - 10:45	Tea/Coffee Break
10:45 - 11:00	**Session 9. (Continued)**
11:00 - 13:00	**Session 10. Application of Congruency Methods** (Presentation and exercise 10)

13:00 — 14:00 Lunch

14:00 - 15:30	**Session 11. Identification of Major Research Themes through Constraints Analysis** (Presentation and exercise 11)
15:30 - 15:45	Tea/Coffee Break
15:45 - 17:00	**Session 11. (Continued)**
17:00 - 17:30	**Feedback on the Day's Activities and PAPA**

Exercise 9. Identifying research target zones (part 2 – exercise 7) (group exercise)

Note: This is exercise 7 continued. The results of this exercise will be used during some of the following sessions.

1. Form the *same groups as in exercise 7* and select a rapporteur.

Phase 1. Presentation of maps (5 minutes)

2. The trainer presents the maps of research target zones and facilitates discussion for clarification.

Phase 2. Group discussion and report preparation (45 minutes)

3. Discuss the results and prepare a report to present to the audience.

4. The rapporteurs discuss items related to the new tables developed by the group members (exercise 7) to explain the reasons for choosing the criteria.

Phase 3. Reporting groups' results and discussion (40 minutes)

5. The rapporteurs present the results of their group to the audience. Each rapporteur has five minutes to present.

6. The trainers will invite you to discuss the groups' responses and provide feedback on the content of the presentations.

Exercise 9. Worksheet

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DAY THREE

Session 10
Application of Congruency Methods

Instructions to Trainers

SESSION 10

11:00 – 13:00 Session 10. Application of Congruency Methods

RATIONALE

The magnitude of production is often the crucial factor for setting research priority.

OBJECTIVE

By the end of this session, the participants will be able to do the following:

- Implement a congruency model which prioritizes by magnitude of production.

Use overhead 3.10.1 to present the objective.

PROCEDURE

Training techniques: presentation, group exercise.

PRESENTATION

(*experience*) Give a brief presentation on congruency methods. Four overheads support the presentation: 3.10.2 through 3.10.5. At the end of the presentation distribute handout 3.10.1 and be sure to ask the participants if they have any comments or questions or if they need clarification. (15 minutes)

EXERCISE 10

Exercise 10. A congruency analysis of sorghum target AEZ areas (1,000 ha). (1 hour 40 minutes)

1. Distribute handouts 3.10.2, 3.10.3, 3.10.4, and 3.10.5. Handout 3.10.2 gives clear instructions for the exercise. Go over the instructions with the participants step by step. Ask if clarification is needed. (5 minutes)
2. *(experience)* Assist participants while working in groups. Remind them of the time allocated. (60 minutes)
3. *(process)* Invite the rapporteur to present the gruop's results. Facilitate discusion after each presentation. Each rapporteur has about five minutes to present and you have enough time to summarize the main difficulties encountered during the exercise. (30 minutes)

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CLOSURE

Closure (5 minutes)

1. *(application)* Ask volunteers to list the major things they learned from this exercise. These should be things that will improve their performance of priority-setting tasks in their jobs.
2. Make a transition to the next session.

13:00 – 14:00 Lunch

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DAY THREE

Session 10
Summary of Overheads

Objectives

Session 10: Application of Congruency Methods

3. Implement a congruency model which prioritizes by magnitude of production.

3.10.1

Congruency

In congruency analysis, research priorities are linked directly to an indicator; (e.g. value of production, area planted, or number of farmers affected).

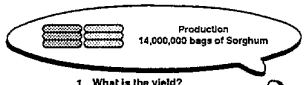
3.10.2

A Congruency Example

Maize Zone	Production (000 mt)	% of Total	Priority Ranking
1	200	20.0	3
2	50	5.0	4
3	470	47.0	1
4	280	28.0	2

3.10.3

What is in a Criterion?



1. What is the yield?
2. Input levels used
3. Amount of rainfall
4. Type of farmers
5. Infrastructure
6. Transporters
7. Agricultural credit (access to)
8. Solar radiation
9. Soil type
10. Farm implementation

3.10.4

Resource allocations may be proportionally to size of indicator or to several highest ranking indicators.

3.10.5

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Application of Congruency Methods (summary of presentation)

1. In **congruency analysis** the importance of a research subject depends on the size of one indicator. The indicator may be value of production, area planted, or number of people earning income from a product. If commodity A has double the value of commodity B, the amount of research resources allocated to A would be double the amount to B. Congruency analysis delivers not only a priority but also a budget allocation. Congruency analysis is transparent, simple and cheap to apply, but its theoretical logic is poor. Though in principle the discriminating potential is clear, it is very doubtful that people will accept the outcome immediately. Rather, it becomes the basis for discussion.

2. Congruency analysis is often used as the basis for reducing the number of alternatives to be analyzed with more vigorous priority setting methods.

Exercise 10. A congruency analysis of sorghum target AEZ areas (1,000 ha) (group exercise)

1. Form *groups as in exercise 7* and elect a rapporteur.

2. Read handout 3.10.4.

3. Take Kenya Sorghum program as an example. Use handout 3.10.3 to complete this exercise.

Phase 1. Group work (60 minutes)

4. Change the production allocation based on the new map (developed in exercise 7 and 9).

5. Rank the zones (identified in exercise 7 and 9) in the following way:
   a. Set up a spreadsheet
   b. Calculate new area and production level within your target zones.

Phase 2. Reporting and discussion (30 minutes)

6. Rapporteurs present the groups' results to the audience.

7. The trainer summarizes the main difficulties encountered during this exercise.

Exercise 10: A Congruency Analysis of Sorghum Target AEZ Areas											
				Potential Area by District							
	Total	Potential		**Turkana**		**Marsabit**		**Mandera**		**Wajir**	
	Cells	% Area									
Total	3667	100.00		456							
					% Area		% Area		% Area		% Area
ZONE 1	871	23.75		0	0	67	15.5814	5	100	2	3.703704
ZONE 2	2796	76.25		456	100	363	84.4186	0	0	52	96.2963
CBA Area Average 1990-93 (1000 Hectares)	336.01			23		43.7		6.5		34	
CBS Production Average 1990-93 (1000 Tonnes)	147.3			12		24.5		2.1		29	
Imputed Area by Zone											
		% Area									
ZONE 1 (1000 Hectarea)	16.40148	6.11		0		6.80907		6.5		1.259259	
ZONE 2 (1000 Hectares)	252.2185	93.89		23		36.89093		0		32.74074	
Imputed Production by Zone											
		% Production									
ZONE 1 (1000 Metric Tonnes)	7,519667	6.82		0		3.817442		2.1		1.074074	
ZONE 2 (1000 Metric Tonnes)	102.7003	93.18		12		20.68256		0		27.92593	
Imputed Yield by Zone											
ZONE 1 (Tn/Ha)	0.458475										
ZONE 2 (Tn/Ha)	0.407188										

Exercise 10. Worksheet

CIAT's Commodity Evaluation Approach[1]

Having reviewed the various research prioritization methods, two decisions were taken. It was decided that the economists' interventions should concentrate more on data analysis and less on interpretation with respect to CIAT's objectives. In designing the commodity evaluation procedure, value judgements could be avoided in all but two cases, which will be discussed later. Where results of the analysis were interpreted, we will try to expose our values as clearly as possible. Second, it was decided that no single method was sufficiently versatile to be used alone, and that most methods had something to offer to the commodity analysis. We therefore adopted a blend of different methods.

Even restricted to a Latin American context, the commodity options were numerous. A two-step analysis was thus conducted. Commodities were first scored on a small number of simple criteria and some were eliminated using a hierarchical prioritization process. Remaining commodities were submitted to in-depth analysis. The determination to discard certain commodities involved a straightforward policy judgement.

A single benefit-cost criterion, as favored by Ryan (personal communication) or a single congruency analysis as applied by McIntire (1985) were too limited to express the different commodities' roles. Instead, we developed criteria for each of the four principle objectives, growth, equity, sustainability, and institutional complementarity. Selection of the final evaluation criteria involved another policy judgement, which was made together with CIAT's management.

Although we opted against a single criterion, agricultural research should be regarded as a long-term investment, and benefit-cost assessments should form the backbone of the analysis. There were no conceptual problems developing a benefit-cost analysis framework with respect to economic growth and equity, although we felt nutrition, employment, and expected future value of the commodity were not adequately addressed. In terms of sustainability and institutional considerations, the investment concept is not as clear or easily applicable, and other criteria were sought.

Scores for the commodities on some criteria could be obtained from original data sources. To score for other criteria, we used a partial equilibrium model as well as a simple general equilibrium model. Most of the data needed for these models were gathered by the economists.

Several critical parameters of an essentially subjective nature, such as expected supply shift in the event of successful research, lead time of research, and speed of technology adoption, were determined in consultation with commodity experts. Whenever possible, the commodity's economic and technical prospects were discussed with an expert. In addition, a questionnaire was developed to elicit judgements on likely type and rate of technical change in a certain commodity as the result of CIAT research. The questionnaire was sent to several specialists for each commodity. Response rate was almost 20% (to date). For sorghum, soybeans, and cotton, the responses formed the basis for subsequent adjustments. In general, we are confident that the information collected provided us with a good estimate. Data for bananas and plantains, though,

1. **Extract from**: Janssen, W. 1990. Trends in CIAT Commodities 1990. Working Document No. 74, pages 4-6, 18. Cali, Columbia: Centro Internacional de Agricultura Tropical.

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should be viewed with care, since little specific information could be obtained on technical changes.

The methodology used can thus be summarized as an initial hierarchical screening process, followed by a multiple criteria model, premised on a benefit-cost analysis using estimates derived from consultations with commodity experts. The intention is to provide clearly interpretable data on potential research benefits in the aggregate, and to different target groups, with the incorporation of additional criteria to support or challenge results of the benefit-cost analysis. The different criteria were not weighted, however.

It should be noted that methodology and model development, data collection, data processing, and reporting occurred in about four months. This is very short and necessarily led to cutting corners on some issues. From a center's management and planning perspective, though, this time frame is favorable. The process is rapid and flexible, and misconceptions by the data analysts can be corrected at a low cost of time invested.

Commodity Screening

Based on communication between CIAT's management and economists, 18 commodities were selected for initial screening: bananas, beans, beef, cassava, citrus (lemons and oranges), cocoa, coffee, cotton, groundnuts, milk, palm oil, pineapple, plantains, rice, rubber, sorghum, soybeans, sugar, vegetables (onions, snap beans and tomatoes) and wood products. These commodities are agricultural products, in the sense that land is a principal factor in their production. Marine products, eggs, poultry, and pork were excluded for this reason. Beef and milk production can also be divorced from the land, but in Latin America they are normally land- dependent.

These commodities were screened for three criteria: (1) value of production within Latin America, as a measure of the commodity's significance; (2) Latin America's share in total developing world production, to determine if research in Latin America could truly contribute to scientific progress; and (3) level of research effort by national programs and producer organizations, to evaluate the merits of international research.

For value of production and Latin America's share of total developing world production, data developed for TAC by Davis, Oram and Ryan (1989) were used. As the authors admit, this data set could be improved on, but it is, nevertheless, adequate for the initial screening process. Assessing the merits of international research was based on our collective in-house knowledge of the strength of public-and private-sector research programs in Latin America.

Table 1 shows the outcome of the screening process. Because of their low production value, cocoa, ground nuts, palm oil, pineapple and rubber were discarded. Coffee and sugar were also discarded because producer organizations have strong research programs. Wood products were not eliminated as such, but the relevance of (agro)forestry research depends more on CIAT's future emphasis on land use rather than on the actual value of wood products.

Table 1. Outcome of initial screening of commodity options.

	Value of L.A. production (million US $)	% of total developing world production	Decision taken[a]
Beans (*Phaseolus*)[b]	4,131	61.30	I
Beef	10,023	61.94	I
Cassava	6,209	21.76	I
Citrus (oranges + lemons)	7,302	61.95	I
Cotton	2,700	14.13	I
Milk	11,845	30.40	I
Plantain/Banana	9,530	39.53	I
Rice	4,070	6.59	I
Sorghum	1,716	33.21	I
Soybeans	6,214	64.34	I
Vegetables[c]	1,887	21.68	I
Cocoa	1,443	35.08	V
Coffee	11,930	65.81	M
Ground nuts	340	4.73	V
Palm oil	118	4.48	V
Pineapple	417	24.15	V
Rubber	70	1.38	V
Sugar	3,701	50.46	M
Wood	24,815	20.80	L

a. I = Included for further analysis. V = Discarded because of low value of production. M = Discarded because of apparent lack of merit of international research. L = Decision depends on CIAT's position with respect to land use research.
b. For beans, value in other target regions included Africa, West Asia and North Africa, and Asia for cassava.
C. Snap beans, tomatoes, and onions.

Source: Data prepared for TAC by Davis, Oram, and Ryan (DOR).

Notes: Beans: DOR-data do not distinguish between *Phaseolus* and non-*Phaseolus*. Data presented are farm-gate value as estimated by Janssen, Sanint, and Sere (JSS) for 1989 presentation in CIAT's annual review. Snap beans: Estimates by Henry and Janssen for Snap Bean Economic Study, 1989. Rice: Value for L.A. corrected with JSS calculations.

DAY THREE

Session 11
Identification of Major Research Themes through Constraints Analysis

Instructions to Trainers

SESSION 11

14:00 – 15:30 Session 11. Identification of Major Research Themes through Constraints Analysis

15:30 – 15:45 Tea/Coffee Break

15:45 – 17.:00 Session 11. Continued

RATIONALE

The lists of research program themes which will be prioritized (along with target zones) must be identified early in the prioritization process.

OBJECTIVE

By the end of this session, the participants will be able to do the following:

- Identify major constraints and then allocate those constraints to major research themes.

Use overhead 3.11.1 to present the objective.

PROCEDURE

Training techniques: presentation, group exercise.

PRESENTATION

(*experience*) Give a brief presentation focusing on identification of major research themes through constraints analysis. Six overheads support the presentation: 3.11.2 through 3.11.7. At the end of the presentation distribute handout 3.11.1 and be sure to ask the participants if they have any comments or questions, or if they need clarification. (15 minutes)

EXERCISE 11

Exercise 11. Defining a list of program research themes. (2 hour 25 minutes)

1. Distribute handouts 3.11.2, 3.11.3, and 3.11.4. Handout 3.11.2 gives clear instructions for the exercise. Go over the instructions with the participants step by step. Ask if clarification is needed. (5 minutes)

Phase 1. Group work

2. *(experience)* The same groups will work in this exercise. The Groups write the answers to the four questions asked in handout 3.11.2, on handout 3.11.3. (1 hour 10 minutes)

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Phase 2. Reporting

3. *(process)* Invite the rapporteur to present the groups' results. Facilitate a brief discussion after the presentation of all rapporteurs. (60 minutes)
4. *(process and generalize)* Summarize main issues and ask participants feedback on the exercise. (10 minutes)

CLOSURE

Closure (5 minutes)

1. *(application)* Ask the participants to tell one of their neighbors two things they might do differently in their job as a result of what they learned in this exercise. Choose some volunteers to give samples.
2. Make a transition to the last session.

17:00 – 17:30 Feedback on the Day's Activities and PAPA

OBJECTIVES

By the end of this session participants will be able to do the following:

- Provide feedback on the day's activities.
- Consider possible actions they would like to implement in their own organizations.

PROCEDURE

Training technique: individual exercise.

Highlight positive and negative points of the day. Note areas that may need additional attention in the workshop. Participants can write some strengths and weaknesses of this day on handout 3.11.5, and use handout 3.11.6 to facilitate their task. (15 minutes)

PAPA

(application) Ask the participants to take some time to jot down some "action ideas" they may have for themselves as a result of today's activities. They can use handout 3.11.7. (15 minutes)

DAY THREE

Session 11
Summary of Overheads

Objectives

Session 11: Identification of Major Themes Through Constraints Analysis

4. Identify major constraints and then allocate those constraints to major research themes.

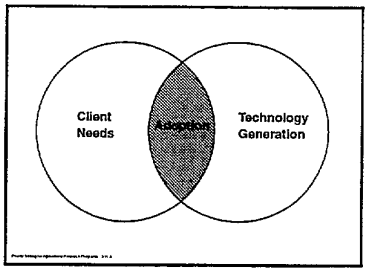
3.11.1

Define a List of Alternatives

Methods:

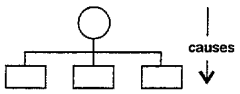
- Brain storming
- Problem-tree analysis
- Exhaustive listing

3.11.2



3.11.3

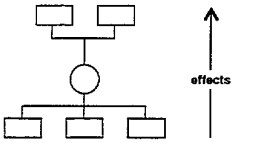
Problem Tree Analysis



The substantial and direct *causes* of the core problem are placed parallel to each other *underneath* the core problem

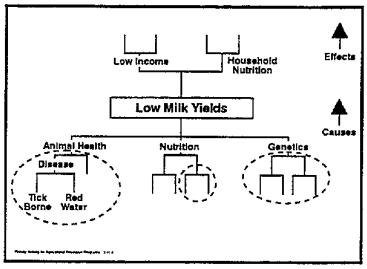
3.11.4

Problem Tree Analysis



The substantial and direct *effects* of the core problem are placed parallel to each other *above* the core problem

3.11.5



3.11.6

An Example of Research Theme Identification

Crop: Maize
Zone: Low-land tropics

Theme: Crop management

Constraints (ranked):
- Weed control under high rainfall and temperature
- Poor fertility on sandy soils
- Poor stand establishment (in intercrop)

3.11.7

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Defining a List of Program Research Themes (summary of presentation)

1. Research impact derives from the adoption of research technologies. Adoption occurs only when client needs for technologies overlap with the technologies generated by research.

   Therefore, in order to have a demonstrable impact, programs must be formulated to address client needs and constraints.

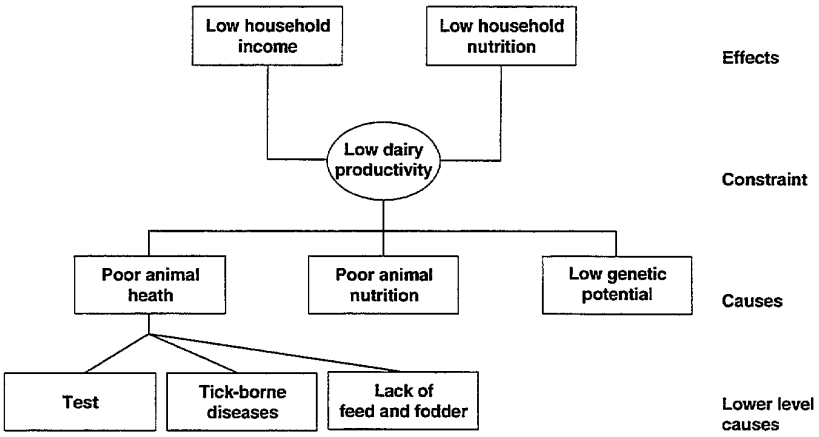
2. Constraints, and research themes addressing those constraints, can be identified through informal methods such as brain storming and exhaustive listing or formal methods such as problem-tree analysis.

   However, good informal survey (PRA, RRA) information and or formal survey information is a prerequisite for any analysis of farmer constraints.

3. Problem tree analysis lets us analyze constraints in terms of causes and effects.

   The direct causes of a core problem or constraints are placed parallel to each other underneath. The direct effects of the core constraint are placed parallel to each other above the core problem.

   Example



4. Research themes group constraints which can be addressed by a common thrust within a research program.

5. This session will assist participants to identify major constraints and then group those constraints into major research themes.

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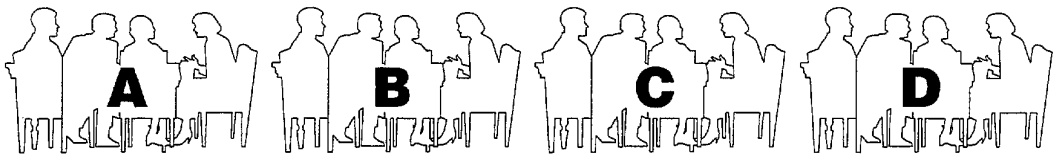
Exercise 11. Defining a list of program research themes (group exercise)

1. Form the same four groups as in earlier sessions. Elect a rapporteur.



Phase 1. Group work (1 hour 10 minutes)

2. Read handout 3.11.4.

3. Use the table in handout 3.11.3 to answer the following questions:

   (a) Identify sources of information on constraints (e.g., surveys, extension workers).
   (b) List major constraints to sorghum production and utilization in your identified research zones.
   (c) Which constraints are researchable?
   (d) Identify three major research themes which address the major researchable constraints through problem tree analysis.

Phase 2. Reporting (1 hour 10 minutes)

5. Rapporteurs record responses made by their group members, prepare a flip chart and present the results of the groups' discussions to the audience.

6. The trainer will summarize the groups' results, emphasize the lessons learned and close the session.

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Exercise 11. Worksheet

(a) Sources of information	
(b) Major constraints	
(c) Researchable constraints	
(d) Three research themes	1. 2. 3.

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Farmer Participation in Priority Setting[1]

Farmer participation in farming system research and development (FSR&D)

Active participation by farmers creates several advantages for FSR&D. *First*, by definition the purpose of FSR&D is *to improve farming systems by working directly with farmers* to generate workable and economically feasible solutions to farm problems. If farmers are not active participants in that process, if they do not feel a part of the solution to their own problems, then it is unlikely that they will adopt the technologies recommended by the FSR program. Scientists do not have to live with the results of their technologies, but farmers do. By involving farmers from the beginning as 'watchdogs' for the research process, success is enhanced. Farmers, therefore, are central to the process and must not be relegated to a minor role.

Second, farmers possess substantial local knowledge about problems and resources, including the plants, soils, and animals in their regions. The old assumption that scientists' knowledge is unequivocally superior to that of farmers has been abandoned in the past few years. No longer do we look upon traditional agriculture as a primitive, backward production system destined to be replaced by modern farming before 'progress' can advance. Scientists have now realized that it is cost-effective to build on this indigenous knowledge, rather than trying to supplant it altogether. In many tropical areas, traditional agriculture has persisted for centuries, allowing human groups to meet their basic physical and social needs. Often such traditional systems operate with minimal energy inputs, are capable of withstanding major external disturbances (both ecological and economic), and are managed by people whose goal is integrating complex biological and social components, rather than simply increasing the yield of single crop or animal components.

Third, farmers are known to be active innovators, experimenters, and seekers of new knowledge in their own right. Prehistoric farmers invented agriculture itself; in the process they selected and domesticated all the major and minor food crops which humankind still uses to survive today. Even in the modern era, farmers continue to contribute to science — not only specific technologies (e.g. agronomic techniques) but sustainable systems (for example, farmers have practiced agroforestry for centuries). Many 'improved' technologies being promoted by international agriculture research centers are in fact farmer-derived. A study in the 1970s documented that most of IRRI's rice technologies were in this category (Goodell, 1981). The classic case of diffused light storage was a technique CIP scientists learned from farmers and then helped spread to other farmers.

Fourth, only farmers can bring realistic 'holism' to a research project. FSR scientists and extension workers are often justifiably focused on the technical matters at hand. However, 'technology' is only part of the story. Important political, social, and even religious concerns affect farmers, who must weigh technologies within a broader framework of 'life'. *Higher farmer productivity and economic efficiency may be the goal of an FSR team, but may not be the highest ranking priority of farm households.*

1. **Extracted from**: Douwe Meindertsma, J., editor. 1994. Setting Research Priorities towards effective farmer-oriented research. Amsterdam: Royal Tropical Institute. Article by Robert E. Rhoades.

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Roles of farmers

A farmer can serve in many roles: advisor, colleague, student, and extension agent (farmer-to-farmer, or farmer-to-scientist). FSR teams that are open to farmers will benefit, because they approach the research process in an honest and direct manner. Farmers are no fools; they are quick to see through superficiality, and detect when scientists are missing the point or promoting ill-conceived technologies. On the other hand, farmers respond positively to open, direct researchers who make it crystal clear what they know (e.g. disease) and what they do not know (e.g. local conditions). In such an open dialogue, the role of the farmer will vary in relation to the knowledge and expertise of an FSR team. Clearly, though, farmers may not understand that an aphid in the stored seeds is the vector of a virus that hits the field several months later. The theory, or even the concept, of disease may not be understood. In this case, the farmer is a student, usually eager to learn and try new ideas. In another case, perhaps the FSR team will be unaware of the complex field rotation system in a community, but they need to know how a new practice would fit in. This time the farmer becomes the teacher, the one who gives knowledge. Finally, the farmer can be a colleague: the parties may join each other in trying new technologies or researching a question of common interest. This partner relationship is perhaps the most fruitful possibility, but is the one mutual role that is least fostered. Scientists may have a difficult time accepting 'uneducated' farmers as equals or as 'experts' in their own right.

Organizing farmer participation

Strategies for understanding farmers' problems

Admitting that a team needs to understand farmers' problems is only the first step; arriving at an operational and effective strategy is a more difficult issue. In my opinion, it is not only the research tools that must be relevant (see next section), but also the overall model of research guiding the interaction between the FSR team and farmers.

One of the most widely used models for farmer-scientist interaction is 'farmer-back-to-farmer', which was formulated at the International Potato Center in the early 1980s (Figure 1). This model was based on the premise that agricultural research and development must both begin and end with farmers — that they must be involved at all stages, from diagnosis to evaluation of results. Variants of this model have been proposed over the past decade, including farmers first (Chambers et al., 1989), farmer participatory research, and people first (Cernea, 1985). However, the underlying assumption — that farmers are active participants, not passive, in the technology generation process — remains the same. The model requires a 'psychological flip' in which scientists' standard philosophy of 'techno-scientific salvationism' (that is, the idea that scientific technology alone will solve our problems) gives way to a more humanistically based orientation that accords respect and appreciation to traditional indigenous knowledge and practices. If an FSR team is able to make this shift, then the next steps of research execution will be manageable, although never easy.

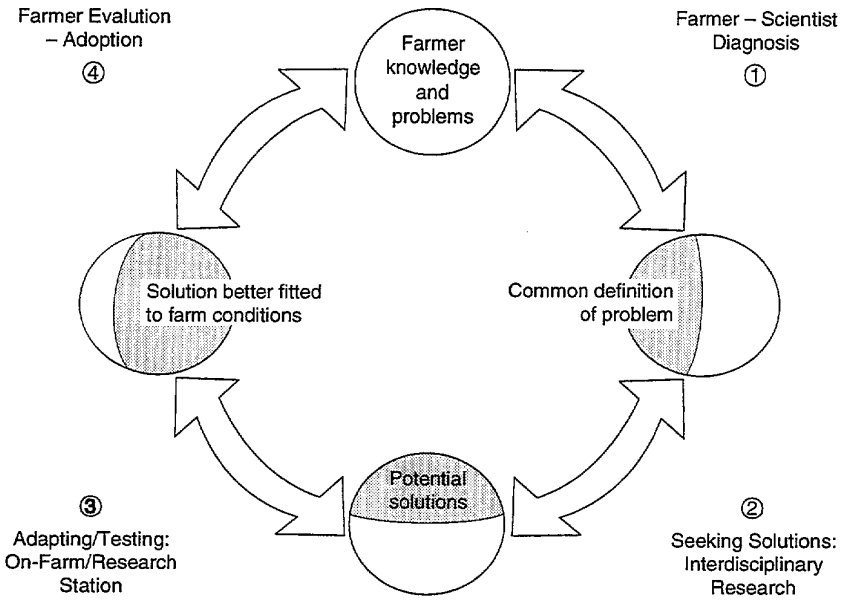
Appreciating farmers' priorities

Priority means 'precedence in order or rank'. However, it should be realized that there are several dimensions to farmers' priorities. First of all, for farm households around the world farming is a means to an end, not the end in itself. Therefore, the aim of farming is to provide needed food for the family or cash to buy items or services not produced on the farm. The basic priorities of farm households are happiness, health, and hope, especially for their children. Farming research teams sometimes over-estimate the importance of technical priorities (increasing production)

believing that farmers are likewise equally concerned. Sometimes a village would rather hold a festival than attend a series of experiments.

A second point is that, even within the farming enterprise, there are difficult priorities for each major activity (e.g. herding, cultivation, irrigation, marketing, etc.).

Figure 1. Farmer-back-to-farmer



The farmer-back-to-farmer model begins and ends with the farmer. It involves four major activities, each with a goal. The shaded areas in the circle indicates an increasing understanding of the technological problem are as research progresses. Note that research may constantly recycle.

Activities	Goals
1. Diagnosis	Common definition of problem by farmers and scientists
2. Interdisciplinary team research	Identify and develop a potential solution to the problem
3. On-farm testing and adaptation	Better adapt the proposed solution to farmer's conditions
4. Farmer evaluation/adaptation	Modify technology to fit local conditions: understand farmer adoption

The few studies that have compared farmers' priorities with those of agricultural researcher/extension agents illustrate that their perceptions of the problems differ significantly. Farmers asked to respond to an open-ended question by ranking their problems generally begin with items such as low prices, lack of credit, shortage of labor, and drought; and end with technical problems of disease, poor soils, etc. Agricultural scientists, however, generally reverse this order, placing technical issues high while undervaluing the other items. This is one of the reasons the farmer-back-to-farmer model is so important; it requires that a 'common definition' of the problem be mutually identified from the start (stage 1 in the figure).

Finally, there is a third dimension, so that even if farmers and FSR scientists agree on a list of priorities, it must be realized that economically feasible solutions do not exist for all problems.

Furthermore, problems and hence priorities shift through time, and priorities are systematically linked to each other. In the light of this complexity, the key to getting a better understanding of farmers' priorities lies in a process of continuous feedback. Again, this is the essence of the farmer-back-to-farmer model. At any point in the research cycle, it may be necessary to return to a previous stage (for example, moving from experimentation back to diagnosis) if the research activity is not producing new results or testable hypotheses. It is this willingness to be flexible, humble, and tenacious that will lead to a proper understanding of ever-changing priorities.

Involving farmers in all stages

Farmers will enthusiastically be involved at all stages if they have a vested interest in the outcome. Fostering this strong interest will only be possible if researchers stay close enough to farm conditions to work on well-defined problems that are truly priorities for the farmers themselves. There are many interesting research questions that are fascinating to scientists, but which are of limited interest to farmers (e.g. chemical fertilizer trials where the fertilizers are unavailable or too expensive). Scientists frequently design technologies (often in laboratories or experiment stations) and then send the technologies out (through an extension agency) in search of farmers and their problems. Such technologies rarely find the problem they were designed to solve.

A research team that wants to guarantee that farmers will be involved in all stages, from diagnosis through evaluation — that is, to guarantee continuous farmer input — should ask themselves the following seven questions:

- Is the problem(s) to be solved important to farmers?
- Do farmers understand the farming systems project and its goals?
- Do farmers have the time, inputs, and labor required by the improved technology?
- Does the proposed technology fit the present farming system?
- Is the mood in a region favorable to investing in new technologies or crops?
- Is the proposed change compatible with local preferences, beliefs, and/or community sanctions?
- Do farmers believe the technology will hold up over the long term?

By checking off these seven questions as they go through the research-diagnosis process, the team will get a general idea as to whether farmers will be interested. For example, if a large shipment of wheat from a foreign country has just been dumped in the country's port city, so that prices have been depressed, it is not likely farmers will be putting a great deal of emphasis on wheat technologies.

In addition to asking the seven key questions, the research team must become acquainted with local customs and social habits. Although it is not necessary to 'go native', the team must be willing to participate in village festivals. Team members should learn the local language, live as close to rural conditions a possible, and get to know the farmers as individuals. In the FSR process, there can be no substitute for 'missionary zeal' and close contact with clients.

Deciding which farmers should participate

No farming community in the world is homogeneous. There are rich and poor farmers, young and old, men and women, and even ethnic differences within a single region. There are farmers who are well educated and others who are illiterate. Some live near a road or village, while others

are far away in the hinterland. Deciding with whom one should work is a major early decision for the FSR team.

The target group of farmers depends on the objectives of the FSR project. The objective may be, for example, to work only with the poorest of the poor. Other projects may focus specifically on particular 'components' or 'subsystems' (livestock, poultry, home gardens, and so forth). In most cases, the general problem will have been predefined by the donor agency, which is apt to have special interests. They will provide funds for an FSR team that will address, for example, poverty among rural households in the Sahel; or low productivity in a shifting cultivation system in the Amazon Basin. Rarely do FSR projects go into the field first, inquiring into the problem and asking farmers to define their needs.

However, once the general constraints on farmer selection are set, the team needs to consider carefully with which individuals and with which group of farmers they should participate. In some areas of the world where farmers are organized into tightly knit groups, the farmers (or their leaders) will decide where and with whom the team will work. Normally, however, the team — after working through the local governmental bureaucracy — will be faced with the choice of which household and communities will be their research field.

At this point in the diagnostic phase, it must be realized that each set of farmers (however delineated) will have its own priorities. This diversity can be understood and minimized by selecting research topics that will affect the majority of farmers (focusing, for example, on marketing or a common cropping pattern). Or a sort of sociogram can be constructed for the village, which can be used to describe different points of view.

One technique I have commonly used to set priorities is to study a community in terms of agroecological analysis. Social groupings frequently correspond to specific agroecological zones. For example, large, wealthy farmers may live in the center of a valley, while poor, resource-limited farmers live on the margins. A team can look at how much production comes from the valley center, how many farmers will be impacted by potential research, and how their livelihoods will be affected. There may be trade-offs: one can produce more food volume in the valley center (and thus lower consumer prices in the town), but income and nutrition might be enhanced more if you work on the margins. These are tough questions, and they can only be answered if one knows the social dynamic and the environmental relationships.

As may be apparent, the final decision about which farmers or groups of farmers an FSR team is to work with will nearly always be based on a myriad factors, including convenience, funds, outside constraints, farmer willingness, and researchers' needs.

Tools for achieving farmer participation

For the conventional approach, there is an established sequence of methods that has been outlined in FSR manuals (the CIMMYT manual being the most famous). This sequence, which has advantages and disadvantages, involves collecting background literature and reviews about the region; an informal survey; a formal questionnaire; on-farm trials' recommendations; and follow-up and evaluation of adoption. In reality, teams do not always follow this sequence exactly. However, the 'on-farm trial' is typically the heart of the sequence, and most of the research process is dedicated to finding out what on-farm trial or technology should be tested with farmers. The strengths and weaknesses of some frequently used information-gathering tools for use in applied agricultural research are shown in Table 1.

Table 1. Strengths and weaknesses of information-gathering tools for use in applied agricultural research

Tool	Strength	Weakness
Literature review	Helps prevent 'reinventing the wheel'	Requires time and access to good libraries
Maps, meteorological data, statistical publications	Provide background data on agricultural sector	May be inaccurate or too 'macro'
Informal surveys	Provide rapid overview of land use and farming practices	Allow little quantification; outsiders may consider data 'soft'
Direct observation	Helps avoid problems such as farmer recall, and need to interpret verbal responses	Logistical (transport) problems and small sample size
Formal survey	Quantification; large sample size	Costly; time consuming; and computer-intensive
On-farm experiments	Allow technologies to be tested under farmers' conditions	Very costly; small sample size; require at least one full crop season; logistical problems

A new approach

Although we declare that farmers have always been central to FSR, and we are philosophically committed to the ethics of farmer involvement, I believe that the bankruptcy of social science methods used by FSR teams has defeated the reality of true farmer participation. Elsewhere, I have written about what I call the coming revolution in agricultural research methods (Rhoades, 1990). In this chapter, I argue that FSR has based its work on the philosophical position of 'empiricism', and more specifically on 'scientific positivism', which posits that human social and economic actions can be studied using the models of the physical sciences. This means that we must count and measure just as in chemistry and physics. 'Positivism' can be traced back to the French sociologist Auguste Comte, who wanted to reduce human behavior to scientific principles so that would be come predictable. The questionnaire-based survey was the instrument designed to capture and quantify human behavior. Jackie Ashby of CIAT has noted that the use of the questionnaire has become a major 'industry' in Third World agriculture. However, by its very nature, the questionnaire (and even the single short survey or the informal survey) and the desire to assign numbers to things plant major barriers between scientists and farmers.

What are the options if the old, linear sequence (informal survey ⇒ formal survey ⇒ on-farm trial ⇒ evaluation ⇒ recommendation/feedback) is no longer viable. First, I argue that we need to make a 'psychological flip' in the way we look at research with farmers. Second, I argue that we need to expand our tool kit of methods, drawing on a vast array of methods beyond the survey questionnaire.

The idea that we scientists do 'research' while farmers 'farm' is only partially true. Farmers also do research, and although these priorities may change quickly, they set priorities and determine priority problems. The evidence is overwhelming that farmers are excellent experimenters and researchers in their own right. After all, farmers have created the world's complex farming systems, domesticated all major crops, invented most farming tools, and designed intricate irrigation facilities. The problem has been that we scientists have not been very creative in learning how to harness the research potential of farmers.

At the base of FSR's lack of imagination in dealing with farmers is lack of awareness of the differences between farmers' research methods and 'scientific' research. Farmers have their own ways of calculating, counting, recording, remembering, and predicting. These, however, often do not involve pencil and paper, two items farmers may be uncomfortable with. Modern, urbanized ('Westernized') humans lost many important skills of their ancestors as they began to place greater value on rational and empirical abilities, while emotional and other capabilities have lost their sharpness. Tribal and rural populations in Africa and Asia, however, have not lost these abilities. Moreover, detailed, unwritten oral histories stretching back 10 generations can be related with great precision. Market women can estimate the weight of produce down almost to the gram without weighing it. Indonesian waiters in town restaurants, who may be illiterate, can take and remember precise meal orders for dozens of people without writing down a single item. This is not to argue that these capabilities are 'superior' to our own pencil (now computer) and paper skills, but to note that they are different; and once tapped, they can yield enormous insights and 'data' about farmers' problems and priorities.

The best way to portray the new methodology of farmer-participatory research is to imagine a cafeteria of tools and skills. The cafeteria is a rich one with many and varied techniques to select from, but they are not in any particular order. Among the dozens of selections you will find a conventional questionnaire on on-farm trial, but they will be no more special than the rest. What more will we find? The sampling in Table 2 points out a few of the techniques that can be used with farmers to set priorities.

Table 2. Strengths and weaknesses of selected methods of participatory research

Method	Strength	Weakness
Participatory mapping – resource mapping – social mapping	Provide local view of spatial relationships; fast, inexpensive	Context specific; not 'scientific'; scale problems
Physical models	Gives local understanding of spatial relationships	Expensive; time consuming; scale problems
Interactive visual aids (insect box, sack of seeds)	Uses context; not misunderstanding of discourse item	Limited use
Farmer flow diagrams and pie charts	User-generated; nontraditional concepts	Recall difficulties, not precise
Matrix and preference ranking	Insider precision	
Group interviews	Group dynamics and correction of individual bias	Logistics; group control
Time lines and oral histories	Time depth qualitative data; context	Requires time; questions of generalizability
Group treks	Direct observation; open interaction	Logistics; time required
Traditional games	Easy interaction; openness; culturally sensitive	Outsiders' lack of knowledge; difficult to interpret

While it is clear that no one of the techniques alone will provide enough information to establish FSR priorities, this list illustrates that the survey questionnaire is only one tool among many. The majority of the techniques in Table 2 aim to involve the farmer in the research *and* to capture the farmers' point of view. In reality, it will be necessary to use a combination of these techniques. Contrary to popular belief, most of the techniques can rather quickly yield quantifiable data covering large numbers of farmers. Furthermore, it has been my experience that once FSR teams start to use these techniques, they rarely go back to the old FSR sequence.

We must be realistic, however, and admit that farmers' ranking of priorities may not be the only basis for determining the priorities for an FSR team. Clearly, farmers' priorities may not be in the best interests of the national government (all farmers want higher prices, governments rarely want expensive food). Institutional and donor demands may signal a need for compromise. Farmers in Peru may want to grow coca or Thai farmers may opt for poppy production, but few FSR teams will be encouraged to work on these priorities. Indeed, farmers' goals may not be favorable to long-term sustainable food production. Teams will also have their own priorities; this needs to be recognized, so that the question of how to integrate farmer priorities and team priorities can be openly discussed.

The only major disadvantage of these participatory methods arises when a team is concerned with strict, quantifiable science. These participatory approaches do not begin with hypotheses formulated outside the data set, but are in fact generated while the research process is under way. Often it will not be easy to reduce these generated data to 'numbers'. In addition, many conventional researchers will at first feel uneasy using these techniques, which admittedly stray from convention.

Balancing farmers' and researchers' priorities

The basic principle of the farmer-back-to-farmer model is that FSR projects have only one objective: to generate affordable, sustainable, and appropriate technologies or solutions (though not always technical solutions). Farmer-back-to-farmer (now rephrased by some as farmer first) is an applied action model, not a basic, pure research model. Researchers can pursue their own priorities on the experiment station (although this, too, is ethically questionable), but once research is to be justified on development grounds, then the research priorities of scientists and farmers must be melded together. It may be that farmers have priority problems that lie beyond the mandate of an FSR team (e.g. land inequity or racial discrimination). However, within the areas where FSR can be operationalized, it is essential to find common ground.

The only route to matching priorities is to follow an interactive, participatory method such as the farmer-back-to-farmer model, an approach that insists on constant interaction and maintenance of common definitions. If research strays from the real problems, it must be brought back and even recycled through the steps (that is, by returning to joint farmer-scientist diagnosis). The final decision rests with farmers. If they adopt the changes based on FSR and maintain them, then the FSR approach is working. If not, the cycle must be repeated.

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RHOADES R AND BOOTH R (1982) Farmer-back-to-farmer: a model for generating acceptable agricultural technology. Agricultural Administration 11: 127-137

Strengths and Weaknesses

- **Please list what you consider to be three strengths of day three**

1.
2.
3.

- **Please list what you consider to be three weaknesses of day three**

1.
2.
3.

- **Suggestions for improvements**

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Guidelines to Provide Feedback on the Workshop

1. **The Module**

   Content

   - usefulness/relevance
   - amount of information

   Structure

   - sequence
   - duration
   - balance between trainers' and trainees' participation
   - instructions to trainers
   - visual aids
   - handouts, exercises
   - extra readings
   - PAPA
   - evaluation

2. **Process: training techniques and direction**

   - usefulness/relevance/effectiveness
   - group interaction
   - clarity of questions/exercises instructions
   - opening and closure of the days

3. **Trainers', facilitators', and trainees' performance**

   - presentation/communication skills
   - interaction/effective participation
   - punctuality/interest/commitment/willingness to facilitate learning/willingness to participate
   - other attitudes

4. **Logistical support**

   - organization
   - accuracy
   - punctuality
   - willingness to assist participants
   - services provided in general

5. **Workshop environment**

- physical (training facilities, training material, hotel facilities in general)
- psychological (personal feelings such as self-motivation, interest, satisfaction, self-achievement)
- social (development of friendship, relaxed, comfortable among participants, etc.)

6. **Workshop results/outputs**

- personal and professional assessment
- recommendations

7. **General comments**

FIRST STAGE

PAPA - ideas for action items

Date : _____

Work title : SADC/ESAMI/ISNAR Workshop on Priority Setting for Agricultural Research Programs

Date/Venue : _____

Name : _____

Organization : _____

Ideas I would like to try out when I return to work at my research institute, based on what I have learned in this training workshop.

_____

_____

_____

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Note: You can use the workshop objectives, what you learn during the workshop, the handouts, conversations with participants and trainers, etc., to come up with ideas.

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DAY FOUR

Priority Setting for Agricultural Research Programs

DAY FOUR — Overview

Objectives

By the end of the day the participants will be able to do the following:

1. Systematically identify the potential for generation and adoption of technologies in major identified research themes.
2. Implement an economic surplus analysis of agricultural research benefits.
3. Explain the basic principles of the scoring method, the criteria used, and the data requirements.
4. Explain how to integrate all the criteria to calculate a project score.
5. Identify priority themes among a ranked list.

Handouts

4.12.1 Overview
4.12.2 Tentative Schedule
4.12.3 Identification of the Potential Generation and Adoption of Technologies (summary of presentation)
4.12.4 Exercise 12. Identifying Potential Generation and Adoption of Technologies
4.12.5 Exercise 12. Worksheet
4.12.6 Spreadsheets: Exercise 12a and 12b
4.12.7 Potential for Generation and Adoption of Technologies by Major Research Theme and Zone (text)
4.12.8 Review (chart by R. Taravinga)
4.13.1 Simple Economic Surplus Models: Need and Importance (summary of presentation)
4.13.2 Exercise 13. Estimating Economic Surplus Benefits
4.13.3 Exercise 13. Spreadsheet (2 pages)
4.13.4 Exercise 13. Worksheet
4.13.5 An Economic Analysis of Expected Research Impact (text)
4.13.6 Research Benefits in Spatially Linked Production Zones (text)
4.13.7 Derivation of Research Benefits Formulas for the Closed Economy Case
4.14.1 The Scoring Model at Program Level (summary of presentation)
4.14.2 Exercise 14. Using the Scoring Model to Identify Criteria
4.14.3 Exercise 14. Spreadsheet (1 page)
4.14.4 Exercise 14. Worksheet
4.14.5 Scoring (text)
4.14.6 Strengths and Weaknesses of Day Four
4.14.7 Guidelines to Provide Feedback on the Workshop
4.14.8 PAPA Form — First Stage

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Priority Setting for Agricultural Research Programs

DAY FOUR — Tentative Schedule

08:30 - 09:00	**Opening of the Day's Activities**
09:00 - 10:30	**Session 12. Research Alternatives: Identification of the Potential Generation and Adoption of Technologies** (Presentation and exercise 12)
10:30 - 10:45	Tea/Coffee Break
10:45 - 13:00	**Session 13. Estimating Economic Surplus Benefits** (Presentation and exercise 13)

13:00 — 14:00 Lunch

14:00 - 15:30	**Session 14. Scoring: Inclusion of Multiple Criteria in Priority Setting** (Presentation and exercise 14)
15:30 - 15:45	Tea/Coffee Break
15:45 - 17:00	**Session 14. (Continued)**
17:00 - 17:30	**Feedback on the Day's Activities and PAPA**

Priority Setting for Agricultural Research Programs

DAY FOUR — Checklist for trainers

Handouts

		Yes ✔	No ✔
4.12.1	Overview	❐	❐
4.12.2	Tentative Schedule	❐	❐
4.12.3	Identification of the Potential Generation and Adoption of Technologies (summary of presentation)	❐	❐
4.12.4	Exercise 12. Identifying Potential Generation and Adoption of Technologies	❐	❐
4.12.5	Exercise 12. Worksheet	❐	❐
4.12.6	Spreadsheets: Exercise 12a and 12b	❐	❐
4.12.7	Potential for Generation and Adoption of Technologies by Major Research Theme and Zone (text)	❐	❐
4.12.8	Review (chart by R. Taravinga)	❐	❐
4.13.1	Simple Economic Surplus Models: Need and Importance (summary of presentation)	❐	❐
4.13.2	Exercise 13. Estimating Economic Surplus Benefits	❐	❐
4.13.3	Exercise 13. Spreadsheet (2 pages)	❐	❐
4.13.4	Exercise 13. Worksheet	❐	❐
4.13.5	An Economic Analysis of Expected Research Impact (text)	❐	❐
4.13.6	Research Benefits in Spatially Linked Production Zones (text)	❐	❐
4.13.7	Derivation of Research Benefits Formulas for the Closed Economy Case	❐	❐
4.14.1	The Scoring Model at Program Level (summary of presentation)	❐	❐
4.14.2	Exercise 14. Using the Scoring Model to Identify Criteria	❐	❐
4.14.3	Exercise 14. Spreadsheet (1 page)	❐	❐
4.14.4	Exercise 14. Worksheet	❐	❐
4.14.5	Scoring (text)	❐	❐
4.14.6	Strengths and Weaknesses of Day Four	❐	❐
4.14.7	Guidelines to Provide Feedback on the Workshop	❐	❐
4.14.8	PAPA Form — First Stage	❐	❐

Overheads

4.12.1	Objectives of Day Four	❐	❐
4.12.2	Schedule of Day Four	❐	❐
4.12.3	Objectives of Session 12. Research Alternatives: Identification of Potential Generation and Adoption of Technology	❐	❐

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		Yes	No
4.12.4	Potential Generation and Adoption of Technology	❒	❒
4.12.5	Potential Generation and Adoption of Technology	❒	❒
4.12.6	Potential for Technology Generation	❒	❒
4.12.7	Modeling the Probability Distribution of Research Outcomes	❒	❒
4.12.8	Potential Adoption Profiles	❒	❒
4.12.9	Based Characteristics of a Profile	❒	❒
4.12.10	Technology Adoption Profile	❒	❒
4.12.11	Exercise 12a: Potential for Technology Generation	❒	❒
4.12.12	Exercise 12b: Potential Adoption Parameters	❒	❒
4.12.13	Review	❒	❒
4.13.1	Objectives of Session 13. Estimating Economic Surplus Benefits	❒	❒
4.13.2	Investing in Research is an Economic Problem as:	❒	❒
4.13.3	Main Objectives of Agricultural Research	❒	❒
4.13.4	Evaluating Economic Effects of Agricultural Research Involves	❒	❒
4.13.5	Conceptualize Economic Effects	❒	❒
4.13.6	Modeling Research Impact in a Small Open Economy	❒	❒
4.13.7	Modeling Research Impact in a Closed Economy	❒	❒
4.13.8	Supply Curve Slopes	❒	❒
4.13.9	Technology Shifts	❒	❒
4.13.10	Economic Surplus Measure	❒	❒
4.13.11	Apportioned Economic Surplus	❒	❒
4.13.12	The K Shift is Calculated from the Following Components	❒	❒
4.13.13	Economic Surplus Generated as a Result of Research	❒	❒
4.13.14	Calculations of Shifts in Supply Curves	❒	❒
4.13.15	Net Present Value (NPV)	❒	❒
4.13.16	Conclusion	❒	❒
4.13.17	Conclusion	❒	❒
4.13.18	Exercise 13a: Open Market (spreadsheet)	❒	❒
4.13.19	Exercise 13b: Closed Market (spreadsheet)	❒	❒
4.13.20	Benefits of Research Programs	❒	❒
4.14.1	Objectives of Session 14. Scoring Inclusion of Multiple Criteria in Priority Setting	❒	❒
4.14.2	Scoring	❒	❒
4.14.3	Basic Principle of the Scoring Approach	❒	❒
4.14.4	Major Steps: Scoring Approach	❒	❒
4.14.5	Major Steps: Scoring Approach (continued)	❒	❒
4.14.6	Advantages of Scoring Approach	❒	❒
4.14.7	Allows for Consensus	❒	❒
4.14.8	Limitation of Scoring Approach	❒	❒
4.14.9	Exercise 14A: The Three-Criteria Scoring Model (spreadsheet)	❒	❒

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Materials

	Yes	No
Overhead projector	❒	❒
Projector screen	❒	❒
Flipchart stands (minimum 2)	❒	❒
Flipchart paper/pads (about 10 per day)	❒	❒
Markers for writing on newsprint	❒	❒
Markers for writing on transparencies	❒	❒
Blank transparencies	❒	❒
Stapler	❒	❒
Tape (strong masking tape and regular tape)	❒	❒
Push pins	❒	❒
Glue	❒	❒
Pencils/note pads/pens	❒	❒
Pencil sharpeners	❒	❒
Extension cords	❒	❒
Certificates	❒	❒
Photocopying facilities	❒	❒
Spare bulbs for overhead projector	❒	❒
Extra notepads and pens	❒	❒
Scissors	❒	❒

DAY FOUR

Session 12
Research Alternatives: Identification of the Potential Generation and Adoption of technologies

Instructions to Trainers

PRE-SESSION

08:30 – 09:00 Opening of the Day's Activities
– Review of the previous day's activities.
– Summary of the evaluation of the previous day.
– Overview of the day's activities.

OBJECTIVES

By the end of the pre-session the participants will be able to do the following:

- Assess the progress of the workshop.
- List the objectives and describe the agenda for the day's activities.

OPENING

Invite a volunteer to review the previous day's activities. (10 minutes)

Summarize the evaluation of the previous day. (10 minutes)

Distribute the overview and the schedule for day four (handouts 4.12.1 and 4.12.2) to the participants. Review the objectives and schedule, using overheads 4.12.1 and 4.12.2. Ask if clarification is needed. (10 minutes)

SESSION 12

09:00 – 10:30 Session 12. Identification of the Potential Generation and Adoption of technologies

RATIONALE

Research benefits will depend on the potential for generation and adoption of technologies, in addition to production levels.

OBJECTIVE

By the end of this session, the participants will be able to do the following:

- Systematically identify the potential for generation and adoption of technologies for major identified research themes.

Use overhead 4.12.3 to present the objective.

PROCEDURE

Training techniques: presentation, computer-based exercise in small groups.

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PRESENTATION

(*experience*) Give a brief presentation focusing on identifying research objectives. Ten overheads support the presentation: 4.12.4 through 4.12.13. At the end of the presentation distribute handout 4.12.3 and be sure to ask the participants if they have any comments or questions, or if they need clarification. (15 minutes)

EXERCISE 12

Exercise 12. Identifying potential generation and adoption of technologies. (1 hour 10 minutes)

1. Distribute handouts 4.12.4, through 4.12.8. Handout 4.12.4 outlines the exercise. Go over the instructions with the participants step by step. Ask if clarification is needed. (5 minutes)

Phase 1. Group work

2. **Important!** Divide the participants into the *same four groups* as in the earlier session.
3. *(experience)* Groups select rapporteurs. They then work on the task and prepare their presentations. As the groups work, circulate from group to group to check progress. Clarify any concerns the groups may have while they are working. Be sure to remind the groups of the time remaining. (30 minutes)

Phase 2. Reporting and discussion

4. *(process)* Groups report for exercise 12. Facilitate the presentations. Approximately three minutes are available for each group. (15 mintues)
5. *(process)* Open the discuss to the audience and, finally, provide your view on the results of the exercise. (15 minutes)
6. *(process, generalize)* At the end of the exercise provide feedback on the content of the presentations. Ask the participants questions such as "How did you feel doing this exercise?" and "What did you learn?" (5 minutes)

CLOSURE

Closure (5 minutes)

1. (*application*) Ask the participants "What might you do differently in your job as a result of what you have learned?"
2. Make a transition to the next session.

10:30 – 10:45 Tea/Coffee Break

DAY FOUR

Session 12
Summary of Overheads

Objectives of Day Four

1. Systematically identify the potential for generation and adoption of technologies in major identified research themes.
2. Implement an economic surplus analysis of agricultural research benefits.
3. Explain the basic principles of the scoring method, the criteria used, and the data requirements.
4. Explain how to integrate all the criteria to calculate a project score.
5. Identify priority themes among a ranked list.

4.12.1

Schedule of Day Four

08:30 – 09:00	Opening of the Day's Activities
09:00 – 10:30	Session 12. Research Alternatives: Identification of the potential generation and adoption of technologies
	Tea/Coffee Break
10:45 – 13:00	Session 13. Estimating economic surplus benefits
	Lunch
14:00 – 15:30	Session 14. Scoring: Inclusion of Multiple Criteria in Priority Setting
	Tea/Coffee Break
15:45 – 17:00	Session 14. (Continued)
17:00 – 17:30	Feedback on the Day's Activities and PAPA

4.12.2

Objective of Session 12. Research Alternatives: Identification of Potential Generation and Adoption of Technology

1. Systematically identify the potential for generation and adoption of technologies in major identified research themes.

4.12.3

The potential for the generation and adoption of technologies, must be examined by major program research themes and zones.

4.12.4

- The information on the potential for the generation and adoption of technologies can only be provided by program experts
- Benchmark data on historical trends can usefully orient expert opinion

4.12.5

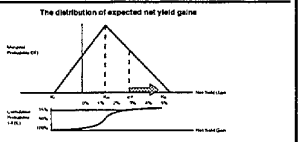
Potential for Technology Generation

- Technology generation is best represented by a distribution of possible outcomes
- Relevant measures are usually minimum, and most likely and maximum net yield gains

4.12.6

Modeling the Probability Distribution of Research Outcomes

The distribution of expected net yield gains



Let K represent the net yield gain of an innovation. The maximum possible yield gain is K_0; the most probable net yield gain is K_m; and maximum net yield gain is K_n. The minimum net yield gain necessary for an innovation to be released for dissemination is K^*, (a 3% gain in this sample). For every K there is a corresponding probability f(K) which is assumed to follow a triangular probability distribution. The probability of achieving an increase in yields that is greater or equal to K^*, Pr(K≥K*), is given by the cumulative density function (1-F(K)) in the figure. In the example, the probability of a net yield gain from research above 3% is quite low, approximately 15%. The expected net yield gain is simply the expected value of K, conditional on K^* being achieved. E[K|K≥K*].

4.12.7

Potential Adoption Profiles

- The adoption profile determines the speed and magnitude by which research results are translated into an impact on farmers' fields

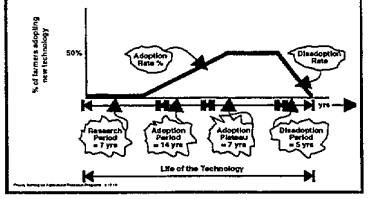
4.12.8

Based Characteristics of a Profile

a. The research development phase.
b. A phase of increasing adoption.
c. Adoption plateau.
d. A declining adoption phase.

4.12.9

Technology Adoption Profile



4.12.10

Exercise 12a: Potential for Technology Generation

Theme/Zone	Estimated Net Yield Gain			Estimated Dissemination Threshold	Probability of Crossing Threshold	% Net Yield Gain
	Minimum	% Likely	Maximum			Conditional
	K_l	K_m	K_h	K_0		
Theme 1						
Zone 1	6.75	40.50	54.00	15.00	0.96	34.74
Zone 2	5.25	37.50	49.50	15.00	0.93	32.13
Theme 2						
Zone 1	22.50	45.00	75.00	25.00	0.99	62.82
Zone 2	15.00	37.50	45.00	20.00	0.87	36.35
Theme 3						
Zone 1	0.00	75.00	100.00	13.30	0.98	59.74
Zone 2	0.00	100.00	250.00	20.00	0.98	318.58

4.12.11

Exercise 12b: Potential Adoption Parameters

	Research & Development Lag (years)	Maximum Adoption Rate (%)	Maximum Adoption Rate (%)	Start of Disadoption (years cumulative)	Complete Disadoption (years cumulative)
Theme 1					
Zone 1	6	22	5	29	44
Zone 2	7	16	29	22	32
Theme 2					
Zone 1	4	12	20	na	na
Zone 2	4	14	25	na	na
Theme 3					
Zone 1	7	10	21.7	na	na
Zone 2	5	13	28.3	na	na

4.12.12

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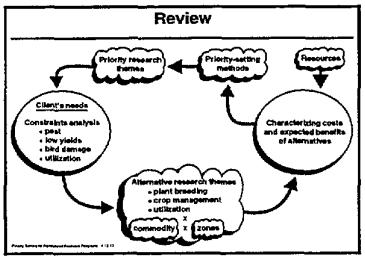
Review
Priority research themes
Priority-setting methods
Resources
Client's needs
Constraints analysis
• pest
• low yields
• bird damage
• utilization
Characterizing costs and expected benefits of alternatives
Alternative research themes
• plant breeding
• crop management
• utilization
commodity
x
zones

4.12.13

Handout - Overview of Day Four

Priority Setting for Agricultural Research Programs

Objectives

By the end of the day the participants will be able to do the following:

1. Systematically identify the potential for generation and adoption of technologies in major identified research themes.
2. Implement an economic surplus analysis of agricultural research benefits.
3. Explain the basic principles of the scoring method, the criteria used, and the data requirements.
4. Explain how to integrate all the criteria to calculate a project score.
5. Identify priority themes among a ranked list.

Handouts

4.12.1 Overview
4.12.2 Tentative Schedule
4.12.3 Identification of the Potential Generation and Adoption of Technologies (summary of presentation)
4.12.4 Exercise 12. Identifying Potential Generation and Adoption of Technologies
4.12.5 Exercise 12. Worksheet
4.12.6 Spreadsheets: Exercise 12a and 12b
4.12.7 Potential for Generation and Adoption of Technologies by Major Research Theme and Zone (text)
4.12.8 Review (chart by R. Taravinga)
4.13.1 Simple Economic Surplus Models: Need and Importance (summary of presentation)
4.13.2 Exercise 13. Estimating Economic Surplus Benefits
4.13.3 Exercise 13. Spreadsheet (2 pages)
4.13.4 Exercise 13. Worksheet
4.13.5 An Economic Analysis of Expected Research Impact (text)
4.13.6 Research Benefits in Spatially Linked Production Zones (text)
4.13.7 Derivation of Research Benefits Formulas for the Closed Economy Case
4.14.1 The Scoring Model at Program Level (summary of presentation)
4.14.2 Exercise 14. Using the Scoring Model to Identify Criteria
4.14.3 Exercise 14. Spreadsheet (1 page)
4.14.4 Exercise 14. Worksheet
4.14.5 Scoring (text)
4.14.6 Strengths and Weaknesses of Day Four
4.14.7 Guidelines to Provide Feedback on the Workshop
4.14.8 PAPA Form — First Stage

Handout - Tentative Schedule of Day Four

Priority Setting for Agricultural Research Programs

08:30 - 09:00	**Opening of the Day's Activities**
09:00 - 10:30	**Session 12. Research Alternatives: Identification of the Potential Generation and Adoption of Technologies** (Presentation and exercise 12)
10:30 - 10:45	Tea/Coffee Break
10:45 - 13:00	**Session 13. Estimating Economic Surplus Benefits** (Presentation and exercise 13)

13:00 — 14:00 Lunch

14:00 - 15:30	**Session 14. Scoring: Inclusion of Multiple Criteria in Priority Setting** (Presentation and exercise 14)
15:30 - 15:45	Tea/Coffee Break
15:45 - 17:00	**Session 14. (Continued)**
17:00 - 17:30	**Feedback on the Day's Activities and PAPA**

Identification of the Potential Generation and Adoption of Technologies (summary of presentation)

1. The potential for the generation and adoption of technologies must be examined by major program research themes and zones.

2. This information can only be provided by program experts. However, benchmark data on historical trends can usefully orient expert opinions.

3. *Potential for technology generation.* Technology generation is better represented by a distribution of possible outcomes. The relevant measures are the minimum, the most likely, and the maximum net yield gained as well as the threshold net yield necessary for technologies to be released for dissemination.

4. *Potential adoption profiles.* The adoption profiles determine the speed and magnitude by which research results are translated into an impact on farmers' fields.

5. Based characteristics of a profile:

   a. The research characteristic phase.
   b. A phase of increasing adoption.
   c. Adoption plateau.
   d. A declining adoption phase.

Exercise 12. Identifying potential generation and adoption of technologies (group exercise)

Phase 1. Group preparation and discussion (20 minutes)

1. For the *same four groups* as in earlier sessions and elect a rapporteur.

2. Read and discuss handout 4.12.7 and 4.12.8 (chapter 3 of Sorghum research priorities at the Kenya Agricultural Research Institute)

Phase 2. Responding to the questionnaire (30 minutes)

3. Read, discuss and respond to the questionnaire. (handout 4.12.5)

4. Enter data on your spreadsheet (see attached spreadsheets, exercises 12a and 12b). (handout 4.12.6)

5. The rapporteur will summarize the group responses.

Phase 3. Reporting and discussion (20 minutes)

6. The rapporteur will report the group results to the audience, emphasizing the area(s) of difficulties that the group members faced while carrying out this exercise.

7. The trainer will synthesize the major issues and provide feedback.

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Exercise 12. Worksheet

Questionnaire on technical potential of research

Program: _____

Techology zone: _____

Persons interviewed: Date:

_____ _____
_____ _____
_____ _____
_____ _____

1. What are the program research themes? _____
_____
_____

2. How many program scientists (full time equivalents) are currently conducting research in each theme?

   theme 1: _____
   theme 2: _____
   theme 3: _____

   total: _____

3. What are the expected yield gains per unit (%) for conducting the research?

Program theme	Commodity	Minimum	Most likely	Maximum

4. What percentage of these yield gains are embodied in additional costs?

Program theme	Commodity	Most likely

5. Calculated distribution of net yield gains (%) for the research theme: {Q3x(100-Q4)/100}

Program theme	Commodity	Minimum	Most likely	Maximum

6. Dissemination Threshold: what level of net yield gain (%) is necessary to ensure some level of adoption by farmers?

Program theme	Dissemination threshold

Questionnaire on technology adoption profile

Program: _____

Techology zone: _____

1. When will key research results be available to the farmer?

Program theme	Number of years

2. What percentage of farmers are likely to adopt new technologies in this theme after release? How many years after release will maximum adoption occur

Program theme	Maximum % of adoption farmers	Number of years to maximum adoption

3. Will the technology become obsolete or degenerate over time, (yes or no)? If yes, number of years before the start of disadoption? Number of years to total disadoption?

Program theme	Number of years to start disadoption	Number of years to complete disadoption

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Exercise 12a: Potential for Technology Generartion						
	Estimated Net Yield Gain			Estimated	Probability of	Conditional
Theme/Zone		%		Dissemination	Exceeding	% New Yield
	Minimum	Likely	Maximum	Threshold	Threshold	Gain
	K_l	K_m	K_h	K_a		
Theme 1						
Zone 1	6.75	40.50	54.00	15.00	0.96	34.71
Zone 2	5.25	37.50	49.50	15.00	0.93	32.11
Theme 2						
Zone 1	22.50	45.00	75.00	25.00	0.99	47.62
Zone 2	15.00	37.50	45.00	30.00	0.67	36.25
Theme 3						
Zone 1	0.00	75.00	100.00	13.30	0.98	59.74
Zone 2	0.00	100.00	250.00	20.00	0.98	118.56

Exercise 12b: Potential Adoption Parameters					
	Research &	Maximum	Naximum	Start of	Complete
	Development Lag	Adoption	Adoption	Disadoption	Disadoption
	(years)	(years -	Rate	(years -	(years -
		cumulative)	(%)	cumulative)	cummulative)
Theme 1					
Zone 1	6	22	5	29	44
Zone 2	7	16	20	22	32
Theme 2					
Zone 1	4	19	20	na	na
Zone 2	4	14	25	na	na
Theme 3					
Zone 1	7	19	21.7	na	na
Zone 2	5	13	28.3	na	na

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Potential for Generation and Adoption of Technologies by Major Research Theme and Zone[1]

Once target zones are identified, the potential for the generation and adoption of technologies within the major program research themes must be examined by zone. This section presents the Working Group assumptions on the potential for the generation and adoption of technologies. The assumptions are based on group about the importance of farm level constraints in each production zone. However, benchmark data on historical growth trends were used to orient working group estimates.[2] In the next step of the priority setting process, a Program Stakeholder Group will next review the assumptions and suggest modifications.

Potential for technology generation

Technology generation, by the nature of the research process, is uncertain and best represented as a distribution of possible outcomes. For commodities, outcomes are most commonly conceptualized in terms of yield increases (or yield losses that have been avoided). However, potential yield increases from adopting new sorghum technologies often involve the use of additional inputs such as fertilizer or labor that effectively lower yield increases which can be attributed to new technologies. Therefore, the Working Group specified research outcomes in terms of net yield gains, taking both yield increases and required additional input costs into account (Table 3). Further, for each major research theme, the Working Group defined the threshold net yield increase necessary for technologies to be released for dissemination.[3]

The minimum, most likely, and maximum potential net yield increases achieved by research were assumed to form a triangular distribution, (see Box 1 for further details) and two parameters were calculated: a) the probability of exceeding the net yield gain threshold for the technology to be released for dissemination, (commonly referred to as the "probability of research success"), and b) the expected net yield increase conditional on the dissemination threshold being exceeded. The results of these calculations are also presented in Table 3, while the formulas calculating the probability of research success and expected net yield increases are given in Appendix 2.

1. **Extract from**: Sorghum Research Priorities at the Kenya Agricultural Research Institute, pages 4-8. The Sorghum Priority Setting Workshop Group. 1995. Nairobi: KARI.

2. See Mills et al. 1995 for a review of historical area, production, and yield growth rates for sorghum.

3. Dissemination thresholds are based on the criteria used by program scientists to identify technologies for release to extension and farmers.

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Table 3: Estimated Expected Yield Gains From Research

Theme/Zone	% net yield gains				Probability of dissemination[a]	Conditional expected net yield increase[b] (%)
	Min.	Most Likely	Max.	Adoption threshold		
Varietal Development						
Humid	6.75	40.50	54.00	15.00	0.96	34.71
Costal						
Semi-Arid Lowlands	5.25	37.50	49.50	15.00	0.93	32.11
Moist-Mid Altitude	0.00	14.30	42.00	15.00	0.63	22.91
Cold-Dry Highlands	0.00	10.00	22.00	15.00	0.19	17.05
Crop Management						
Humid	22.50	45.00	75.00	25.00	0.99	47.62
Costal						
Semi-Arid Lowlands	15.00	37.50	45.00	30.00	0.67	36.25
Moist-Mid Altitude	17.50	37.50	125.00	50.00	0.60	71.97
Cold-Dry Highlands	25.00	50.00	83.30	30.00	0.98	53.19
Technology Dissemination						
Humid	0.00	75.00	100.00	13.30	0.98	59.74
Costal						
Semi-Arid Lowlands	0.00	100.00	250.00	20.00	0.98	118.56
Moist-Mid Altitude	0.00	100.00	150.00	25.00	0.96	86.96
Cold-Dry Highlands	0.00	100.00	150.00	20.00	0.97	85.62
Processing, Utilization, and Storage						
Humid	10.00	17.50	25.00	20.00	0.22	21.46
Costal						
Semi-Arid Lowlands	3.50	7.50	20.00	15.00	0.12	16.46
Moist-Mid Altitude	10.00	20.00	50.00	12.50	0.98	27.09
Cold-Dry Highlands	0.00	10.00	20.00	15.00	0.13	16.46

a. $Pr(K \geq K^a)$.
b. $E[K \mid \geq K^a]$.

Potential adoption profiles

The realized commodity supply shift due to research will depend on the rate and extent of adoption of the technology. Thus, it is essential to include an assessment of the likely adoption pattern of the innovation in order to accurately measure potential impact. Figure 3 shows an adoption profile with a trapezoidal form. This functional form is used in order to simplify subsequent calculations. Several basic characteristics of the profile are noteworthy. These are labelled in the figure as: A) the research development phase, ending with the release of the new technology (at year 4 in the example); B) a phase of increasing adoption as a growing number of farmers in the target area become exposed to the technology and opt to use it; C) an adoption plateau where most farmers have been exposed to the technology and have decided whether or not to adopt; and D) a phase of declining adoption as the technology becomes obsolete.

Combined, these components determine the speed and magnitude by which research results are translated into an impact on farmers' fields. However, these adoption parameters depend directly on the magnitude of the net yield gain embodied in the technology being disseminated. Generally, larger expected net yield gains will result in a more rapid or complete adoption pattern. The working group used the expected net yield gains, conditional on the dissemination threshold being exceeded, as the basis for estimating potential adoption profiles.

Like the technical potential of research, the ex-ante specification of adoption profiles are based on expert opinions of the working group, conditioned by available benchmark data. The component estimates of the profiles are presented in Table 4 by theme and zone.

Box 1: Modeling the Probability Distribution of Research Outcomes

Let K represent the net yield gain of an innovation. The minimum possible net yield gain is K_l; the most probable net yield gain is K_m; and maximum net yield gain is K_h. The minimum net yield gain necessary for an innovation to be released for dissemination is K^a, (a 3% gain in this example). For every K there is a corresponding probability f(K) which is assumed to follow a triangular probability distribution. The probability of achieving an increase in yields that is greater or equal to K^a, $Pr(K \geq K^a)$, is given be the cumulative density function (1-F(k)) in Figure 2. In the example, the probability of a net yield gain from research above 3% is quite low, approximately 15%. The expected net yield gain is simply the expected value of K, conditional on K^a being achieved: $E[K \mid \geq K^a]$.

Figure 2: The distribution of expected net yield gains

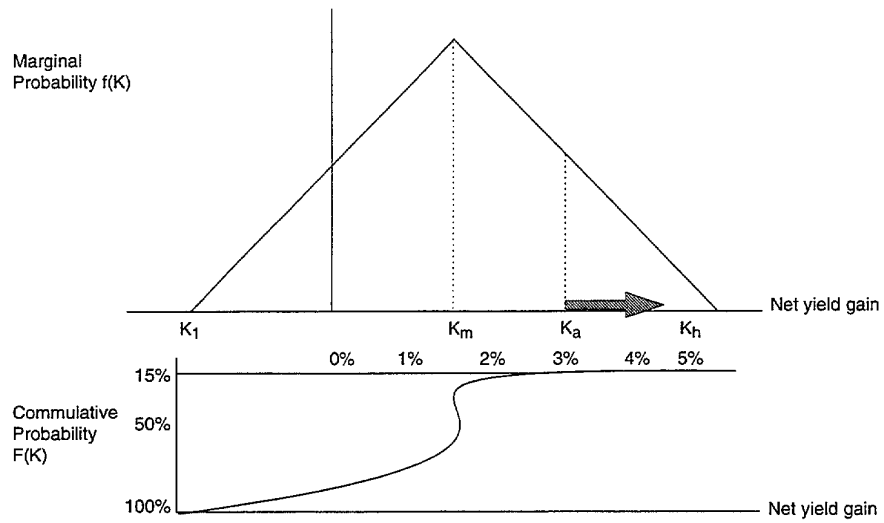

Figure 3: Technology adoption

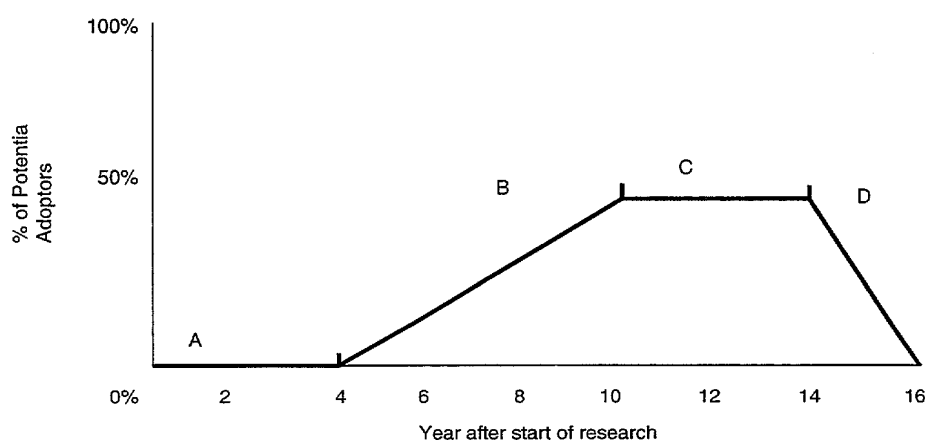

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Table 4: Estimated Adoption Parameters

Theme/Zone	Research and Development Lag (yrs)	Maximum Adoption (yrs)	Maximum adoption Rate (%)	Start of disadoption (yrs)	Complete disadoption (yrs)
Varietal Develoment					
Humid Costal	7	22	5	29	44
Semi-Arid Lowlands	6	16	20	22	32
Moist-Mid altitude	6	16	20	22	32
Cold-Dry Highlands	8	23	50	31	46
Crop Management					
Humid Costal	4	19	20	na	na
Semi-Arid Lowlands	4	14	25	na	na
Moist-Mid altitude	4	14	5	na	na
Cold-Dry Highlands	4	14	40	na	na
Technology Dissemination					
Humid Costal	7	19	21.7	na	na
Semi-Arid Lowlands	5	13	28.3	na	na
Moist-Mid altitude	5	13	31.7	na	na
Cold-Dry Highlands	7	17	34	na	na
Processing, Utilization, and Storage					
Humid Costal	3	8	40	na	na
Semi-Arid Lowlands	2	7	40	na	na
Moist-Mid Altitude	2	5	70	na	na
Cold-Dry Highlands	3	8	12.5	na	na

Note: na - No significant disadoption of technologies is expected over the 30 year research planning horizon.

DAY FOUR

Session 13
Estimating Economic Surplus Benefits

Instructions to Trainers

SESSION 13

10:45 – 13:00 Session 13. Estimating Economic Surplus Benefits

RATIONALE

Economic surplus methods systematically combined information on production levels and the potential for generation and adoption of technologies in order to calculate research benefits.

OBJECTIVE

By the end of this session, the participants will be able to do the following:

- Implement an economic surplus analysis of agricultural research benefits.

Use overhead 4.13.1 to present the objective.

PROCEDURE

Training techniques: presentation, group exercise.

PRESENTATION

(*experience*) Give a brief presentation on estimating economic surplus benefits. Nineteen overheads support the presentation: 4.13.2 through 4.13.20. At the end of the presentation, distribute handout 4.13.1 and be sure to ask the participants if they have any comments or questions or if they need clarification. (15 minutes)

EXERCISE 13

Exercise 13. Estimating economic surplus benefits. (1 hour 55 minutes)

1. Distribute handouts 4.13.2 through 4.13.4. Handout 4.13.2 gives clear instructions for the exercise. Go over the instructions with the participants step by step. Ask if clarification is needed. (5 minutes)

Phase 1. Group work

2. **Important!** Divide the participants into the *same four groups* as in the earlier session.
3. *(experience)* Groups select rapporteurs. They then work on the task and prepare their presentations. As the groups work, circulate from group to group to check progress. Clarify any concerns the groups may have while they are working. Be sure to remind the groups of the time remaining. (1 hour 20 minutes)

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Phase 2. Reporting and discussion

4. *(process)* Groups report for exercise 13. Facilitate the presentations. Approximately three minutes is available for each group. (15 mintues)
5. *(process)* Open the discuss to the audience and, finally, provide your view on the results of the exercise. (10 minutes)
6. *(process, generalize)* At the end of the exercise provide feedback on the content of the presentations. Ask the participants questions such as "How did you feel doing this exercise?" and "What did you learn?" (5 minutes)

CLOSURE

Closure (5 minutes)

1. *(application)* Ask volunteers to list the major things they learned from this exercise. These should be things that will improve their performance of priority-setting tasks in their jobs.
2. Make a transition to the next session.

13:00 – 14:00 Lunch

DAY FOUR

Session 13
Summary of Overheads

Objectives

Session 13: Estimating Economic Surplus Benefits

2. Implement an economic surplus analysis of agricultural research benefits.

4.13.1

Investing in Research is an Economic Problem as:

- Research must compete with other activities for scarce resources
- Choices must be made
  - about the resources to devote to research
  - how to allocate them to alternative programs or themes within programs

4.13.2

The main objectives of agricultural research are economic efficiency and equity.

4.13.3

Evaluating economic effects of agricultural research involves

(a) A relationship between the size of the investment in research and output or productivity

(b) A relationship between increases in productivity and flows of economic benefits

(c) A procedure to account for the timing of benefits and costs.

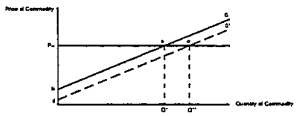
4.13.4

Economists usually conceptualize economic effects in terms of supply and demand for goods and services.

4.13.5

Modeling Research Impact in a Small Open Economy

The market consequences of technical innovations



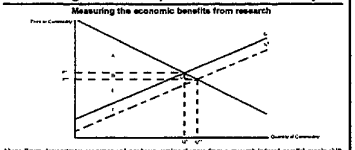
In a small, open economy, the aggregate demand curve for wheat is horizontal (see figure). Consumers can get all the wheat desired without changing the world price of the commodity. However, the supply curve is upward sloping as producers are willing to devote additional resources to wheat production at higher prices or lower costs. The slope of the supply response curve is determined by the supply elasticity and, in the absence of any information to the contrary, the shift in supply due to research here (as in most similar applications) is to be parallel.

When measuring the economic surplus gains from research, the impact of a unit cost reduction will increase the profitability of wheat production and shift the supply curve downward. In the without research case producer surplus is represented by triangle P$_w$ab (the summation of the area above the supply curve and below the world price). With the research-induced supply shift, producer surplus increases to triangle P$_w$cd. Thus, producer surplus gains due to research is equal to the area P$_w$cd - P$_w$ab or acb. Because the derived demand curve is horizontal, consumers neither gain or lose from the research-induced supply shift.

4.13.6

Modeling Research Impact in a Closed Economy

Measuring the economic benefits from research



Above figure demonstrates consumer and producer surplus changes from a research-induced parallel supply shift from S to S'. On the pre-research supply curve, consumers receive area A in surplus. The commodity supply shift then results in a price decrease from P^w to P^{nw} and consumers now receive economic surplus equal to the area A+B+C+D. Thus, the consumer benefit from research is given by area B+C+D.

The impact of the research-induced supply shift on producer surplus is more complex. Originally producer surplus is represented by area E+H (the area below the commodity price but above the cost of production). After the supply shift, producer surplus is given by area F+E+G. Thus, the change in producer surplus is determined by two factors, gains from the unit cost reduction in production, area F+G, and losses from commodity supply shifts (through lower prices), area H. Producer welfare may either increase or decrease as a result of technical change, depending on the relative size of the gains and losses. However, society as a whole (the aggregate of consumer and producer surplus changes) unambiguously gains (area C+B+F+G).

4.13.7

The supply curve slopes upward because producers will supply more at a higher price.

4.13.8

Adoption of new technology shifts the supply curve to S'

4.13.9

The economic surplus measure can be modified to account for effects of

- trade
- pricing policies
- demand shifts, etc.

4.13.10

The economic surplus can be apportioned into the benefits that accrue to different groups in society.

4.13.11

The K Shift is Calculated from the Following Components

- The net expected yield gain (calculated as the probability of exceeding the dissemination threshold * the conditional expected yield gain) (times)
- The period specific adoption rate (divided by)
- The supply elasticity

NB: The supply elasticity translates the yield increase into a unit cost reduciton

4.13.12

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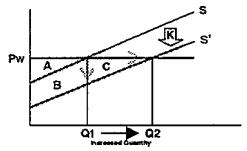
Economic Surplus Generated as a Result of Research



Net K shift: the proportional downward shift in the supply curve in each year

Producer surplus (profits) increases from area 'A' to area 'A+B+C'

4.13.13

A series of calculations of shifts in supply curves and of economic surplus changes can be made over 15 to 20 years, tracing the effects of a research expenditure.

4.13.14

Net Present Value (NPV)

$$\sum_{0}^{T} \frac{B^t}{(1+r)^t}$$

Time Period	Gross Benefits	Discounted Benefits
0	100	100
1	100	95
2	100	91
3	100	86
4	100	82
5	100	78
6	100	75
7	100	71
8	100	68
9	100	64

NPV = 831

4.13.15

Conclusion

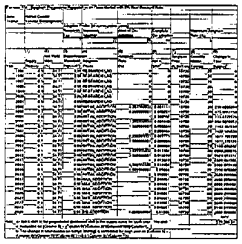
Total economic bemefits of research and their distribution to different groups can be approximated by measures of changes in economic surpluses.

4.13.16

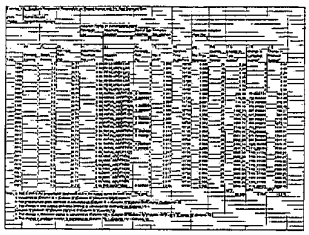
- time lags
- adoption patterns
- research depreciation, and
- uncertainty

should be considered in the calculations.

4.13.17



4.13.18



4.13.19

The benefits of research programs can be disaggregated by type of technology or disciplinary as well, e.g.

- crop protection
- plant breeding
- crop management
- animal nutrition, etc.

4.13.20

Simple Economic Surplus Models: Need and Importance (summary of presentation)

1. Agricultural research involves investment of scarce resources in the production of knowledge to increase future agricultural productivity and, thereby, contribute to a range of objectives. Investing in research is an economic problem as:

   (a) Research must compete with other activities for scarce resources.
   (b) Choices must be made about the resources to devote to research and how to allocate them to alternative programs or themes within programs.

2. The main objectives of agricultural research are economic efficiency and equity. The efficiency objective relates to whether the investment is an efficient use of resources — or could the resources earn a higher rate of return in an alternative investment? The equity issue concerns how the effects are distributed among groups in society. In most cases some people are made better off and others worse off by changes in technology. Economic analysis can estimate the likely effects of alternative research investments on the size and distribution of national income.

3. Few objectives are truly "non-economic", but some effects are difficult to incorporate directly into an economic analysis. For example, economic analysis can shed light on the effects of research on employment and on environmental sustainability using tools developed to value activities or benefits that are not priced in the market place. The difficulty of applying these "non-economic" evaluation tools, however, may render them most useful when the number of programs to be evaluated is relatively small.

4. Evaluating the economic effects of agricultural research — either in retrospect or in advance — involves these central elements. They are:

   (a) The relationship between the size of the investment in research and output or productivity,
   (b) The relationship between increases in productivity and flows of economic benefits, and
   (c) A procedure to account for the timing of benefits and costs.

   Any research evaluation or priority procedure must consider these elements.

5. Economists usually conceptualize economic effects in terms of supply and demand for goods and services. We represent supply and demand on a graph with a demand curve and a supply curve. The graph has price on the vertical axis and quantity on the horizontal axis. The demand curve (D) for an article or service slopes downward because consumers will demand more as the price drops.

6. The supply curve slopes upward because producers will supply more at a higher price. An equilibrium price and quantity are found at price P^* and quantity Q^*.

7. Adoption of new technology shifts the supply curve to S^1 resulting in a new equilibrium price and quantity of P^{**} and Q^{**}. The supply curve shifts because the new technology lowers the cost of production per unit of output. Therefore producers will supply more at every price.

8. Gross annual research benefits are measured as the shaded area between the supply curves and beneath the demand curve. This area represented by C+D+F+G is called the change in economic surplus. This area can be divided into producer benefits and consumer benefits. Producers may gain or lose. They may gain because they are producing more at a lower cost. They may lose if price declines too much. Consumers will always gain as long as there is a price decline in price.

9. The economic surplus measure can be modified to account for the effects of trade, pricing policies, demand shifts, etc. It can be apportioned into the benefits that accrue to different groups in society.

10. The economic surplus measure presented in the graph illustrates the benefits of research in one time period, say a year. Because research takes time to complete, adoption of new technologies may occur over several years, and technologies may eventually depreciate. Analysis of the effects of research programs should attempt to calculate the effects of research, year by year. A series of calculations of shifts in supply curves and of economic surplus changes can be made over say 15 to 20 years, tracing the effects of a research expenditure.

11. Agricultural research is a high-risk activity. Uncertainty is inherent in virtually all aspects of the research process. It surrounds most of the variables involved in the calculation of research benefits. There is uncertainty whether the research will be scientifically successful and commercially successful, and if so, how much so. The time lags and adoption paths are uncertain and so are several of the market parameters. Representing uncertainty appropriately in agricultural research evaluation and priority setting is not straightforward. At the very least, however, it is important to take into account the possibility of failure of the research through the use of some measures of probabilities of success. These probabilities vary by commodity and type of research and can be used to adjust the size of the supply curve shift.

12. In conclusion, the total economic benefits of research and their distribution to different groups can be approximated by measures of changes in economic surpluses. Time lags, adoption patterns, research depreciation, and uncertainty should be considered in the calculations.

13. The basic economic surplus model of research benefits is distinguished from the more complete models based on whether detailed information on the distribution of research benefits among geographic areas and components of the marketing chain is included or not. The basic model does not include this geographic or marketing chain information.

14. The basic model of research benefits for a commodity with little trade (closed economy case) is shown on overhead 4.13.13. In this model, D represents demand for the product, and S_0 and S_1 represent, respectively, the supply of the product before and after a research-induced technical change. The initial equilibrium price and quantity are P_0 and Q_0; after the supply shift they are P_1 and Q_1.

    The total (annual) benefit from the research-induced supply shift is equal to the area beneath the demand curve and between the two supply curves (change in total surplus = ΔTS = area I_0abI_1). The total benefit is comprised of the sum of benefits to consumers in the form of the change in consumer surplus (ΔCS = area P_0abP_1) and the benefits to producers in the form of the change in produce surplus (ΔPS = area P_1bI_1 - P_0aI_0).

15. We can express these effects algebraically as follows:

    $\Delta CS = P_0Q_0Z\ (1+0.5Z\eta$

    $\Delta PS = P_0Q_0\ (K-Z)(1+0.5Z\eta)$

    $\Delta TS = \Delta CS + \Delta PS = P_0Q_0K(1+0.5Z\eta)$

    Where K is the vertical shift in the supply curve expressed as a percentage of the initial price, η is the absolute value of the elasticity of demand, ε is the elasticity of supply, and $Z=K\varepsilon/(\varepsilon+\varepsilon)$ is the reduction in price, relative to its initial value, due to the supply shift.

    The model applies primarily to products that are costly to transport.

16. (Optional) The derivation of the formulas is summarized in handout 4.13.4. The central principle in the derivations is to make use of the formula for an elasticity in order to eliminate the unobservable P_1 and Q_1 from the formulas.

17. Most products are traded in part (imported or exported). For most commodities in most countries the domestic price is heavily influenced by the world price because the country is small in the world market for the commodity. Graphical depictions of the economic surplus models for a small importer and for a small exporter are shown on overhead 4.13.15. In either case, all the benefits of research accrue to producers and are measured as the area I_0abI_1.

18. The formula for research benefits from a K percent parallel shift down of supply in this case of small open economy is simply: $\Delta PS = \Delta TS = P_wQ_0K(1.5K\varepsilon)$. It applies for both the importer and the exporter case.

19 Discounting benefits over years to a NPV.

    Net Present Value (NPV) $\sum_{0}^{T} \frac{B_t}{(1+r)^t}$

20. The benefits of research programs can be disaggregated by type of technology or disciplinary area as well (e.g. crop protection, plant breeding, crop management, animal nutrition, etc.).

21. The basic economic surplus model presented here is useful when detailed interregional or vertical market analyses are not required. Yet the resources are available to move beyond the simplest model that ignores elasticities, etc. Analysis with this model for a relatively large number of commodities in a medium-size system may take 6 to 8 months (with most of the time devoted to data collection).

22. The basic economic surplus model is perhaps the most commonly used tool for evaluating the benefits of agricultural research.

Key Reference

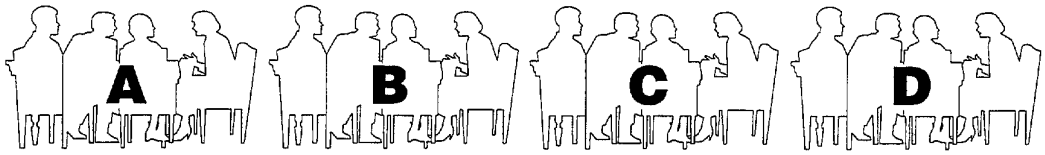
Norton, G.W. and P.G. Pardey. 1994. A Trainer's Guide to Strategic Priority Setting and Ex Post Evaluation in Agricultural Research. The Hague: ISNAR.

Alston, J.M., G.W. Norton, and P.G. Pardey. 1995. Science under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting. Ithaca: Cornell University Press.

Exercise 13. Estimating economic surplus benefits (group exercise)

Phase 1. Group preparation (20 minutes)

1. Form the same groups as in earlier sessions and elect a rapporteur.



2. Read handouts 4.13.5 and 4.13.6.

Phase 2. Group work (60 minutes)

3. Based on the attached exercise 13a and 13b (handout 14.13.3 - 2 pages) of your spreadsheet, **calculate** economic surplus benefits in an **open** and **closed** economy.

4. Remember that the information for this exercise comes from the previous exercises 10, 12a and 12b.

5. Use the worksheet (handout 4.13.4) when necessary.

Phase 3. Summary of results, reporting and discussion (30 minutes)

6. The rapporteur will summarize the group results and report to the audience.

7. The group rapporteur is expected to include in the summary the content of this exercise and the process of the group work: how did they go about it, major strengths and difficulties faced, and lessons learned.

8. The trainer will summarize the group's results, emphasize the lessons learned and close the session.

Exercise 13a: Sorghum Programme Research in an Open Market with 5% Real Discount Rate.

Zone:	Humid Coastal								
Theme:	Varietal Development								
			Adoption Profile (in cummulative years)						
			Research	Maximum	Start of Dis-	Complete		Maximum Adoption	
			Lag	Adoption	Adoption	Dis-adoption		Rate (%)	
			7	22	29	44		5	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Net Yield	Dissemination		Adoption		Sorghum	Quantity	Change in
	Supply	Gain	Threshold	Adoption	Rate	Net K	Price	Metric	Total
Year	Elasicity	(%)	Pr(K>=K*)	Phase	(%)	Shift[a]	(K.Sh/Ton)	Tonnes	Surplus[b]
1995	0.5	34.71	0.96	RESEARCH LAG	0	0	10730	20	0
1996	0.5	34.71	0.96	RESEARCH LAG	0	0	10730	20	0
1997	0.5	34.71	0.96	RESEARCH LAG	0	0	10730	20	0
1998	0.5	34.71	0.96	RESEARCH LAG	0	0	10730	20	0
1999	0.5	34.71	0.96	RESEARCH LAG	0	0	10730	20	0
2000	0.5	34.71	0.96	RESEARCH LAG	0	0	10730	20	0
2001	0.5	34.71	0.96	RESEARCH LAG	0	0	10730	20	0
2002	0.5	34.71	0.96	INITIAL ADOPTION	0.333333333	0.001111	10730	20	238.4266999
2003	0.5	34.71	0.96	INITIAL ADOPTION	0.666666667	0.002221	10730	20	476.9857758
2004	0.5	34.71	0.96	INITIAL ADOPTION	1	0.003332	10730	20	715.6772275
2005	0.5	34.71	0.96	INITIAL ADOPTION	1.333333333	0.004443	10730	20	954.5010552
2006	0.5	34.71	0.96	INITIAL ADOPTION	1.666666667	0.005554	10730	20	1193.457259
2007	0.5	34.71	0.96	INITIAL ADOPTION	2	0.006664	10730	20	1432.545838
2008	0.5	34.71	0.96	INITIAL ADOPTION	2.333333333	0.007775	10730	20	1671.766793
2009	0.5	34.71	0.96	INITIAL ADOPTION	2.666666667	0.008886	10730	20	1911.120125
2010	0.5	34.71	0.96	INITIAL ADOPTION	3	0.009996	10730	20	2150.605832
2011	0.5	34.71	0.96	INITIAL ADOPTION	3.333333333	0.011107	10730	20	2390.223915
2012	0.5	34.71	0.96	INITIAL ADOPTION	3.666666667	0.012218	10730	20	2629.974374
2013	0.5	34.71	0.96	INITIAL ADOPTION	4	0.013329	10730	20	2869.857208
2014	0.5	34.71	0.96	INITIAL ADOPTION	4.333333333	0.014439	10730	20	3109.872419
2015	0.5	34.71	0.96	INITIAL ADOPTION	4.666666667	0.01555	10730	20	3350.020006
2016	0.5	34.71	0.96	INITIAL ADOPTION	5	0.016661	10730	20	3590.299968
2017	0.5	34.71	0.96	MAX. ADOPTION	5	0.016661	10730	20	3590.299968
2018	0.5	34.71	0.96	MAX. ADOPTION	5	0.016661	10730	20	3590.299968
2019	0.5	34.71	0.96	MAX. ADOPTION	5	0.016661	10730	20	3590.299968
2020	0.5	34.71	0.96	MAX. ADOPTION	5	0.016661	10730	20	3590.299968
2021	0.5	34.71	0.96	MAX. ADOPTION	5	0.016661	10730	20	3590.299968
2022	0.5	34.71	0.96	MAX. ADOPTION	5	0.016661	10730	20	3590.299968
2023	0.5	34.71	0.96	MAX. ADOPTION	5	0.016661	10730	20	3590.299968
2024	0.5	34.71	0.96	DIS-ADOPTION	4.666666667	0.01555	10730	20	3350.020006
									NPV
									$20,389.64

Note: a- Net K shift is the proportional downward shift in the supply curve for each year. The shift is calcualted as (Column 6) = (Column 2)*(Column 3)*(Column4/100)/Column1).

b- The change in total surplus (in Kenya Shilling) is calculated for each year as (Column 9) = (Column 6)*(Column 7)*(Column 8)*(1+0.5*(Column 6)*(Column 1))).

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Exercise 13b: *Sorghum Programme Research in an Closed Market with 5% Real Discount Rate.*

Zone: Humid Coastal
Theme: Varietal Development

Adoption Profile (in cummulative years)			
Research Lag	Maximum Adoption	Start of Dis-Adoption	Complete Dis-adoption
7	22	29	44

Maximum Adoption Rate (%): 5

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Year	Demand Elasicity	Supply Elasicity	Net Yield Gain (%)	Dissemination Threshold Pr(K>=K*)	Adoption Phase	Adoption Rate (%)	Net K Shift[a]	Sorghum Price (K.Sh/Ton)	Net Price Decrease	Quantity Metric Tonnes	Change in Total Surplus[c]	Change in Consumer Surplus[d]	Change in Producer Surplus[e]
1995	1	0.5	34.71	0.96	RESEARCH LAG	0	0.000	10730	0.000	20	0.00	0	0.00
1996	1	0.5	34.71	0.96	RESEARCH LAG	0	0.000	10730	0.000	20	0.00	0	0.00
1997	1	0.5	34.71	0.96	RESEARCH LAG	0	0.000	10730	0.000	20	0.00	0	0.00
1998	1	0.5	34.71	0.96	RESEARCH LAG	0	0.000	10730	0.000	20	0.00	0	0.00
1999	1	0.5	34.71	0.96	RESEARCH LAG	0	0.000	10730	0.000	20	0.00	0	0.00
2000	1	0.5	34.71	0.96	RESEARCH LAG	0	0.000	10730	0.000	20	0.00	0	0.00
2001	1	0.5	34.71	0.96	RESEARCH LAG	0	0.000	10730	0.000	20	0.00	0	0.00
2002	1	0.5	34.71	0.96	INITIAL ADOPTION	0.3333333	0.001	10730	0.000	20	238.40	79.4682124	158.94
2003	1	0.5	34.71	0.96	INITIAL ADOPTION	0.6666667	0.002	10730	0.001	20	476.90	158.965842	317.93
2004	1	0.5	34.71	0.96	INITIAL ADOPTION	1	0.003	10730	0.001	20	715.48	238.492888	476.99
2005	1	0.5	34.71	0.96	INITIAL ADOPTION	1.3333333	0.004	10730	0.001	20	954.15	318.049351	636.10
2006	1	0.5	34.71	0.96	INITIAL ADOPTION	1.6666667	0.006	10730	0.002	20	1192.91	397.635231	795.27
2007	1	0.5	34.71	0.96	INITIAL ADOPTION	2	0.007	10730	0.002	20	1431.75	477.250528	954.50
2008	1	0.5	34.71	0.96	INITIAL ADOPTION	2.3333333	0.008	10730	0.003	20	1670.69	556.895241	1113.79
2009	1	0.5	34.71	0.96	INITIAL ADOPTION	2.6666667	0.009	10730	0.003	20	1909.71	636.569372	1273.14
2010	1	0.5	34.71	0.96	INITIAL ADOPTION	3	0.010	10730	0.003	20	2148.82	716.272919	1432.55
2011	1	0.5	34.71	0.96	INITIAL ADOPTION	3.3333333	0.011	10730	0.004	20	2388.02	796.005883	1592.01
2012	1	0.5	34.71	0.96	INITIAL ADOPTION	3.6666667	0.012	10730	0.004	20	2627.30	875.768264	1751.54
2013	1	0.5	34.71	0.96	INITIAL ADOPTION	4	0.013	10730	0.004	20	2866.68	955.560062	1911.12
2014	1	0.5	34.71	0.96	INITIAL ADOPTION	4.3333333	0.014	10730	0.005	20	3106.14	1035.38128	2070.76
2015	1	0.5	34.71	0.96	INITIAL ADOPTION	4.6666667	0.016	10730	0.005	20	3345.70	1115.23191	2230.46
2016	1	0.5	34.71	0.96	INITIAL ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2017	1	0.5	34.71	0.96	MAX. ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2018	1	0.5	34.71	0.96	MAX. ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2019	1	0.5	34.71	0.96	MAX. ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2020	1	0.5	34.71	0.96	MAX. ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2021	1	0.5	34.71	0.96	MAX. ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2022	1	0.5	34.71	0.96	MAX. ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2023	1	0.5	34.71	0.96	MAX. ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2024	1	0.5	34.71	0.96	DIS-ADOPTION	4.6666667	0.016	10730	0.005	20	3345.70	1115.23191	2230.46
											NPV	NPV	NPV
											20,368	6,789	13,578

Note: a- Net K shift is the proportional downward shift in the supply curve for each year. The shift is calcualted as (Column 6) = (Column 2)*(Column 3)*(Column4/100)/Column1).

b- Net proportionate price decrease is calculated as (Column 9) = (Column 7)*(Column 2)/((Column 2)+(Column 1))

c- The change in total surplus (in Kenya Shilling) is calculated for each year as (Column 11) = (Column 7)*(Column 8)*(Column 10)*(1+0.5*(Column 9)*(Column 1))).

d- The change in consumer suplus is calculated as (Column 12) = (Column 8)*(Column 9)*(Column 10)*[1+(0.5*(Column 9)*(Column 1))]

e- The change in producer surplus is calculated as (Column 13) = (Column 11) - (Column 12)

Exercise 13. Worksheet

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An Economic Analysis of Expected Research Impact[1]

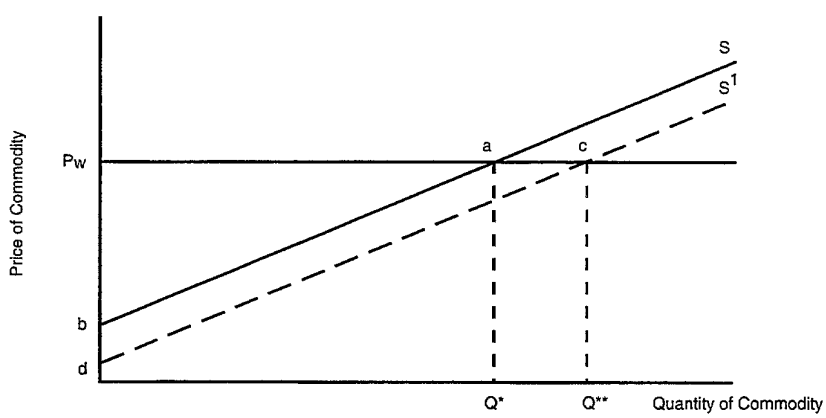
Since internal demand does not affect world prices, the Kenya wheat market can be modeled as a small open economy. Box 2 discusses how the economic surplus generated from commodity research can be measured in a small open economy. Formulas for measuring research impact are given in the section and discussed in detail in Alston, Norton, and Pardey (1995). Estimates of the change in economic surplus due to research, by theme and zone, are also presented in the section.

Box 2. Modeling Research Impact in a Small Open Economy

In a small, open economy the aggregate demand curve for wheat is horizontal (Figure 4). Consumers can get all the wheat desired without changing the world price of the commodity. However, the supply curve is upward sloping as producers are willing to devote additional resources to wheat production at higher prices or lower costs. The slope of the supply response curve is determined by the supply elasticity and, in the absence of any information to the contrary, the shift in supply due to research here (as in most similar applications) is assumed to be parallel.

When measuring the economic surplus gains from research, the impact of a unit cost reduction will increase the profitability of wheat production and shift the supply curve downward. In the 'without research' case producer surplus is represented by triangle $P_w$ab (the summation of the area above the supply curve and below the world price). With the research-induced supply shift, producer surplus increases to triangle $P_w$cd. Thus, producer surplus gains due to research is equal to the area $P_w$cd - $P_w$ab = acdb. Because the derived demand curve is horizontal, consumers neither gain or lose from the research-induced supply shift.

Figure 4: The market consequences of technological innovation



The total economic surplus change at time t due to wheat research is calculated from two components: the proportional downward supply shift in each year, (K_t), and the change in total surplus arising from this proportional shift, (ΔTS_t).

The proportional downward supply shift for every period is simply calculated as the product of the probability of exceeding the dissemination threshold, the expected unit cost reduction, (conditional upon the dissemination threshold being exceeded), and adoption rate for the specific period divided by the supply elasticity.

1. **Extracted from**: Mills, B. and Karanja, D. 1995. Processes and Methods for Research Program Priority Setting: The Experience of the Kenya Agricultural Research Institute Wheat Program, p. 14-16. Nairobi: KARI.

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$K_t = P_r(K \geq K^a)\, E[K \mid \geq K^a] A_t/\varepsilon$ where:

A_t = The adoption rate at time t as determined by the trapezoid adoption profile and parameters in Table 4; and

ε = the intermediate-run supply elasticity.

The change in total economic surplus is calculated as:

$\Delta TS_t = K_t P_t Q_t(1+0.5K_t\varepsilon)$ where:

P_t = the market price in Kenya; ($270 USD based on 1991 metric ton price); and

Q_t = Base quantity produced from Table 2, (this can be adjusted for exogenous change in each year).

Finally, the net present value of total surplus changes across all years is calculated based on real discount rates of three percent and five percent. Rates in this range are felt to reflect the long-run real rate of borrowing for government funds. The results for the traditional wheat growing zones, by target zone and major research theme, are presented in Table 6. A sample spreadsheet explaining the calculations for plant breeding in the High-Mid Moist Zone is presented in Appendix 3.

Table 6: Potential Economic Surplus Generated by Wheat Programme Research Themes, (100,000 US Dollars)

Theme	High-mid moist	High-mid wet	Highlands
Discount rate = 3%			
Plant breeding	60.5	376.4	77.6
Plant protection	11.0	1.4	0.9
Crop management	376.1	453.0	46.1
Technology dissemination	498.0	238.1	56.8
Discount rate = 5%			
Plant breeding	41.9	254.2	54.5
Plant protection	9.0	1.2	0.8
Crop management	257.3	329.0	33.5
Technology dissemination	393.8	188.0	46.6

In the High-Mid Moist Zone, crop management and technology dissemination appear to be the research themes with the most potential. The estimated change in total surplus is large for these themes because of the high probability of generating technologies with large expected net yield gains. Further, benefits from technology dissemination are higher than crop management due to a relatively rapid adoption profile. In the High-Mid Wet Zone, crop management continues to show high economic surplus changes, in spite of a lower expected net yield gain from research. This is due to the large area under production and an increase in the speed of adoption relative to the High-Mid Moist Zone. At the same time, the estimated change in economic surplus from technology dissemination is small in the zone due to the lower potential for generating significant net yield increases. On the other hand, plant breeding has a high potential for generating higher yielding varieties in the High-Mid Moist Zone and, therefore, high surplus estimates. Finally, the Highland Zone has relatively small benefit estimates, partially due to the small quantity of wheat currently produced in the zone and to intensive past research efforts which limit the

possibilities for further technical advance. It should also be noted that the relative ranking of total surpluses does not change under the three percent and five percent per annum real discount rate scenarios.

In the target expansion zones, it is difficult to model the impact of research because the current area under wheat production is negligible. Additional assumptions would need to be made with regard to the rate of area expansion and profitability of wheat relative to other crops that may be displaced. Such calculations would require moving towards an explicit multiple market framework for the modeling of research impact.

An examination of probability of research success and adoption profiles in the two target expansion zones reveals that none of the research themes in the Mid Altitude Wet Zone shows a positive probability of developing technologies for dissemination. In the Mid Altitude Moist Zone, by contrast, a research thrust in technology dissemination has a very high probability of producing rapid net yield gains. In fact only 25,000 hectares of wheat need to be brought into production in the zone in order for this theme to generate total benefits similar to that for technology dissemination in the High-Mid Wet Zone. Thus if the programme believes that significant expansion in the area under wheat is possible in the Mid-Altitude Moist Zone, it may wish to concentrate on disseminating available wheat technologies, particularly from the High-Mid Moist zone.

Research Benefits in Spatially Linked Production Zones[1]

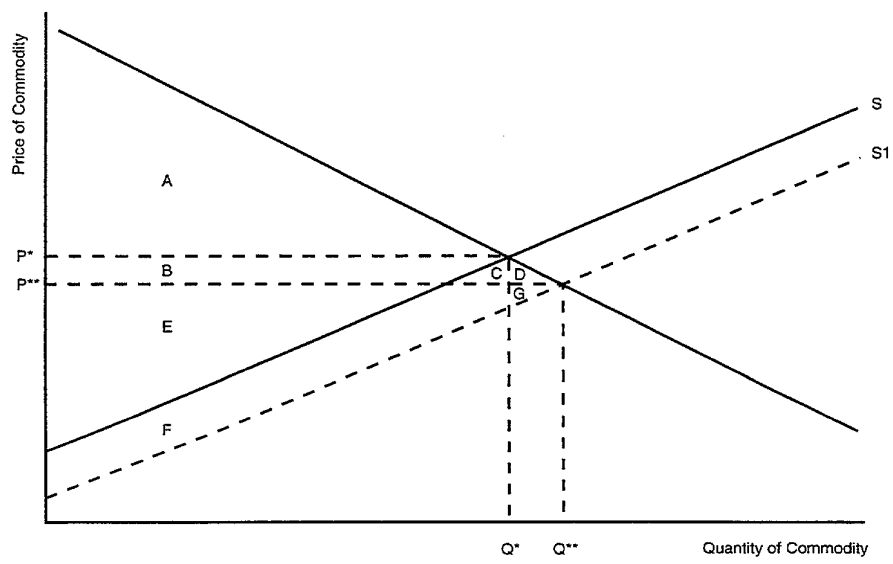
The change in economic surpluses, (consumer surplus and producer surplus), is the most commonly used measure of the economic benefits generated from agricultural research.[2] Consumer surplus measures the surplus value of a good to consumers over the price paid for that good. Producer surplus measures the surplus of the price received for a good over the variable costs of production. In this section, changes in consumer and producer surplus are calculated for specific research themes within zones over a 30 year time period. Box 2 describes the basic model used to calculate economic benefits from research in a single period, single market situation.

Box 2

Figure 5 demonstrates consumer and producer surplus changes from a research-induced parallel supply shift from S to S'. On the pre-research supply curve, consumers receive area A in surplus. The commodity supply shift then results in a price decrease from P* to P** and consumers now receive economic surplus equal to the area A+B+C+D. Thus, the consumer benefit from research is given by area B+C+D.

The impact of the research-induced supply shift on producer surplus is more complex. Originally producer surplus is represented by the area E+B (the area below the commodity price but above the cost of production). After the supply shift, producer surplus is given by area F+E+G. Thus, the change in producer surplus is determined by two factors, gains from the unit cost reduction in production, area F+G, and losses from commodity supply shifts (through lower price), area B. Producer welfare may either increase or decrease as a result of technical change, depending on the relative size of the gains and losses. However, society as a whole (the aggregate of consumer and producer surplus changes) unambiguously gains (area C+D+F+G).

Figure 5: Measuring the Economic Benefits from Research



1. **Extract from**: Sorghum Research Priorities at the Kenya Agricultural Research Institute, pages 11-14. The Sorghum Priority Setting Working Group. 1995. Nairobi: KARI.

2. See Alston, Norton, and Pardey, 1995 Chapter 2 for a discussion of economic surplus measures in agricultural research evaluation.

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A multiperiod, multiple (interlinked) market version of this basic model is used to generate estimates of research benefits. The model is presented in Appendix 2 and draws on the multimarket model described in appendix 5.1.2. of Alston, Norton, and Pardey (1995). The model accounts for the dynamics elements of agricultural research measured in the previous sections, including: the specific time profiles for technology generation and adoption; increased demand for commodities due to population growth; variable prices across production zones; and the impact of research induced price spill-overs to other production zones.

Results

The estimated research induced changes in producer and consumer surplus, aggregating the direct impact of zone specific research with the indirect impact through research induced price changes in other sorghum production zones, are presented in Table 8. The real discount rate is assumed to be 5%. As discussed, the Nairobi market price of sorghum is based on the January to April 1995 average price of 804 K. Sh. per bag or 8935 K. Sh. per ton.

Table 8: Potential Economic Surplus Generated by Sorghum Research in 1,000,000 K. Sh.: Real Discount rate = 5%, Nairobi Price = 8935 K.Sh per M ton

	Humid Costal	Semi-Arid Lowlands	Mosit-Mid Altitude	Cold-Dry Highlands	All Zones
Varietal Development					
Producer Surplus	0.03	55.91	88.54	2.46	145.89
Consumer Surplus	0.02	46.20	98.84	2.77	148.17
Total Surplus	0.05	102.10	187.39	5.23	294.06
Crop Management					
Producer Surplus	0.24	78.04	90.55	56.67	222.74
Consumer Surplus	0.12	64.29	101.13	56.26	222.70
Total Surplus	0.37	142.23	191.67	112.92	445.43
Technology Dissemination					
Producer Surplus	0.29	487.84	1185.33	65.26	1643.40
Consumer Surplus	0.15	349.84	1276.15	62.23	1719.41
Total Surplus	0.44	837.68	2461.47	127.49	3362.82
Processing, Utilization, and Storage					
Producer Surplus	0.07	12.97	1134.43	0.78	1146.17
Consumer Surplus	0.04	10.92	1233.78	0.89	1246.29
Total Surplus	0.10	23.89	2368.21	1.67	2392.46

Simulated changes in total surplus, along with producer and consumer components, vary markedly across research themes and target zones. Based on the assumptions described in the previous sections and its current allocation of human resources, the Sorghum Programme expects to generate total benefits of 294 million 1995 K. Sh. through varietal development research; 445 million K. Sh. through crop management research; 3,363 million K. Sh. through technology dissemination activities; and 2,392 million K. Sh. through research into processing and the utilization of sorghum products. However, within research themes, the potential benefits from research vary widely by zone.

The base level of production appears to be the most important determinant of potential research benefits. Within all themes, the ranking of benefits estimates corresponds to the ranking of the size of production areas. However, the potential for generation and adoption of technologies plays an important role in determining the relative level of research benefits within each zone. In the Moist-Mid Altitude Zone, the technology dissemination and processing, utilization, and

storage research themes show far greater potential benefits than the varietal development and crop management research themes due to the higher estimated potential for generating yield increasing technologies. Similarly, for the Semi-Arid Lowlands zone, technology dissemination shows the greatest estimated benefits. While in the Cold-Dry Highlands, crop management and technology dissemination show higher benefits than the other themes. Finally, technology dissemination and crop management show the greatest potential benefits of all themes in the Humid Coastal Zone, but the absolute magnitude of all benefit estimates in the zone are extremely low due to the small production base.

In all cases, producer surplus changes comprise a slightly higher proportion of total surplus changes than consumer surplus. However, producer surplus changes are concentrated within the zone where the research occurs and are negative (losses) in other zones. Consumer surplus benefits, by contrast, are widely distributed across Kenya. These results stem from the fact that under the assumption of inter-linked markets, real sorghum prices will be lower in all zones under the with-research scenario compared to the without-research scenario. Producers in the targeted zone benefit because the additional surplus generated from lower unit costs outweigh the losses from lower prices, (see Box 2). However, producers in all other zones show negative changes in surplus estimates due to lower equilibrium prices without accompanying unit cost reductions.

The equilibrium dynamics of the model also suggest some sobering trends for sorghum markets in Kenya. Even under the most optimistic research scenarios, given the extremely high rate of population growth in Kenya, demand for sorghum will drive real prices up by over 60 percent over the next 30 years. A more realistic scenario is that increasing real sorghum prices will force consumers to more tradable commodities, such as maize and wheat. Further, given the rapid rates of population growth across all zones, Kenya will have to become increasingly reliant on imports of these commodities.

Finally, a more appropriate measure of the potential returns to sorghum research is the ratio of benefits to the quantity of human or financial resources invested. In Table 9 the current commitment of programme resource to sorghum research is specified by theme and zone. Human resource allocations are then compared to potential benefits. Zone specific themes with present discounted benefits to full-time equivalent researcher ratios greater than 100 million K. Sh. (grey) and 500 million (black) highlighted are potential priority areas for allocation of further resources to sorghum research.

Eight, of a possible sixteen, zone specific research themes show benefits to full-time equivalent researcher ratios greater than 100 million (varietal development, crop management, and technology dissemination in the Semi-Arid Lowlands; varietal development, technology dissemination, and processing, utilization, and storage in the Moist-Mid Altitude; and crop management technology dissemination in the Cold-Dry Highlands). Of these, technology dissemination in the Semi-Arid Lowlands and Moist-Mid Altitude Zones, as well as processing, utilization, and storage in the Moist-Mid Altitude Zone show benefits to researcher ratios greater than 500 million K. Sh. and represent the most productive areas for additional investment of programme resources.

Table 9: A Comparison of Current Human Resource Allocations and Potential Benefits

	Humid Costal	Semi-Arid Lowlands	Moist-Mid Altitude	Cold-Dry Highlands	Total
Current allocation of program scientists (FTE)[a]					
Varietal Development	0.3	1.0	1.0(1.0)	1.0(1.0)	3.3(2.0)
Crop Management	0.7	1.0	2.0	0.1	4.0
Technology Dissemination	1.0(0.5)	1.6(2.0)	2.8	1.0	6.4(2.5)
Processing, Utilization, and Storage	0.2	1.0	1.1	2.0	4.3
Ratio of Benefits to FTEs[b]					
Varietal Development					
Crop Management					
Technology Dissemination					
Processing, Utilization, and Storage					

Note: a - Time allocation is in full-time researcher equivalents. Parentheses indicate researchers currently on training. b - Lightly shaded cells indicate discounted present value of research benefits greater than 100 million K. Sh. per equivalent full-time researcher. Darkly shaded cells indicate discounted present value of research benefits greater than 500 million K. Sh. per equivalent full time researcher.

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Derivation of research benefits formulas for the closed economy case

1. Relative reduction in Price = $Z = K\varepsilon/(\varepsilon+\eta) = -(P_1-P_0)/P_0$

   where: P_0 and Q_0 are equilibrium price and quantity before supply shift, η is the supply elasticity, _ is absolute value of price elasticity of demand
   supply: $Q_s = \alpha+\beta(P+k) = (\alpha+\beta k)+\beta P$
   demand: $Q_D = \gamma-\delta P$
   where: $k = P_0-d$ and $K = (P_0-d)/P_0 = k/P_0$

2. Set $Q_s = Q_D$ so that $P = (\gamma-\alpha-\beta k)/(\beta+\delta)$

   when: $k = 0$, $P_0 = (\gamma-\alpha)/(\beta+\delta)$
   when: $k = KP_0$, $P_1 = (\gamma-\alpha-\beta KP_0)/(\beta+\delta)$
   Research-induced price change =
   $(P_1-P_0) = -\beta KP_0/(\beta+\delta)$ and $-(P_1-P_0)/P_0 = \beta K/(\beta+\delta)$
   Converting to elasticities by multiplying the numerator and denominator by P_0/Q_0 gives $Z = K\varepsilon/(\varepsilon+\eta)$

3. Change in consumer surplus $= \Delta CS = P_0abP_1 = P_0aeP_1+abe$
   $= (P_0-P_1)Q_0 + 0.5(P_0-P_1)(Q_1-Q_0)$
   $= (P_0-P_1)Q_0[1+0.5(Q_1-Q_0)/Q_0]$

   because $Z = -(P_1-P_0)/P_0$, multiplying $(Q_1-Q_0)Q_0$ by Z/Z

   gives $(Q_1-Q_0)Q_0 = Z\eta$ and $\Delta CS = P_0Q_0Z(1+0.5Z\eta)$

4. Change in producer surplus $= \Delta PS = P_1bI_1 - P_0aI_0$
   $= P_1bcd + dcI_1 - P_0aI_0 = P_1bcd$
   $= P_1ecd + bce = (P_1-d)Q_0 + 0.5(P_1-d)(Q_1-Q_0)$

   thus, $\Delta PS = (P_1-d)Q_0[1+0.5(Q_1-Q_0)/Q_0]$

   We may define $(P_1-d) = (P_0-d) - (P_0-P_1) = KP_0-ZP_0$ and $(Q_1-Q_0)/Q_0 = Z\eta$

   thus, $\Delta PS = (K-Z)P_0Q_0(1+0.5Z\eta)$

5. Change in total surplus $= \Delta TS = \Delta CS + \Delta PS$

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DAY FOUR

Session 14
Scoring: Inclusion of Multiple Criteria in Priority Setting

Instructions to Trainers

SESSION 14

14:00 – 15:30 Session 14. Scoring: Inclusion of Multiple Criteria in Priority Setting

15:30 – 15:45 Tea/Coffee Break

15:45 – 17:00 Session 14. (Continued)

RATIONALE

In many developing countries, data are often unreliable or not available. Skilled analysts are scarce and therefore represent a high-opportunity cost. To build consensus on priorities and unbiased results, participation of research users in priority setting may be highly desirable. For these reasons, a priority-setting method that would minimize data and analyst skill requirements and enable users' participation, while maintaining the basic principles of the more sophisticated method, would be highly desirable. Moreover, priority-setting exercises will sometimes wish to include other criteria with efficiency estimates generated from economic surplus models.

OBJECTIVES

By the end of this session, the participants will be able to do the following:

- Explain the basic principles of the scoring method, the criteria used, and the data requirements.
- Explain how to integrate all the criteria to calculate a project score.
- Identify priority themes among a ranked list.

Use overhead 4.14.1 to present the objectives.

PROCEDURE

Training techniques: presentation, computer-based exercise in small groups.

PRESENTATION

(*experience*) Give a brief presentation focusing on identification of major research themes through constraints analysis. Eight overheads support the presentation: 4.14.2 through 4.14.9. At the end of the presentation, distribute handout 4.14.1 and be sure to ask the participants if they have any comments or questions, or if they need clarification. (15 minutes)

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EXERCISE 14

Exercise 14. Using scoring model to identify criteria. (2 hour 20 minutes)

1. Distribute handouts 4.14.2 through 4.14.5. Handout 4.14.2 gives clear instructions for the exercise. Go over the instructions with the participants step by step. Ask if clarification is needed. (5 minutes)

Phase 1. Group work

2. **Important!** Divide the participants into the *same four groups* as in the earlier session.

3. *(experience)* Groups select rapporteurs. They then work on the task and prepare their presentations. As the groups work, circulate from group to group to check progress. Clarify any concerns the groups may have while they are working. Be sure to remind the groups of the time remaining. (1 hour 40 minutes)

Phase 2. Reporting and discussion

4. *(process)* Groups report for exercise 14. Facilitate the presentations. Approximately five minutes is available for each group. (20 mintues)

5. *(process)* Open the discuss to the audience and, finally, provide your view on the results of the exercise. (15 minutes)

6. *(process, generalize)* At the end of the exercise provide feedback on the content of the presentations. Ask the participants questions such as "How did you feel doing this exercise?" and "What did you learn?" (5 minutes)

CLOSURE

Closure (5 minutes)

1. *(application)* Ask the participants to tell one of their neighbors two things they might do differently in their job as a result of what they learned in this exercise. Choose some volunteers to give samples.

2. Make a transition to the last session.

17:00 – 17:30 Feedback on the Day's Activities and PAPA

OBJECTIVES

By the end of this session participants will be able to do the following:

- Provide feedback on the day's activities.
- Consider possible actions they would like to implement in their own organizations.

PROCEDURE

Training technique: individual exercise.

Discuss any highlights or low points of the day. Note areas that may need additional attention in the workshop. Participants can write some strengths and weaknesses of this day on handout 4.14.6, and use handout 4.14.7 to facilitate their task. (15 minutes)

PAPA

(application) Ask the participants to take some time to jot down some "action ideas" they may have for themselves as a result of today's activities. They can use handout 4.14.8. (15 minutes)

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DAY FOUR

Session 14
Summary of Overheads

Objectives

Session 14: Scoring Inclusion of Multiple Criteria in Priority Setting

3. Explain basic principles of scoring method, criteria used, and data requirements.
4. Explain how to integrate all the criteria to calculate a project score.
5. Identify priority themes among a ranked list.

4.14.1

Scoring

Chooses projects on basis of their contribution to efficiency and other criteria such as equity and sustainability

4.14.2

Basic Principle of the Scoring Approach

To integrate criteria representing multiple objectives into a simple indicator.

4.14.3

Major Steps: Scoring Approach

1. Identify and weigh research system objectives
2. Measure standards

4.14.4

Major Steps: Scoring Approach (continued)

3. Assessment of alternative research activities. The score (measure of objectives) will combine criteria, usually by summing them
4. Ranking of research activities (comparison of alternatives)

4.14.5

Advantages of Scoring Approach

- Easier than economic surplus models
  - less: • data
  - • time
  - • skill
- Participatory process

4.14.6

Allows for Consensus

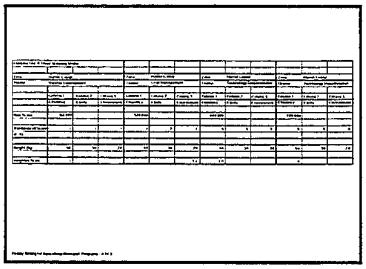
Without consensus, there is no point in having more rigorous results.

4.14.7

Limitation of Scoring Approach

- not rigorous

4.14.8



4.14.9

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The Scoring Model at Program Level (summary of presentation)

1. There is no single correct process for a priority-setting analysis. The basic principle of the scoring approach proposed here is to integrate criteria representing multiple objectives into a simple indicator.

2. The first step is to *identify and weight research system objectives.*

3. The next step involves the derivation of *measure standards*. This will allow objective and systematic comparison among similar research activities.

4. The derivation of measures is done in the same process which weights on the objectives are specified. Weights are often made by research directors and policymakers who have very little technical know-how, hence the need for the opinions of researchers/extension workers to specify technical criteria while economic theory gives guidance on how to combine the criteria into useful measures of the contribution of research to the given objective.

   Once the measurement standards are set and the information base established, *assessment of the alternative research* activities is the next step. This involves the assignment of judgement values using the standards. In essence this is scoring. The question asked is: *How well does the research activity address/satisfy the objective via the individual criteria?* The answers are given on an agreed scale, i.e., percentage, probability, absolute number, etc. and constitute a measure of objective for the project.

   The score (measure of objective) will combine the criteria, usually by adding them.

5. The final step involves ranking of the research activities (comparison of alternatives).

   Rankings from a priority-setting analysis can be presented

   - by commodity
   - by research program area within particular geographic regions
   - by research program area within commodities

   It can be useful to divide the prioritized list of commodities into high-, medium-, and low-priority groups:

   - The high-priority group would receive most of the support.
   - The medium-priority group would receive some support.
   - The low-priority group would include commodities for which scientists might not maintain research programs. They may attempt to keep abreast of research developments in other countries in the event that of a useful technology being developed that might be transferred.

   This grouping forces decision makers to think hard about priorities while not pretending that the results of the analysis are precise.

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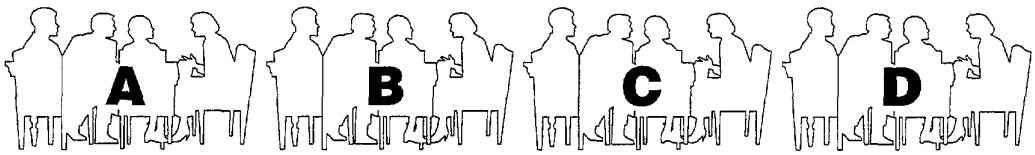
6. The results of the priority-setting scores can be presented to and discussed among those responsible for setting strategic research priorities. These people can be given a chance to question the results, and experiment with alternative assumptions, particularly on weights. These alternative assumptions can be incorporated in a spreadsheet program and new weights generated relatively quickly.

Exercise 14. Using score model to identify criteria (computer-based exercise in small groups)

Phase 1. Group preparation (5 minutes)

1. **Important!** Form the *same four groups* as in earlier sessions and elect a rapporteur.



Phase 2. Group work (1 hour 40 minutes)

2. Read and briefly discuss the handout 4.14.5: Defining a simple scoring model.

3. Use the scoring model on your spreadsheet (attached handout 4.14.3) and worksheet (handout 4.14.4).

4. Identify criteria additional to efficiency objectives measured by the economic surplus model in exercise 13.

5. Provide relative weight to each of the criteria.

6. Standardize the rank of all criteria in a scale of **0** to **5**.

7. Provide subjective assessment of non-efficiency criteria to be used in a scoring model.

8. Identify priority research themes and compare those rankings to the ranking from the economic surplus exercise.

Phase 3. Summary of results, reporting and discussion (40 minutes)

9. The rapporteur will summarize the group results on the flip chart and report to the audience.

10. The group rapporteur is expected to include in the summary the responses to the phase 2 questions, feedback on the process of this exercise and lessons learned.

11. The trainer will invite the participants to discuss the major issues, summarize results and close the session.

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Exercise 14a: A Three Scorning Model												
Zone:	Humid Costal			Zone:	Humid Costal		Zone:	Humid Costal		Zone:	Humid Costal	
Theme:	Varietal Development			Theme:	Crop Management		Theme:	Technology Dissemination		Theme:	Technology Dissemination	
	Criteria 1	Criteria 2	Criteria 3	Criteria 1	Criteria 2	Criteria 3	Criteria 1	Criteria 2	Criteria 3	Criteria 1	Criteria 2	Criteria 3
	Efficiency	Equity	Environment	Efficiency	Equity	Environment	Efficiency	Equity	Environment	Efficiency	Equity	Environment
Raw Score	50,000			370,000			440,000			100,000		
Standardized Score	1	1	1	4	2	4	5	5	3	5	5	0
(0 - 5)												
Weight (%)	50	30	20	50	30	20	50	30	20	50	30	20
Weighted Score	1					3.4	4.6			4		

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Exercise 14. Worksheet

Scoring*

7.1.1 Common Practice verses Basic Principles *Common Practice in Scoring Methods*

Many scoring studies make little, if any, appeal to a meaningful conceptual framework, a feature that limits their usefulness for any purpose. Often, they also lack a sound methodological basis, and do not proceed logically; they have usually been conceived and executed in an ad hoc fashion. To focus discussion, and provide a foundation for critical review of common practice, we define a hypothetical scoring study that is comparatively coherent, drawing on elements from the best studies. It should be emphasized that most scoring studies have not involved all of the following steps:

- Identify objectives: Several quantifiable objectives, including economic efficiency, distributional, and security objectives, are defined in discussion with the clients of the study. Often research policymakers do not perceive the objectives in this fashion at the outset and, as discussed in chapters 2 and 5, the objectives are commonly derived from a set of broader development goals.

- Identify program alternatives: Depending on the institutional context of the study, commodity and noncommodity research programs are usually listed. Often the list is long and includes relatively disaggregated "alternatives." Sometimes alternatives overlap. Often they are not represented quantitatively (i.e., the current funding of programs or alternative amounts of support is not identified).

- List criteria (grouped by objectives): "Criteria" replace objectives as performance measures to be used to assess program alternatives. As we show below, criteria are often incompatible with one another and are poor proxies for achievement of objectives. This need not be the case, at least to such a great extent. For publicly funded research investments, criteria that relate closely to measures of efficiency or distributional impact could be identified by drawing on the relevant economic theory. Different criteria, corresponding to private objectives, may be used for private research or for producer-funded research organizations.

- **Score programs according to criteria:** Scientists and policymakers are asked to "score" each of the alternative programs. Often, in the scoring process, little or no distinction has been drawn between (a) scoring as a ***measure*** of contribution to an objective and (b) scoring as a *weight* to be attached to different objectives. As a result, "scores" have been either weights or measures or a hybrid of both. Because there is no format framework, the analyst must choose units for scores on some arbitrary basis. Often the scores used as measures are ranks (say on a five-point scale from 1 to 5), and the scores used as weights are fractions (from 0 to 1) or percentages (from 0 to 100). Higher scores are usually taken to indicate either a greater contribution to an objective or a contribution to a more important objective, but sometimes the opposite is true. As seen later, unclear or inappropriate definitions of what scores are meant to represent can lead to serious errors.

*. **Extract from**: Alston, J.M., Norton, G.W. and Pardey, P.G. 1995. Science Under Scarcity (Chapter 5, pages 465–472). Ithaca: Cornell University Press.

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- **Rank programs according to scores:** Each program alternative (e.g., each commodity program) can be scored according to each criterion and then ranked from highest to lowest. This provides a separate ranking of all programs according to each criterion.
- **Calculate overall scores for program alternatives:** To produce a summary, overall ranking, each program alternative can be scored overall by adding across criteria. The scores on individual criteria might be weighted for aggregation or simply summed. This step might be absent from some studies, which use multiple rankings in decision analysis without reducing them to a summary, overall ranking.
- **Dialogue:** 'Me rankings of program alternatives (either overall or according to individual criteria) are presented to research policymakers and reviewed. The review process is intended to derive implications for resource allocation and, at the same time, to "validate" the results. Thus, in the dialogue, the analyst draws on advice from scientists and policymakers to review the rankings and reevaluate scores, weights, ranks, and implications. How this happens in practice is not always clear.

In summary, problems anise with respect to (a) how objectives are defined and measured, (b) how criteria are defined and what the scores associated with them are supposed to reflect (either a measure of the contribution of research to an objective or a weight reflecting the importance of an objective or elements of both), (c) how scores on criteria are traded off in developing a ranking, (d) how the rankings are validated, and (e) how the results are used to support decisions.

Principles for Scoring

If the economic approach is to be followed when using scoring for evaluating research and for setting priorities, four operational principles are especially pertinent:

Identify meaningful objectives: Setting priorities for agricultural research requires that clear objectives for the research system be identified from discussions with research policymakers (i.e., the research directors, agricultural research boards, or other policymakers who are the "clients" for the work). It is essential that objectives not be confused with *means and measures* of achieving them. For example, increasing production and employment and improving nutrition are means of improving economic and physical well-being. If the research policymakers list means and measures, rather than meaningful objectives, additional work is needed to elicit the fundamental and analytically more meaningful efficiency, distributional, or security objectives.

Distinguish weights from measures: Weights on objectives should reflect the clients' value judgments about the trade-offs among objectives. Determining weights is different from calculating the measures used to assess the research programs' contributions to each objective. Various criteria - such as value of production, probability of research success, and expected adoption rates - can be combined to provide a simple measure of the contribution of research to the efficiency objective. White research policymakers may have views about the relative importance of different objectives, they often have little understanding of how the criteria should be combined to generate meaningful measures of the contributions of research to those objectives.[5] The opinions of scientists, extension workers, and others are needed to specify values for

5. They might not be too good at defining weights, either, as discussed in chapters 5 and 6. Often it is necessary to review the weights in the light of a sensitivity analysis that shows the implications of varying the weights, in order to obtain weights that reflect the preferences of policymakers in relation to trading off the various objectives of the research system.

technical criteria, white economic theory provides a guide for how to combine these criteria into a useful measure of the contribution of research to the stated objectives.

In what follows we use "criteria" to refer to performance measures: thus an efficiency criterion is meant to measure the contributions of programs to an efficiency objective. Where possible, we use "scores" to purely reflect weights on objectives. However, we acknowledge that as criteria become increasingly remote from explicit measures of objectives, so too must their corresponding scores stray further from pure measures of weights on the objectives. For instance, the multiplier for area planted to a crop, used as one efficiency criterion, ought to be different from the multiplier on the NPV of research on that crop, used as an additional or, more appropriately, alternative efficiency criterion.

Recognize that research is a blunt instrument: If research policymakers treat research as the only policy instrument available for meeting social objectives, they might select a research portfolio that trades off substantial efficiency for additional equity (or some other objective). If they recognize the presence of other policy instruments, however, they might be less willing to trade off efficiency for, say, equity in selecting a particular research portfolio. Other policies may be more efficient than research at contributing to equity.[6]

Attempt to approximate economic surplus measures: When criteria that relate to the total research **benefit** and its distribution are being developed, where possible they ought to be combined in ways that correspond to the economic surplus measures described in chapter 5. For instance, an efficiency index that corresponds relatively closely to economic surplus measures may be calculated according to equation 7. 1. In this equation, the benchmark or baseline value of production for each commodity ($P_i \times Q_i$, for commodity i) is multiplied (a) by the anticipated proportional reduction in per unit costs, or proportional yield increase, $\mathrm{E}\left(Y_i^{MAX}\right)$, that would follow if the program were fully successful (at the particular funding level in question, usually the current level, and given other factors such as time to complete the research and so on) and the results were fully adopted, (b) by the estimated probability of success, pi (treating success as an all-or-nothing outcome), and (c) by the proportion of farmers likely to eventually adopt the new technologies, A_i^{MAX}. The result is a gross efficiency index for each commodity research program, G_i:[7]

$$G_i = A_i^{MAX} p_i \mathrm{E}\left(Y_i^{MAX}\right) P_i Q_i \qquad (7.1)$$

This is a proxy for gross annual research benefits. Many factors are excluded, such as the costs of research and effects of agricultural policies.

6. In chapter 2 we discuss the fact that research is but one instrument of social policy and is of often a high-cost way to attain nonefficiency objectives. In chapter 5 (section 5.4.5), the concepts of opportunity costs and weighting objectives in the presence of multiple policy instruments were related to the discussion of benefit transformation curves, BTCs, and indifference curves, ICs, introduced in chapter 2.

7. It can be seen that if this efficiency index is divided by the quantity of output Q_i, the resulting expression corresponds closely to the measure of the per unit research-induced cost saving, k_i, defined in chapter 5 (box 5.1) The main difference is that the expression for k was time-subscripted, reflecting the time path of adoption and research depreciation, δ_i.

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A net efficiency index, N_i, can be calculated by dividing the gross efficiency index by the research costs, R_i, that were assumed when questions pertaining to research benefits were asked (e.g., costs of the current research program over the next five years), as in equation 7.2.[8] These net efficiency indexes can be ranked from highest to lowest to provide what is best thought of as an *ordinal* ranking of commodities for the efficiency objective. While the efficiency indexes do provide a rough cardinal ranking as well, their imprecision should be kept in mind - as noted, many factors are not explicitly considered.[9]

$$N_i = \frac{G_i}{R_i} = \frac{A_i^{MAX} p_i \mathrm{E}\left(Y_i^{MAX}\right) P_i Q_i}{R_i} \tag{7.2}$$

This index is an improvement over the gross efficiency index in that it takes some research costs into account, but there is still no accounting for differences in the timing of flows of benefits and the fact that benefits accrue over many years.[10]

A similar approach will yield indexes of contributions to distributional objectives - for instance the total benefits can be apportioned roughly between consumers and producers using information about elasticities of supply and demand. Thus, an index of producer benefits, $N_{p,i}$, might be derived by multiplying the commodity-specific efficiency indexes by the ratio of the corresponding consumer demand elasticity (in absolute value terms, $\eta i > 0$) to the sum of the supply-and-demand elasticities ($\eta_i + \varepsilon_i$):[11]

$$N_{p,i} = N_i \frac{\eta_i}{\eta_i + \varepsilon_i} \tag{7.3}$$

8. An alternative would be to *subtract* the research program costs. The program is one of scale. The gross index Gi is a one-shot measure of the peak annual flow of research benefits for program i, while the research cost is closer to the present value of costs of the program. In many cases the difference between the two will be a negative number even though the rate of return would be positive, and the difference will be larger for larger programs. Thus the ranking of (G_i - R_i) will tend to favor smaller programs (smaller R_i) and would be entirely unrelated to the ranking according to the NPVs or IRRs obtained using the procedures in chapter 5.

9. Expected yield change probabilities of research success, and adoption rates together reflect the technical feasibility and usefulness of the research. Elasticities, agricultural policies, and trade patterns are of secondary importance in that they affect the distribution more than the size of the total benefits.

10. In chapter 5 we discussed the use of the net present value per unit of research resources (N_i^* NPV_i/R_i) as the conceptually correct criterion for ranking research programs when the total research budget is limited. The use of approximate economic surplus measures rather than the net present value of economic surplus measures to approximate the efficiency benefits of research implies that differences in the timing of research benefits and costs among program alternatives are relatively unimportant. Timing is likely to be unimportant for ranking if the timing of flows of benefits and costs is similar across research programs or if the discount rate is zero; either of these situations is unlikely.

11. Figure 2.7 and associated text show how the distribution of benefits is determined by the relative sizes of the elasticities of supply and demand. That equation 7.3 provides a reasonable approximation can be verified from the algebra in section 4.1.1 (equation 4.1).

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Review and Critique of Previous Scoring Studies

Scoring, as commonly practiced, violates many of the principles for evaluating research and setting priorities identified in the previous chapters of this book.[12] Scoring models have been employed for many years for selecting research projects in private industry." They have also been used in public agricultural research systems for more than 20 years, although most of the examples reported in the literature have occurred in the past 10 years.[14] Early attempts to apply scoring models took place in the mid- to late-1960s in the United States, first in a joint study for the U.S. Department of Agriculture and the state universities and land-grant colleges, and later at the Iowa State and North Carolina State agricultural experiment stations.[15] Subsequent studies have been conducted in Peru, the Dominican Republic, Ecuador, Uruguay, Colombia, Venezuela, Argentina, Kenya, West Africa, The Gambia, Bangladesh, Tanzania, and many other countries.[16]

Most of these studies (including some of our own) have violated, and in some cases grossly violated, several basic principles for research priority setting. While most of the studies established objectives for the research system, some did not. In several cases, weights were elicited from research directors to establish the relative importance of objectives or criteria. Commodity and noncommodity research programs, research program components, or projects were ranked according to each objective or criterion, and these rankings were multiplied by the elicited weights and summed to arrive at overall research rankings.

However, in many cases weights were placed directly on measures that are inappropriate criteria — measures that do not translate usefully into objectives - which made assigning weights effectively meaningless.[17] Several criteria related to the efficiency objective, which have been employed in previous scoring studies, may partially overlap with one another or with the efficiency indexes defined above. These include, for example, (a) value of production per hectare, (b) number of hectares, (c) yield gap between the country of interest and other countries, (d) foreign exchange earnings, (e) comparative advantage, (f) potential completion of research in a reasonable period of time, (g) likelihood of immediate adoption, and (h) current program capacity. Such criteria provide a less precise approximation to economic surplus than those calculated by combining multiple "criteria" into an appropriate criterion that corresponds to the efficiency objective. Thus, we argue that these other "efficiency criteria" should not be used.

The distributional criteria used in prior studies include (a) the number of people employed in producing a particular commodity, (b) the number of producers, (c) average farm size, (d) the quantity of calories and protein in the diet attributable to consumption of a commodity, (e) contribution to sustainable agriculture, (f) political visibility, and (g) the proportion of a commodity consumed on the farm where it is produced. We argue that these criteria, and others like them, should not bc used. Most of them do relate to potentially legitimate distributional

12. A number of previous studies have discusses the advantages and disadvantages of scoring and how scoring as commonly practices relates to economic principles. These include Parton, Anderson and Makeham (1994), Fox (1987), Scobie and Jardine (1988), and Norton (1993).

13. See, for example, Moore and Baker (1969) and the literature review by Havlicek and Norton (1981).

14. See the studies cited in footnotes 2 and 3.

15. The studies included Paulsen and Kaldor (1968), Mahlstede (1971), Williamson (1971), and Shumway and McCracken (19175).

16. See the studies cited in footnotes 2 and 3.

17. Examples include Moscoso et al.(1986), Venezian and Edwards (1986), and Gryseels et al.(1992).

objectives; however, as quantitative proxies for the research benefits accruing to particular groups, they are likely to be misleading indicators. For example, if demand for a commodity is inelastic such that the demand for total inputs is reduced when supply increases, then the more people employed in its production, the more will be displaced unless the change in technology is biased in favor of labor. Hence, the number of people employed is a poor proxy for the potential positive benefits of research on employment. As another example, if significant income gains are sacrificed as a result of placing weight on calories or protein as a crude proxy for nutritional benefits, then the malnourished could be harmed more than helped for reasons discussed in chapter 2. The bottom line is that these other proxies for measures of research contributions to objectives are just too crude to be of use - and they will often be downright misleading.

Previous studies have included overlapping criteria that double-count effects. For example, the Technical Advisory Committee (TAC) for the Consultative Group on International Agricultural Research (CGIAR) conducted a study, reported by Gryseels, et al. (1992), that included both value of production and usable land as separate criteria. Clearly these two criteria are highly correlated and both pertain to efficiency. Medina Castro (1991) included value of production, value of trade, and comparative advantage as purportedly independent measures of research contributions to efficiency. The overlapping nature of these criteria is often subtle, but the fact that they are poor proxies for research contributions to efficiency is not.

A separate and equally serious problem with these criteria is that their units are usually incompatible with one other, even for different criteria related to the same objective. Therefore, if weights are attached to them directly in the scoring model, the choice of units for criteria can dominate the weighting and the resulting ranking in unintended ways, as illustrated in appendix A7. 1. Several studies have attempted to circumvent this problem by weighting the *rankings* corresponding to the numerical values for the criteria rather than weighting the actual values. However, this procedure introduces a new problem because it eliminates the cardinality of the values within each criterion. And differences across criteria in these cardinal aspects of the data can convey useful information to decision makers when programs are compared.

Although scoring methods are usually implemented when resource constraints preclude a more complete analysis, it is possible to achieve greater consistency with basic principles than has been achieved in the past. Below, we suggest how a scoring model can be constructed and applied so as to achieve as much of this consistency as possible, while economizing on time and other resources. Scoring is not the only shortcut method for informing the priority-setting process when resources for analysis are tight. In many cases it might be preferable to apply some basic priority-setting principles, or guidelines, without calculating economic surplus per se or explicitly weighting even simple surplus measures. Section 7.2 discusses some alternative shortcut procedures that might be preferred to scoring in some settings.

Strengths and Weaknesses

- **Please list what you consider to be three strengths of day four**

1.
2.
3.

- **Please list what you consider to be three weaknesses of day four**

1.
2.
3.

- **Suggestions for improvements**

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Guidelines to Provide Feedback on the Workshop

1. **The Module**

   Content

   - usefulness/relevance
   - amount of information

   Structure

   - sequence
   - duration
   - balance between trainers' and trainees' participation
   - instructions to trainers
   - visual aids
   - handouts, exercises
   - extra readings
   - PAPA
   - evaluation

2. **Process: training techniques and direction**

   - usefulness/relevance/effectiveness
   - group interaction
   - clarity of questions/exercises instructions
   - opening and closure of the days

3. **Trainers', facilitators', and trainees' performance**

   - presentation/communication skills
   - interaction/effective participation
   - punctuality/interest/commitment/willingness to facilitate learning/willingness to participate
   - other attitudes

4. **Logistical support**

   - organization
   - accuracy
   - punctuality
   - willingness to assist participants
   - services provided in general

5. **Workshop environment**

- physical (training facilities, training material, hotel facilities in general)
- psychological (personal feelings such as self-motivation, interest, satisfaction, self-achievement)
- social (development of friendship, relaxed, comfortable among participants, etc.)

6. **Workshop results/outputs**

- personal and professional assessment
- recommendations

7. **General comments**

FIRST STAGE

PAPA - ideas for action items

Date : _____

Workshop title: SADC/ESAMI/ISNAR Workshop on Priority Setting for Agricultural Research Programs

Date/Venue : _____

Name : _____

Organization : _____

Ideas I would like to try out when I return to work at my research institute, based on what I have learned in this training workshop.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Note: You can use the workshop objectives, what you learn in class, the course handouts, conversations with participants and trainers, etc., to come up with ideas.

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DAY FIVE

Priority Setting for Agricultural Research Programs

DAY FIVE — Overview

Objectives

By the end of the day the participants will be able to do the following:

1. Describe a protocol for approval and implementation of priority-setting results.
2. Identify sources of information needed for different priority-setting methods.
3. Identify available data in their own country.
4. Suggest appropriate methods for their country.
5. Draft a plan for priority-setting exercise in their own country.
6. List short-term actions to be taken to implement their action plan designed in session 17.
7. Evaluate and provide feedback on the five-day workshop.

Handouts

5.15.1 Overview
5.15.2 Tentative Schedule
5.15.3 Priority Setting: Results Approval, Implementation, and Management of the Process (summary of presentation)
5.15.4 Linking the Results to Resource Allocation Decisions (text)
5.15.5 Information Flows and Institute Structure (KARI example) (figure)
5.15.6 Implementation (KARI example)
5.15.7 Exercise 15. Outlining Resource Allocation Guidelines from a Priority-Setting Exercise
5.15.8 Exercise 15. Worksheet
5.16.1 Data Collection (summary of presentation)
5.16.2 Exercise 16. Reviewing Data and Human Resource Requirements for Economic Surplus and Scoring Models
5.16.3 Exercise 16. Checklist
5.16.4 Exercise 16. Worksheet
5.17.1 Exercise 17. Drafting a Priority-Setting Exercise. Plan of Action
5.17.2 Executive Summary of Priority Setting in the 21st Century: A Position Paper by the Priority-Setting Working Group (text)
5.17.3 Exercise 17. Worksheet
5.18.1 PAPA Form — Second Stage
5.18.2 Evaluation Form for the Five-Day Workshop
5.18.3 Guidelines to Provide Feedback on the Workshop

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Priority Setting for Agricultural Research Programs

DAY FIVE — Tentative Schedule

08:30 - 09:00	**Opening of the Day's Activities**
09:00 - 10:30	**Session 15. Managing the Priority-Setting Process** (Presentation and exercise 15)
10:30 - 10:45	Tea/Coffee Break
10:45 - 11:10	**Session 15. (Continued)**
11:10 - 13:00	**Session 16. Data Collection** (Presentation and exercise 16)

13:00 — 14:00 Lunch

14:00 - 15:30	**Session 17. The Priority-Setting Process** (Exercise 17)
15:30 - 15:45	Tea/Coffee Break
15:45 - 16:15	**Session 17. (Continued)**
16:15 - 17:15	**Session 18. Participant Action Plan Approach (PAPA) and Workshop Evaluation**
17:15 - 17:30	**Final Remarks and Closing**

Priority Setting for Agricultural Research Programs

DAY FIVE — Checklist for trainers

Handouts

		Yes ✔	No ✔
5.15.1	Overview	❒	❒
5.15.2	Tentative Schedule	❒	❒
5.15.3	Priority Setting: Results Approval, Implementation, and Management of the Process (summary of presentation)	❒	❒
5.15.4	Linking the Results to Resource Allocation Decisions (text)	❒	❒
5.15.5	Information Flows and Institute Structure (KARI example) (figure)	❒	❒
5.15.6	Implementation (KARI example)	❒	❒
5.15.7	Exercise 15. Outlining Resource Allocation Guidelines from a Priority-Setting Exercise	❒	❒
5.15.8	Exercise 15. Worksheet	❒	❒
5.16.1	Data Collection (summary of presentation)	❒	❒
5.16.2	Exercise 16. Reviewing Data and Human Resource Requirements for Economic Surplus and Scoring Models	❒	❒
5.16.3	Exercise 16. Checklist	❒	❒
5.16.4	Exercise 16. Worksheet	❒	❒
5.17.1	Exercise 17. Drafting a Priority-Setting Exercise. Plan of Action	❒	❒
5.17.2	Executive Summary of Priority Setting in the 21st Century: A Position Paper by the Priority-Setting Working Group (text)	❒	❒
5.17.3	Exercise 17. Worksheet	❒	❒
5.18.1	PAPA Form — Second Stage	❒	❒
5.18.2	Evaluation Form for the Five-Day Workshop	❒	❒
5.18.3	Guidelines to Provide Feedback on the Workshop	❒	❒

Overheads

5.15.1	Objectives of Day Five	❒	❒
5.15.2	Schedule of Day Five	❒	❒
5.15.3	Objectives of Session 15. Managing the Priority-Setting Process	❒	❒
5.15.4	Priority Setting Should be	❒	❒
5.15.5	Process of Priority Setting Should be	❒	❒
5.15.6	Those Responsible	❒	❒
5.15.7	A Participative Process	❒	❒
5.15.8	Information Flows and Institute Structure	❒	❒
5.15.9	Implementation	❒	❒

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		Yes	No
5.16.1	Objectives of Session 16. Data Collection	❒	❒
5.16.2	Data Collection	❒	❒
5.16.3	Basic Recommendations to Collect Data	❒	❒
5.16.4	Basic Recommendations to Collect Data	❒	❒
5.16.5	Basic Recommendations to Collect Data	❒	❒
5.16.6	Basic Recommendations to Collect Data	❒	❒
5.16.7	Data come from	❒	❒
5.16.8	Data/Information can be	❒	❒
5.16.9	Economic Surplus Analysis	❒	❒
5.16.10	Research-Related Data are	❒	❒
5.16.11	Research-Related Data	❒	❒
5.16.12	Meaningful Priority-Setting Exercise	❒	❒
5.16.13	Checklist	❒	❒
5.17.1	Objectives of Session 17. The Priority-Setting Process	❒	❒
5.17.2	Major Elements of Your Scheme to Carry Out Priority Setting at Your NARS	❒	❒
5.18.1	Objectives of Session 18. PAPA and Workshop Evaluation	❒	❒

Materials

• Overhead projector	❒	❒
• Projector screen	❒	❒
• Flipchart stands (minimum 2)	❒	❒
• Flipchart paper/pads (about 10 per day)	❒	❒
• Markers for writing on newsprint	❒	❒
• Markers for writing on transparencies	❒	❒
• Blank transparencies	❒	❒
• Stapler	❒	❒
• Tape (strong masking tape and regular tape)	❒	❒
• Push pins	❒	❒
• Glue	❒	❒
• Pencils/note pads/pens	❒	❒
• Pencil sharpeners	❒	❒
• Extension cords	❒	❒
• Certificates	❒	❒
• Photocopying facilities	❒	❒
• Spare bulbs for overhead projector	❒	❒
• Extra notepads and pens	❒	❒
• Scissors	❒	❒

DAY FIVE

Session 15
Managing the Priority-Setting Process

Instructions to Trainers

PRE-SESSION

08:30 – 09:00 Opening of the Day's Activities
– Review of the previous day's activities.
– Summary of the evaluation of the previous day.
– Overview of the day's activities.

OBJECTIVES

By the end of the pre-session the participants will be able to do the following:

- Assess the progress of the workshop.
- List the objectives and describe the agenda for the day's activities.

OPENING

Invite a volunteer to review the previous day's activities. (10 minutes)

Summarize the evaluation of the previous day. (10 minutes)

Distribute the overview and the schedule for day five (handouts 5.15.1 and 5.15.2) to the participants. Review the objectives and schedule, using overheads 5.15.1 and 5.15.2. Ask if clarification is needed. (10 minutes)

SESSION 15

09:00 – 10:30 Session 15. Managing the Priority-Setting Process

10:30 – 10:45 Tea/Coffee Break

10:45 – 11:10 Session 15. (Continued)

RATIONALE

Once the results of the priority-setting exercise have been produced, the research management should put them to use. This requires an approval of the results and their translation of the results into tangible research allocation decisions.

OBJECTIVE

By the end of this session, the participants will be able to do the following:

- Describe a protocol for approval and implementation of priorit- setting results.

Use overhead 5.15.3 to present the objective.

PROCEDURE

Training techniques: presentation, group exercise.

PRESENTATION

(*experience*) Give a brief presentation on managing the priority-setting process. Six overheads support the presentation: 5.15.4 through 5.15.9. At the end of the presentation, distribute handout 5.15.3 and be sure to ask the participants if they have any comments or questions or if they need clarification. (15 minutes)

EXERCISE 15

Exercise 15. Outlining a resource allocation guidelines from a priority-setting exercise. (1 hour 35 minutes)

1. Distribute handouts 5.15.4, 5.15.5, 5.15.6, 5.15.7 and 5.15.8. Handout 5.15.7 gives clear instructions for the exercise. Go over the instructions with the participants step by step. Ask if clarification is needed. (5 minutes)

Phase 1. Group work

2. Divide the participants into the same four groups as in the earlier session.
3. *(experience)* Groups select rapporteurs. They then work on the task and prepare their presentations. As the groups work, circulate from group to group to check progress. Clarify any concerns the groups may have while they are working. Be sure to remind the groups of the time remaining. (60 minutes)

Phase 2. Reporting and discussion

4. *(process)* Groups report for exercise 15. Facilitate the presentations. Approximately three minutes are available for each group. (15 mintues)
5. *(process)* Open the discuss to the audience and, finally, provide your view on the results of the exercise. (10 minutes)
6. *(process, generalize)* At the end of the exercise provide feedback on the content of the presentations. Ask the participants questions such as "How did you feel doing this exercise?" and "What did you learn?" (5 minutes)

CLOSURE

Closure (5 minutes)

1. *(application)* Ask volunteers to list the major things they learned from this exercise. These should be things that will improve their performance of priority-setting tasks in their jobs.
2. Make a transition to the next session.

10:30 – 10:45 Tea/Coffee Break

DAY FIVE

Session 15
Summary of Overheads

Objectives of Day Five

1. Describe a protocol for approval and implementation of priority-setting results.
2. Identify information sources for priority-setting methods.
3. Identify available data in your country.
4. Suggest appropriate methods.
5. Draft a priority-setting comprehensive plan of action.
6. List major short-term actions to implement your comprehensive action plan designed in previous sessions.
7. Evaluate and provide feedback on the workshop.

5.15.1

Schedule of Day Five

08:30 – 09:00	Opening of the Day's Activities
09:00 – 10:30	Session 15. Managing the Priority-Setting Process
Tea/Coffee Break	
10:45 – 11:10	Session 15. (Continued)
11:10 – 13:00	Session 16. Data Collection
Lunch	
14:00 – 15:30	Session 17. The Priority-Setting Process
Tea/Coffee Break	
15:45 – 16:15	Session 17. (Continued)
16:15 – 17:15	Session 18. Participating Action Plan Approach (PAPA) and Workshop Evaluation
17:15 – 17:30	Final Remarks and Closing

5.15.2

Objectives

Session 15: Managing the Priority-Setting Process

1. Describe a protocol of approval and implementation of priority-setting results.

5.15.3

Priority Setting should be

- *Participative*
  so as to build consensus at the level where priority setting is being done
- *Approved by a committee*
  composed of a cross-section of major stakeholders in the research results

5.15.4

Process of Priority Setting should be

- *Interactive*
  in order to accomodate changing environments
- *Initiated*
  by the person who is directly responsible for the implementation of the results

5.15.5

Those responsible should clearly understand how the results will be translated into resource allocation decisions.

5.15.6

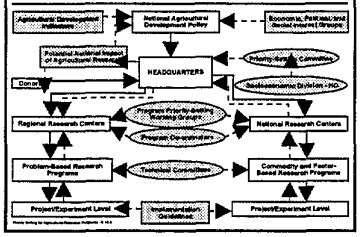
A Participative Process

Priority setting requires that

- all stakeholders play a part and be involved in the consensus building, i.e.
  - policymakers
  - research clients
  - researchers
  - donors
- this stakeholder group should establish medium-term resource allocation guidelines based on identified priorities

5.15.7

Information Flows and Institute Structure



5.15.8

Implementation

Facilitator	- identifies benchmark data - operates priority-setting applications - ensures cross-program compatibility in priority-setting exercises
Working group	- consists of key-program experts - provides initial assumptions - is responsible for write-up of program exercise
Stakeholder group	- reviews/modifies initial assumptions - builds program consensus

5.15.9

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Handout — Overview of Day Five

Priority Setting for Agricultural Research Programs

Objectives

By the end of the day the participants will be able to do the following:

1. Describe a protocol for approval and implementation of priority-setting results.
2. Identify sources of information needed for different priority-setting methods.
3. Identify available data in their own country.
4. Suggest appropriate methods for their country.
5. Draft a plan for a priority-setting exercise in their own country.
6. List short-term actions to be taken to implement their action plan designed in session 17.
7. Evaluate and provide feedback on the five-day workshop

Handouts

5.15.1 Overview
5.15.2 Tentative Schedule
5.15.3 Priority Setting: Results Approval, Implementation, and Management of the Process (summary of presentation)
5.15.4 Linking the Results to Resource Allocation Decisions (text)
5.15.5 Information Flows and Institute Structure (KARI example) (figure)
5.15.6 Implementation (KARI example)
5.15.7 Exercise 15. Outlining Resource Allocation Guidelines from a Priority-Setting Exercise
5.15.8 Exercise 15. Worksheet
5.16.1 Data Collection (summary of presentation)
5.16.2 Exercise 16. Reviewing Data and Human Resource Requirements for Economic Surplus and Scoring Models
5.16.3 Exercise 16. Checklist
5.16.4 Exercise 16. Worksheet
5.17.1 Executive Summary of Priority Setting in the 21st Century: A Position Paper by the Priority-Setting Working Group (text)
5.17.2 Exercise 17. Drafting a Priority-Setting Exercise. Plan of Action
5.17.3 Exercise 17. Worksheet
5.18.1 PAPA Form — Second Stage
5.18.2 Evaluation Form for the Five-Day Workshop
5.18.3 Guidelines to Provide Feedback on the Workshop

Handout — Tentative Schedule of Day Five

Priority Setting for Agricultural Research Programs

08:30 - 09:00	**Opening of the Day's Activities**
09:00 - 10:30	**Session 15. Managing the Priority-Setting Process** (Presentation and exercise 15)
10:30 - 10:45	Tea/Coffee Break
10:45 - 11:10	**Session 15. (Continued)**
11:10 - 13:00	**Session 16. Data Collection** (Presentation and exercise 16)

13:00 — 14:00 Lunch

14:00 - 15:30	**Session 17. The Priority-Setting Process** (Exercise 17)
15:30 - 15:45	Tea/Coffee Break
15:45 - 16:15	**Session 17. (Continued)**
16:15 - 17:15	**Session 18. Participant Action Plan Approach (PAPA) and Workshop Evaluation**
17:15 - 17:30	**Final Remarks and Closing**

Priority Setting: Results Approval, Implementation, and Management of the Process (summary of presentation)

It has been stressed that priority setting should be a participative process which builds a *consensus* on the medium- to long-term direction of the research program.

The process of priority setting should be *iterative* in order to accommodate changing environments.

The process should be initiated by the person who is directly responsible for the implementation of the results. This person should understand the objectives of priority setting and how the results will be translated into resource allocation decisions.

As a participative process priority setting requires that all the stakeholders play a part i.e. policymakers, research clients, researchers and donors must be involved in the consensus building. Their roles have been spelt out above as providers of data/information, however, their representatives must be involved in translating these results into guidelines for resource allocation decisions.

The overheads give an example of the management of a priority-setting process.

Linking the results to resource allocation decisions[1]

Since priority setting is primarily a consensus building process, care must be taken not to make methods, models, and data the end goal of priority setting exercises. There are no 'correct' priorities in terms of predicting agricultural research impact in future environments. There are, however, priorities which build a clear consensus on the direction of a programme or institute using expert opinion, data, and models as important tools in the process. As part of the consensus building process, economic methods for measuring potential research impact must be combined with effective institutional structures for setting programme guidelines on resource allocation decisions. Therefore, the working group results were presented to a larger group of programme research stakeholders where their assumptions were reviewed and modified.[2] The group then developed a consensus on high priority programme research themes and zones, Table 7. While the results of the priority setting exercise were an important base for building a consensus on programme priorities, other considerations, particularly the stated national policy goal of expanding wheat production into the Mid-Altitude Moist zone, could be taken into account.

Table 7: A Comparison of Programme Priorities and Current Human Resource Allocations

	High-mid alt. moist	High-mid alt. wet	Highlands	Mid-alt. moist	Mid-alt. wet	Total[c]
Program priorities[a]						
Plant breeding						
Plant protection						
Crop management						
Technology dissemination						
Current allocation of program scientists (FTE)[b]						
Plant breeding	1.0	1.0	2.0	1.0	1.0	6(2)
Plant protection	2.0	2.0	2.0	0.0	0.0	6(1)
Crop management		2.0		2.0	0.0	4(1)
Technology dissemination		0.45		0.8	0.0	1.25(.75)

Note: a. Darkly shaded cells indicate high priority research themes within the zones.
b. Time allocation is in full time researcher equivalents. Lightly shaded cells indicate an indivisible allocation of scientist time across the traditional wheat growing zones.
c. Parentheses indicate researchers currently on training.

1. **Extract from**: Mills, B. and Karanja, D. 1995. Processes and Methods for Research Program Priority Setting: The Experience of the Kenya Agricultural Research Institute Wheat Program, pages 14-16. Nairobi: KARI.

2. The Stakeholder Group was composed of farmer, extension, seed company, chemical company, and processing sector representatives, as well as a broader coalition of Wheat Programme scientists.

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Finally, the Stakeholder Group compared high priority themes and zones with current human resource allocations within the Wheat Programme. Based on this comparison, several recommendations arose for adjusting the medium term focus of the programme. These were:

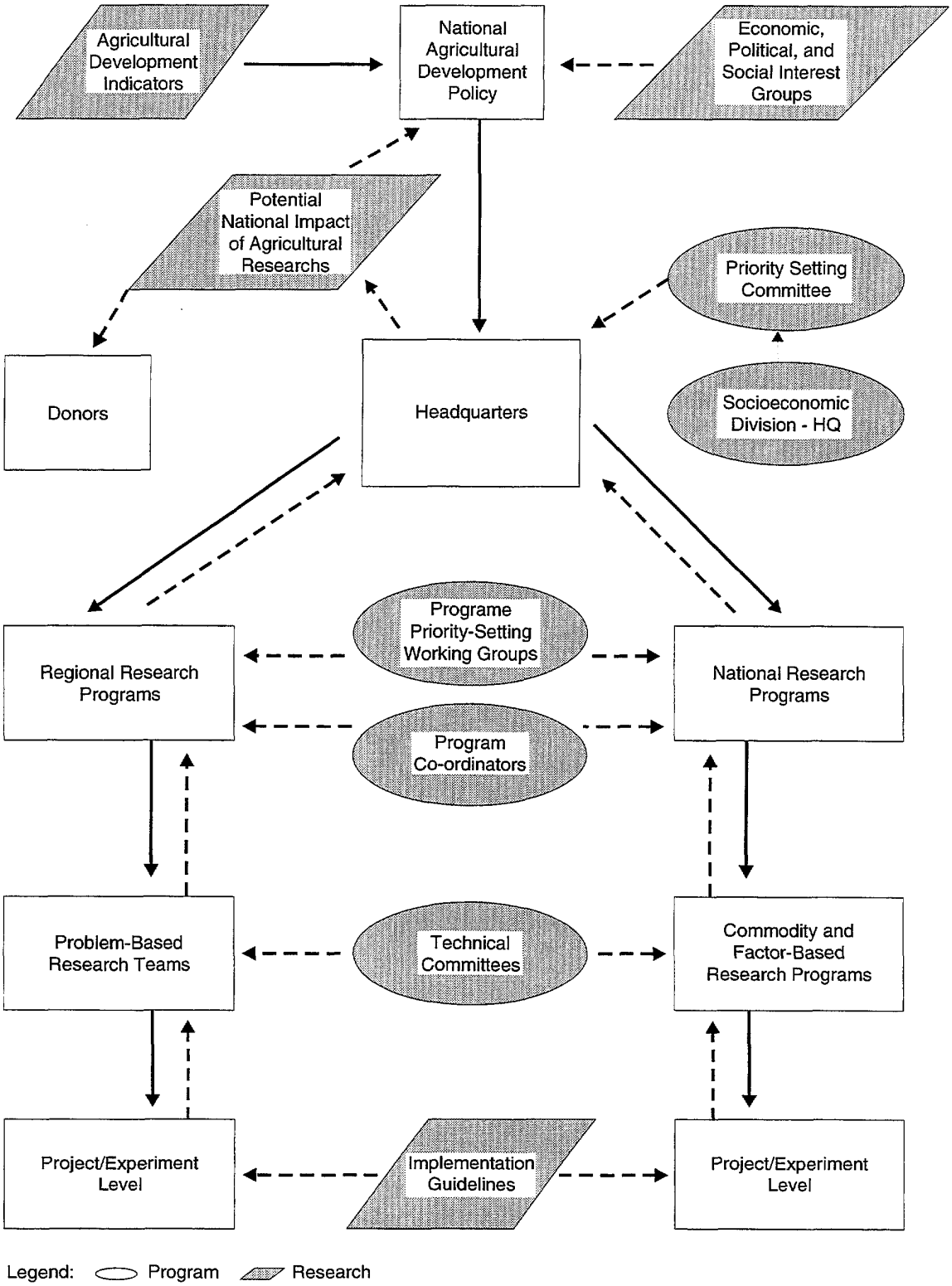
- Reduce the previous programme emphasis on plant protection;
- Increase the programme focus on technology dissemination research themes, particularly in the moist rainfall zones;
- Concentrate crop management activities in the High Mid-Altitude Moist and High Mid-Altitude Wet zones; and
- Concentrate wheat breeding activities in the High Mid-Altitude Wet and Moist Mid-Altitude zones.

Since stability is an important factor in programme performance, these recommendations do not necessary suggest an immediate re-allocation of programme resources. Rather, they are guidelines for the further development of programme activities and human resources.

In conclusion, the goal of the priority setting process described in this paper was to assist the KARI Wheat Programme in setting research priorities both spatially and by major research themes. The process was designed to minimize information, methodological, and human resource requirements without sacrificing conceptual rigor. At the programme level, such structured priority-setting exercises provide scientists with a better understanding of the environment for technology development. Target zones identify the area associated with key bio-physical parameters for production of the commodity. These zones also allow the programme to examine potential spill-overs in coordinating its work with regionally based adaptive research centres. A review of the current production situation within zones, based on historical data sources, also improves the programme understanding of commodity trends to be addressed. Finally, a systematic analysis of the potential for the generation and adoption of research results within the current production environment improves programme understanding of potential impact.

Combined, this information can help the national commodity programmes to refine their research agendas and make coherent arguments on the potential contribution of those agendas to national agricultural development objectives. However, to have such an impact on the research agenda, the information must be effectively integrated into an institutional process for setting research priorities and then translating those priorities into resource allocation decisions. In order to achieve this objective, the priority setting process formally constituted a stakeholder group to assist the Wheat Programme in establishing programme priorities and accompanying medium term resource allocation guidelines.

Information Flows and Institute Structure (KARI example)



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Implementation (KARI example)

Facilitator

Identified benchmark data

Operates priority-setting applications

Ensures cross-program compatibility in priority-setting exercises

Working group

Key-program experts

Provides initial assumptions

Is responsible for write-up of program exercise

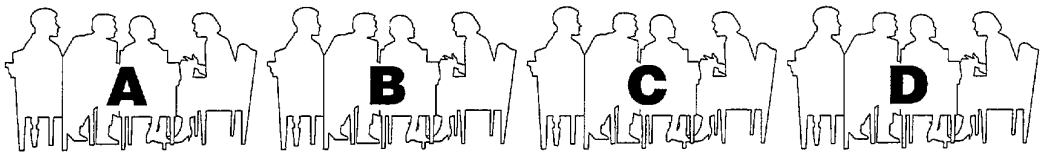
Stakeholder group

Reviews/modifies initial assumptions

Builds program consensus

Exercise 15. Outlining a resource allocation guidelines from a priority-setting exercise (group exercise)

1. **Important!** Form the *same groups* of participants as in earlier sessions of computer-based sessions and elect a rapporteur.



Phase 1. Group work (60 minutes)

2. Read the handout 5.15.4 "Linking the results to resource allocation decisions". Use the handout 5.15.8 (worksheet) to take notes of the major issues of your discussion.

3. Outline an appropriate set of resource allocation guidelines from a priority-setting exercise.

4. What group should be responsible for implementing these guidelines?

Phase 2. Reporting and discussion (30 minutes)

5. The rapporteur will summarize the results of the group exercise on a flip chart to present to the audience.

6. The trainer will facilitate discussion among the participants to promote additional learning opportunity, provide feedback and close the session.

Exercise 15. Worksheet

DAY FIVE

Session 16
Data Collection

Instructions to Trainers

SESSION 16

11:10 – 13:00 Session 16. Data Collection

RATIONALE

A lot of data and information is used in the priority setting process. The quality of these inputs is of paramount importance as it ultimately determines the quality of the priority-setting exercise.

OBJECTIVES

By the end of this session, the participants will be able to do the following:

- Identify sources of information needed for different priority-setting methods.
- Identify available data in their own country.
- Suggest appropriate methods for their country.

Use overhead 5.16.1 to present the objectives.

PROCEDURE

Training techniques: presentation, group exercise.

PRESENTATION

(*experience*) Give a brief presentation focusing on data collection. You will find the information in the handout very useful. Twelve overheads support the presentation: 5.16.2 through 5.16.13. At the end of the presentation, distribute handout 5.16.1 and be sure to ask the participants if they have any comments or questions, or if they need clarification. (15 minutes)

EXERCISE 16

Exercise 16. Reviewing data and human resource requirements for economic surplus and scoring methods. (1 hour 25 minutes)

1. Distribute handouts 5.16.2, 5.16.3, and 5.16.4. Handout 5.16.2 outlines the exercise. Go over the instructions with the participants step by step. Ask if clarification is needed. (5 minutes)

Phase 1. Group work

2. **Important!** Divide the participants into the *same four groups* as in the earlier session.
3. *(experience)* Groups select rapporteurs. They then work on the task and prepare their presentations. As the groups work, circulate from group to group to check progress. Clarify any concerns the groups may have

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while they are working. Be sure to remind the groups of the time remaining. (50 minutes)

Phase 2. Reporting and discussion

4. *(process)* Groups report for exercise 16. Facilitate the presentations. Approximately three minutes is available for each group. (15 mintues)
5. *(process)* Open the discuss to the audience and, finally, provide your view on the results of the exercise. (10 minutes)
6. *(process, generalize)* At the end of the exercise provide feedback on the content of the presentations. Ask the participants questions such as "How did you feel doing this exercise?" and "What did you learn?" (5 minutes)

CLOSURE

Closure (5 minutes)

1. (*application*) Ask the participants "What might you do differently in your job as a result of what you learned?"
2. Make a transition to the next session.

13:00 – 14:00 Lunch

DAY FIVE

Session 16
Summary of Overheads

Objectives

Session 16: Data Collection

2. Describe a protocol for approval and implementation of priority-setting results.
3. Identify sources of information for different priority-setting methods.
4. Identify available data in your country.

5.16.1

Data Collection

To collect data, it is necessary to link information needs and information availability.

5.16.2

Basic Recommendations for Collecting Data

(a) Determine information needs for chosen priority-setting criteria and potential methods

5.16.3

Basic Recommendations for Collecting Data

(b) Identify available sources of information

5.16.4

Basic Recommendations for Collecting Data

(c) Identify areas where information is poor.
- can the information base be improved?
- can alternative methods be used which do not rely on missing information?

5.16.5

Basic Recommendations for Collecting Data

(d) Information may be required to measure efficiency (economic growth), equity (distribution of growth), food security, sustainability, and other objectives

5.16.6

Data come from

(a) public sources
(b) research leaders and policymakers
(c) economists

5.16.7

Data/Information can be

- market related
- research related
- quantitative or qualitative

5.16.8

Economic Surplus Analysis

Market-related data include:

(a) quantities produced
(b) prices
(c) policies
(d) elasticities
(e) discount rate
(f) population growth rate
(g) income growth rate

5.16.9

Research-Related Data are

- based on expert opinion
- obtained from research leaders, researchers, and extension workers
- focused on the potential for generation and adoption of technologies

5.16.10

Research-Related Data

- require a good disciplinary, and
- regional mix of opinions

5.16.11

Meaningful Priority-Setting Exercise

- Information on research client constraints is a prerequisite for an effective priority-setting exercise

5.16.12

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Checklist

Example list of data and other information needed for research priority setting using the scoring model (with example sources of information) for each commodities.

	Commodity	Commodity	Commodity	Commodity
I. Information from research situations and policymakers				
1. List of commodities to include in the analysis.				
2. List of research programs to include in the analysis.				
3. Objectives for the research system.				
4. Weights on objectives for the research system.				
5. Estimates of annual research expenditures or assumed years by commodity.				
II. Published data				
1. Quantity of production for each commodity for the previous three to five years by zone.				
2. Prices at producer for the last five years by zone.				
3. Proportion of each commodity produced on smallholder farms.				
III. Information from scientists and extensionists (for Whole and Zone)				
Technology generation:				
1. Anticipated net yield increase.				
2. Demonstrated net yield gain level.				
Technology adoption:				
1. Research investment (e.g.)				
2. Period of increase adoption.				
3. Anticipated peak level of adoption.				
4. Period of decline/phase out.				
IV. Economic data				
1. Elasticities.				
2. Discount rate.				
3. Population growth rate				
V. Information on about needs				
1. Informal surveys				
2. Formal surveys.				

5.16.13

Data Collection
(summary of presentation)

1. In order to collect data that is going to be useful, it is necessary to understand both information needs and information availability. The following steps are suggested:

   (a) Determine information needs for chosen priority-setting criteria and potential methods.
   (b) Identify available sources of information.
   (c) Identify areas where information is poor. Can the information base in this area be improved? Can alternative methods be used which do not require this information?
   (d) Rank the objectives according to the users' needs.

2. In agricultural research, data and information may be required for the following categories of objectives:

   (a) Efficiency objectives = economic growth
   (b) Distributional objectives = equity
   (c) Other objectives = security, sustainability

3. These data may be from different sources:

   (a) Published sources
   (b) Research leaders and policymakers
   (c) Economists

4. The data/information can be market related or research related. These could be quantitative or qualitative.

   Market-related data for economic surplus analysis will include:

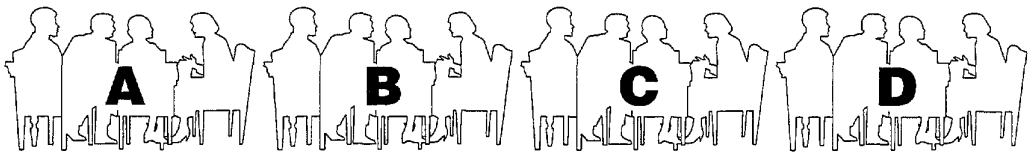
   (a) Quantities produced
   (b) Prices
   (c) Policies
   (d) Elasticities
   (e) Discount rate
   (f) Population growth rate
   (g) Income growth rate

Research-related data is based on expert opinion and obtained from research leaders and from the researchers and extension workers. It is important to get a good disciplinary and regional mix of opinions when collecting this type of data.

Finally, information on research client constraints is essential for a meaningful priority-setting exercise, and is usually obtained through informal survey techniques such as rapid area appraisals.

Exercise 16. Reviewing data and human resource requirements for economic surplus and scoring models (group exercise)

1. **Important!** Form groups of participants from the *same country* and elect a rapporteur.



Phase 1. Small-group exercise (50 minutes)

2. Discuss the "sample list of data" (attached handout 5.16.3) and use the worksheet 5.16.4 to take notes of major issues discussed.

3. What data the researcher needs for each method. (Use the attached checklist to respond to this question.)

4. What data is available in your country?

5. Given data needs and availability of data in your country, which method(s) do you recommend?

6. Will the availability of human resources to conduct the priority-setting exercise affect these choices? **Justify.**

Phase 2. Reporting and discussion (30 minutes)

7. The group rapporteur will summarize the results of phase 1 on the flip chart to report to the audience. Remember that the **name of your country** should be recorded at the top of the flip chart.

8. The trainer will facilitate discussion among the participants, provide feedback to promote better understanding of the content of this exercise, and close this session.

Exercise 16. Checklist

Sample list of data and other information needed for research priority setting using the scoring model (with economic surplus measures of effiency) to rank commodities.

	Congruency	Needed for economic surplus	Needed for scoring	Available in country
I. Information from research directors and policymakers				
1. List of commodities to include in the analysis.				
2. List of research programs to include in the analysis.				
3. Objectives for the research system.				
4. Weights on objectives for the research system.				
5. Estimates of current research expenditures or scientist years by commodity.				
II. Published data				
1. Quantity of production for each commodity for the previous three to five years by zone.				
2. Prices of products for the last three years by zone.				
3. Proportion of each commodity produced on small-holder farms.				
III. Information from scientists and extension workers (by theme and zone)				
Technology generation				
1. Anticipated net yield increase.				
2. Dissemination net yield gain level.				
Technology adaption				
1. Research development lag.				
2. Period of increasing adoption.				
3. Anticipated peak level of adoption.				
4. Period of dis-adoption, if applicable.				
IV. Economic data				
1. Elasticities.				
2. Discount rates.				
3. Population growth rate.				
V. Information on client needs				
1. Informal surveys.				
2. Formal surveys.				

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Exercise 16. Worksheet

DAY FIVE

Session 17
The Priority-Setting Process

Instructions to Trainers

SESSION 17

14:00 – 15:30 Session 17. The Priority-Setting Process

15:30 – 15:45 Tea/Coffee Break

15:45 – 16:15 Session 17. (Continued)

OBJECTIVE

By the end of this session, the participants will be able to do the following:

- Draft a plan for a priority-setting exercise in their own country.

Use overhead 5.17.1 to present the objective.

PROCEDURE

Training technique: group exercise.

EXERCISE 17

Exercise 17. Drafting a comprehensive priority-setting plan of action. (1 hour 55 minutes)

1. Distribute handouts 5.17.1, 5.17.2, and 5.17.3. Handout 5.17.2 gives clear instructions for the exercise. Go over the instructions with the participants step by step. Ask if clarification is needed. (5 minutes)

Phase 1. Group work

2. **Important!** Divide the participants into groups from the *same country.*

3. *(experience)* Groups select rapporteurs. They then work on the task and prepare their presentations. As the groups work, circulate from group to group to check progress. Clarify any concerns the groups may have while they are working. Be sure to remind the groups of the time remaining. (1 hour 20 minutes)

Phase 2. Reporting and discussion

4. *(process)* Groups report for exercise 17. Facilitate the presentations. Approximately three minutes is available for each group. (15 mintues)

5. *(process)* Open the discuss to the audience and, finally, provide your view on the results of the exercise. (10 minutes)

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6. *(process, generalize)* At the end of the exercise provide feedback on the content of the presentations. Ask the participants questions such as "How did you feel doing this exercise?" and "What did you learn?" (5 minutes)

CLOSURE

Closure (5 minutes)

1. *(application)* Ask the participants to tell one of their neighbors two things they might do differently in their job as a result of what they learned in this exercise. Choose some volunteers to give samples.
2. Make a transition to the next session.

DAY FIVE

Session 17
Summary of Overheads

Objectives

Session 17: The Priority-Setting Process

5. Draft a priority-setting comprehensive plan of action.

5.17.1

Major Elements of Your Scheme to Carry Out Priority Setting at Your NARS

- Institutional structures for priority setting
- Criteria
- Methods for national program
- Plan of action

5.17.2

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Priority setting into the 21st century: A position paper by the priority-setting working group

Executive Summary[1]

In this paper we define priority setting as the process of combining institutional structures with information on the potential of research innovations, in order to allocate scare research resources. Based on our analysis of the current institutional structures and methods for priority setting at KARI, we make the following recommendations:

1) Institutional structures for priority setting:

- Priority-setting efforts will need to be undertaken at the institute, program, and project levels. A 'priority-setting committee', composed of senior management will be charged with overseeing the co-ordination of these efforts.
- An institute-level priority-setting effort, undertaken in 1997, should draw mainly on information compiled at program level.
- Program-level priority-setting activities should form the basis of all priority-setting efforts and focus on evaluating the potential contributions of major program research themes to research evaluation criteria.
- Project-level priorities are best set by technical specialists from programs, based on institute guidelines for the development and evaluation of research proposals.

2) Criteria for priority setting:

- The Priority-Setting Committee will be charged with specifying the research evaluation criteria to be used in priority setting. These criteria should reflect contribution of research to national development objectives.
- The most commonly used criteria for priority setting are:
  a. Efficiency - The impact of research impact on national welfare;
  b. Equity - The distribution of research benefits;
  c. Foreign exchange earnings - The impact of research on the balance of trade;
  d. Food self-sufficiency - The contribution of research to meeting all the country's food needs internally;
  e. Food security - The contribution of research to reducing the variability of food availability; and
  f. Sustainability - The contribution of research to protecting the natural resource base for future generations.

1. **Extracted from**: Kenya Agricultural Research Institute. 1995. Priority Setting into the 21st Century: A Position Paper by the Priority Setting Working Group. Nairobi: KARI.

- The priority-setting working group makes the following specific recommendations on criteria.
  a. The efficiency criterion and its consumer and producer surplus measures should form the basis of priority-setting efforts.
  b. The equity criterion should also be included in priority-setting efforts and its measurement should be based on the distribution of efficiency benefits by target groups to be designated.
  c. If food security is determined to be an important component of national agricultural development objectives, a measure of this criterion should be included in priority setting exercises. However, the weight given to the criterion should be determined by the quality of the information available on research's contribution to food security objectives.
  d. Since sustainability issues are vital to the long-term welfare of Kenyan society, methods and information bases for measuring the impact of research on the sustainability of agricultural production systems are under development. KARI must continue research efforts in this area.

3) Methods for national program priority setting.

The specific methods used in priority-setting exercises will depend on the criteria specified by the Priority-Setting Committee. However, there are four crucial steps to all priority-setting exercises.

- Identification of "homogeneous" technology impact zones;
- Elicitation of assessments of the technical potential of research;
- Identification of the adoption potential of successful research; and
- Evaluation of the economic impact of research through induced changes in commodity supply and demand.

KARI is currently developing its capacity to undertake each of these themes through a number of program-based priority-setting efforts.

4) Plan of Action

The working group proposes the following plan of action to improve priority-setting efforts:

- A Priority Setting Committee should be formed from senior management in Headquarters, National Research Centers, and Regional Research Centers, (1st quarter 1995).
- The Priority-Setting Committee should review this position paper and decide on the criteria and methods to be used in future priority-setting exercises, (1st quarter 1995).
- The Committee should then oversee the development of an institutional structure to collect necessary priority-setting information and implement the chosen method. However, issues of analytical methods and assembly of relevant socio-economic data will be managed by the socioeconomics division, drawing on INFORM data and ex-ante assessments of potential research impact formulated by technical specialists. As part of this effort, the specific responsibilities of individuals involved in priority-setting efforts must be outlined, (2nd quarter 1995).

- The socioeconomics division will inform programs with regard to methods and minimum information needs for program-level priority setting, (2nd quarter 1995).
- Programs are expected to complete their first major cycle of priority-setting exercises, in a continuing flow, by the end of 1996.
- These program-level exercises will be used as the basis for a comprehensive institute-wide priority-setting exercise by early 1997.

Exercise 17. Drafting a comprehensive priority-setting plan of action (group exercise)

1. **Important!** Form groups of participants from the *same country* and elect a rapporteur.

Phase 1. Group work (1 hour 20 minutes)

2. Read and discuss the handout 5.17.2 "Executive Summary" of Priority Setting into the 21st century: a position paper by the priority-setting working group. Use handout 5.17.3 (worksheet) to take note of major issues of your discussion.

3. Draft a plan of action to carry out priority-setting exercise at your organization. Remember that your plan should emphasize the following:
   - Institutional structures for priority setting
   - Criteria for priority setting
   - Methods for national program priority setting
   - Plan of action.

Phase 2. Reporting and discussion (30 minutes)

4. The rapporteur will summarize the results of the group work on the flip chart to report to the audience.

5. The trainer will facilitate discussion, and provide feedback.

6. The trainer will also assist the participants to brainstorm on first action that should be taken after returning to their own organizations. The final information of this session will be recorded by the participants in the next and final session of this workshop (Session 18) during the PAPA exercise.

Exercise 17. Worksheet

DAY FIVE

Session 18
Participant Action Plan Approach (PAPA)

Instructions to Trainers

SESSION 18

16:15 – 17:15 Session 18. Participant Action Plan Approach (PAPA) and Workshop Evaluation

OBJECTIVE

By the end of this session, the participants will be able to do the following:

- List short-term actions to be taken to implement their action plan designed in session 17.

Use overhead 5.18.1 to present the objective.

PROCEDURE

Training techniques: presentation, individual work, group sharing, PAPA.

PRESENTATION

(experience) Give a brief presentation reinforcing the use of the PAPA during this workshop. Remind the participants of the information you presented on the PAPA at the beginning of the workshop. You may want to use overheads 5.19.2 and 5.18.3 to review the PAPA. Note that the participants have been jotting down possible action items throughout the workshop. Now is time for them to focus on finalizing their specific action items for when they return to their jobs. Be sure to ask the participants if they have any comments, questions, or need clarification. (5 minutes)

EXERCISE

PAPA Exercise — Second stage. (40 minutes)

1. Distribute handout 5.18.1 (2 forms). These are the forms for the second stage of the PAPA action plan.
2. Individual work: Ask the participants to review the work they have done over the last five days and to refer to the PAPA notes they made throughout the workshop. They should formulate specific action items and write them on the handout. Tell them to refer to the questions about their action items in order to be sure they are written as "specifically" as possible. (15 minutes)
3. Group sharing and discussion: Go around the room and ask each person to tell you their action items. List each item on flip charts. If some people have similar items, just indicate with a check by the item. Do not rewrite. This will give a good idea of the range of action items people are interested in undertaking. (25 minutes)

4. Collect the completed forms from the participants. (Make photocopies to return to the participants before they leave). Remind them that you will be following up with them after several months to see how they have progressed toward their action items.

17:00 – 17:15 Workshop Evaluation

OBJECTIVE

- Evaluate and provide feedback on the workshop.

Distribute handouts 5.18.2 and 5.18.3. Have the participants complete the evaluation before they leave the session. Give them about 15 minutes for this task. As soon as the participants return the evaluation forms, invite them to make oral comments regarding the evaluation of the workshop. Facilitate a brief discussion.

Note: A diskette with the text of the evaluation form in WP5.1 is included and, if necessary, may be adjusted to meet your WorkPerfect 5.1 needs.

17:15 – 17:30 Final Remarks, and Closing and Delivery of Certificates

DAY FIVE

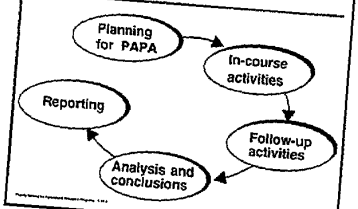
Session 18
Summary of Overheads

Objectives of Session 18.
PAPA and Workshop Evaluation

6. List short-term actions to be taken to implement your action plan designed in session 17.
7. Evaluate and provide feedback on the workshop.

5.18.1

Steps in PAPA



5.18.2

Step 2: In-course Activities

Stage 2

Objectives:

- develop action plan

Procedure:

- prepare preliminary list of action items
- confer with partner
- finalize and prioritize list of action items
- report individual action plans
- make copy and submit to trainer

5.18.3

SECOND STAGE

ACTION PLAN

Date: _____

Workshop Title: SADC/ESAMI/ISNAR Workshop on Priority Setting for Agricultural Research Programs

Name: _____

Organization: _____

Action Items	Start to implement action plan (check if known)		
I plan to:	Within 2 months	After 2 months	As arises

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PARTICIPANT ACTION PLAN APPROACH

Supervisor's Contact Address

Name: _____

Organization/Center: _____

Name of Immediate Superior: _____

Title of Immediate Superior: _____

Address: _____

_____

_____

_____

Tel. No.: _____

Fax No.: _____

Telex No.: _____

Email: _____

Questions about your action items

1. *Preliminary nature of plan*

   - Were you specific in writing the action item?
   - What will you need to do when you return to work in order to find out which actions are possible?

2. *Resources*

   - Who would be carrying out the proposed action, or helping with it (formally or informally)?
   - Are the skills for carrying it out available?
   - How much time would this take?
   - Are special materials or equipment required?
   - What is involved in obtaining them?
   - Will you be using a tool or system or aid from this training workshop?
   - How much adaptation is required?
   - Is continual monitoring or follow-through required?
   - Who will do it?

3. *Implementation*

   - Do you have the authority to implement the action?
   - If not, who does?
   - How do you think you can go about getting approval?
   - What do you think the degree of support is for your idea?
   - Will you need to sell people on it?
   - Who?

4. *Effects*

   - Whom will this action affect?
   - How will it affect them?
   - Will anyone be the worse for the results?
   - Anyone improved?
   - What will be affected?

5. *Environment*

   - What in the organizational environment might interfere with your doing this?
   - What in the organization will support your effort?

Workshop on Priority Setting for Agricultural Research Programs

Evaluation Form

Your co-operation in completing this questionnaire will be greatly appreciated. The information you provide will be useful in planning future events and will help resource persons to improve their materials and presentation.

A. General Reactions

In general, I would rate the workshop as:
- ☐ Excellent
- ☐ Good
- ☐ Average
- ☐ Fair
- ☐ Poor

On balance, would you say that the workshop objectives were achieved?
- ☐ Yes
- ☐ Partially
- ☐ No

(If no, please explain briefly in section G)

B. Objectives

The objectives of this workshop are listed below. Please mark on a scale of 1 to 5 if, in your opinion, the objectives have been achieved. *The scale ranges from 1(the objective has not been achieved), to 5 (the objective has been fully achieved).*

• Discuss the process of setting priorities at your organization.	1	2	3	4	5
• Discuss the need to set priorities, its methods and mechanisms.	1	2	3	4	5
• Identify a key process that should guide any priority-setting exercise.	1	2	3	4	5
• Identify key environmental determinants for research program target zones in their national and regional programs.	1	2	3	4	5
• Indicate how spreadsheets can be used in priority setting.	1	2	3	4	5
• Implement a congruency model which prioritizes by magnitude of production.	1	2	3	4	5
• Identify major constraints and then allocate those constraints to major themes.	1	2	3	4	5
• Implement an economic surplus analysis of agricultural research benefits.	1	2	3	4	5
• Explain the basic principles of the scoring method, the criteria used, and the data requirements.	1	2	3	4	5
• Identify sources of information needed for different priority-setting methods.	1	2	3	4	5
• Suggest appropriate methods.	1	2	3	4	5
• Draft a priority-setting exercise plan of action.	1	2	3	4	5

C. Strengths and Weaknesses

- **Please list what you consider to be three strengths of the workshop**

1.
2.
3.

- **Please list what you consider to be three weaknesses of the workshop**

1.
2.
3.

- **Suggestions for improvements**

D. Features

	Very Good	Good	Fair	Poor
Accommodation	☐	☐	☐	☐
Meals	☐	☐	☐	☐
Lectures	☐	☐	☐	☐
Discussions	☐	☐	☐	☐
Papers/Handouts	☐	☐	☐	☐
Organization and Management	☐	☐	☐	☐
Quality of visual aids	☐	☐	☐	☐
Quantity of visual aids	☐	☐	☐	☐

E. Additional Topics

What additional topics would you have liked included in this activity?

F. Management Topics

On what other management topics would you like to receive training in future events?

G. Comments

Please use the space below to write down any additional comments or suggestions you might have.

Guidelines to Provide Feedback on the Workshop

1. **The Module**

   Content

   - usefulness/relevance
   - amount of information

   Structure

   - sequence
   - duration
   - balance between trainers' and trainees' participation
   - instructions to trainers
   - visual aids
   - handouts, exercises
   - extra readings
   - PAPA
   - evaluation

2. **Process: training techniques and direction**

   - usefulness/relevance/effectiveness
   - group interaction
   - clarity of questions/exercises instructions
   - opening and closure of the days

3. **Trainers', facilitators', and trainees' performance**

   - presentation/communication skills
   - interaction/effective participation
   - punctuality/interest/commitment/willingness to facilitate learning/willingness to participate
   - other attitudes

4. **Logistical support**

   - organization
   - accuracy
   - punctuality
   - willingness to assist participants
   - services provided in general

5. **Workshop environment**

- physical (training facilities, training material, hotel facilities in general)
- psychological (personal feelings such as self-motivation, interest, satisfaction, self-achievement)
- social (development of friendship, relaxed, comfortable among participants, etc.)

6. **Workshop results/outputs**

- personal and professional assessment
- recommendations

7. **General comments**

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Annex 1:
Support reference material

Priority Setting as a Practical Tool for Research Management

Willem G. Janssen

ISNAR

SUMMARY

To turn priority setting in a practical tool for research management, this paper addresses the following five issues:

1. Why set priorities? This is done first of all to make the most effective use of the resources available. Nevertheless, priority setting may deliver a number of important side benefits, such as consensus building, review of resource allocations, increased transparency, and credibility. Moreover if none of these side benefits are being achieved in the process, it is doubtful if it is possible to implement effectively the established priorities.

2. Priority setting as a methodology or as an institutional process. Priority setting has an important methodological component but depends on a number of other institutional processes. It will only become more effective if methodologies and process management are simultaneously improved.

3. Choosing a priority-setting methodology. Many methodologies have been applied for priority setting, with more or less success depending on the specific circumstances. Six criteria that help one choose a priority-setting methodology are discussed. These are transparency, participation, simplicity, theoretical logic, discriminating potential, and cost of application. These criteria are applied to four methodologies: congruency analysis, economic surplus models, scoring models, and multiple objective programming.

4. Designing the priority-setting process. The four principal roles in the priority-setting process are defined as: "decision makers;" "economists" (analytical support); "researchers" (technical support); and "users" (demand for research products). A six-step priority-setting process is outlined: defining research objectives, defining alternative research activities, deriving measurement standards, performance assessment of research alternatives, comparison of research alternatives, and approval and implementation.

5. Managing the priority-setting process. Key elements in the management of priority-setting processes are identified and discussed: initiation and leadership, participation, separating the different hierarchical levels within the institution; the iterative nature, the link with planning, and implementing the forthcoming changes.

Priority setting has to be evaluated by managerial and not by scientific criteria. It may be more or less rigorous depending on the problems at hand. It improves the quality of thinking within an institution as much as the actual decisions.

INTRODUCTION

Priority setting has many dimensions. Managers may emphasize the institutional dimensions while economists concentrate on the analytical dimensions. The quality of priority setting may be improved by concentrating on the methodologies or by better organizing the procedures for participation and discussion. The outcomes can be priority ranks or concrete resource allocations. Priorities may be set at the national or the program level, for commodities or for regions. Priority setting may be done from scratch or may be based on current activities. It may concern highly strategic long-term decisions, as well as how to cut the budget in times of funding shortage. Priority setting may lead to the selection of one option or to the establishment of a balanced institutional portfolio. This paper provides a very brief overview of some of the more practical issues in priority setting by addressing the following five points:

1. Why set priorities?
2. Methodological versus institutional dimensions.
3. A comparison of some priority setting methodologies.
4. A six step procedure for priority setting.
5. Managing the priority setting process.

Before proceeding, the first practical conclusion should be drawn. For a management tool with so many dimensions, one should not expect ready-made solutions. Appropriate guidelines form one of the ingredients for successful priority setting, common sense the other (Mueller, 1989).

WHY SET PRIORITIES?

Priority setting aims to select the best portfolio of research activities for a certain research system, institution, or program. The primary objective of priority setting is to make the most effective use of the resources available for research.

Priority setting has a number of additional benefits. In the process of priority setting, existing resource allocations are normally reviewed. Even when the priorities are not strongly modified after a priority-setting exercise, it may be decided that the existing resource allocation did not reflect those priorities, thereby leading to a budget revision.

A priority-setting exercise may clarify differences of opinion that exist within the organization and may provide the occasion for debating and resolving those differences. It may therefore help to reach consensus on the objectives of the institution and to increase the internal cohesion.

Proper priority setting reviews existing as well as novel alternatives. Priority setting may and should be used to renovate and modernize the research agenda.

Clearly set priorities help to make institutional management more transparent and unambiguous. They provide guidance to management, and if clearly exposed, they clarify the expectations of personnel and stakeholders.

Rigorous priority setting increases credibility towards the outside world. This improves the institute's position in negotiations with the treasury, donors, or possible research partners.

These additional benefits may be as important as the primary benefit of more efficient resource use. Moreover, if priority setting is only concerned with efficient use of resources and not with the other possible results, implementing the outcomes may become very difficult, and the time invested in the exercise may be lost.

INSTITUTIONAL VERSUS METHODOLOGICAL APPROACHES

Priority setting has a different meaning for economists and other analytical scientists than for managers. Economists may focus on the methodological dimensions, while managers are more concerned with the institutional aspects. As a methodological approach, priority setting may be described as "a logical, consistent, and formal approach to identify most important possible research activities." The methodological definition assumes that the objectives and scope of priority setting have been defined in advance and that the identified priorities are actually implemented.

As an institutional approach, priority setting may be defined as "the process of arriving at a best possible set of research activities." In this definition the emphasis is on "process." This does not imply that the methodology is irrelevant, rather that the methodology is part of a larger process. In this process, objectives of the research institution are formulated, scope of the exercise is defined, and prioritized activities are implemented. The emphasis is on the different steps and actions that have to be undertaken to arrive at priorities. In most situations, the institutional approach is the better starting point. Many organizations do not have a clear perspective on their objectives, have never reviewed the possible options for research, and are not well aware of how to implement change.

The discipline that has done the most research on priority setting is economics. It should not come as a surprise, therefore, that the development of economic methodologies has received major attention. However, following the institutional definition of priority setting, many other improvements can be obtained in the process of priority setting. Since a chain is only as strong as its weakest link, strengthening methodologies when the definition of objectives is poor, will not result in improved priorities. Rather the weakest link should be singled out!

METHODOLOGIES FOR PRIORITY SETTING

Thus the question is not the best methodology for setting priorities but what is a proper methodology given the circumstances and the questions at hand. Priority-setting methodologies can be distinguished in single criterion and multiple criteria methods (Contant and Bottomley, 1988; Alston, Norton, and Pardey, 1994). In the single criterion group there is one indicator that reflects the objective of the organization for which priorities are being set. For example, if the objective of research is to contribute to increasing the national income, a single criterion method that measures income growth, such as the economic surplus approach (a brief description follows) is sufficient.

Multiple criteria methods recognize that an institution wants to achieve various objectives,

or that its final objective is so comprehensive that for the purpose of decision making it is better to distinguish different goals. Since there is normally a trade-off between goals, it is important to specify the importance of the different goals. Also since the contribution of the research activities towards different goals may be evaluated in different measurement units, a standardization of the final scores on each criterion is required.

The choice of a priority-setting methodology depends very much on the type of problem that has to be solved, the type of people that are involved in the process, and the implications that are linked to the outcome. To choose a priority-setting methodology six criteria are proposed (Janssen and Correa, 1994):

1. **Transparency.** It must be clear how the final results have been obtained. If outsiders to the priority-setting process cannot understand the arguments that have been used and the way that they have been assembled into a conclusion, they may not accept the outcomes. In this case, the priority-setting exercise may remain on the shelf.

2. **Participation.** Decision making normally improves when the ideas and the knowledge of many people are brought together. It is certainly important to include the final clients of the research. Methods that allow participation should thus be favored.

3. **Simplicity.** Methods that are easy to apply can be used more frequently and by less specialized people. Their possible utilization is therefore increased.

4. **Theoretical logic.** Priority-setting exercises should lead to the best possible outcome. There are two problems, however, with this criterion. First, there are no useful ways to validate the forward-looking nature of priority setting. Second, theoretical correctness changes according to the disciplinary perspective. Economics will emphasize supply and demand aspects of the predictions that are being made, decision sciences will emphasize the inclusion of the different stakeholders and the reconciliation of the different dimensions, organizational psychology will point to the willingness of people to act upon the results.

5. **Discriminating potential.** Methods should clearly distinguish good from bad options and provide clear insight as to why a certain research activity is a good or a poor alternative.

6. **Cheap to apply.** A priority setting exercise can be seen as an investment in knowledge in order to improve the quality of decisions. If such decisions can be improved by cheap applications this is of course preferable.

Two single criterion methods (congruency and economic surplus measurement) and two multiple criteria methods (scoring models and multiple objective programming) are often mentioned in priority setting. Good descriptions are available in Contant and Bottomley (1988) and in Alston, Norton, and Pardey (1995). Here we will briefly compare them on the proposed criteria.

In **congruency analysis** the importance of a research subject depends on the size of one indicator. The indicator may be value of production, area planted, or number of people earning income from it. If commodity A has double the value of commodity B, the amount of research resources allocated to A would be double the amount to B. Congruency analysis delivers not only a priority but also a budget allocation. Congruency analysis is transparent, simple and cheap to apply, but its theoretical logic is poor (table 1). Though in principle the discriminating potential is clear, it is very doubtful that people will accept the outcome immediately. Rather it becomes the basis for discussion.

Economic surplus methodology tries to predict the economic benefits of research. For each activity, it tries to estimate the physical impact of research (e.g., an increase in yields by 10%, at the same costs per ha as before) and translates this in a shift of the supply function. Afterwards the effect of the supply shift on the market equilibrium (price and quantity) is calculated and welfare economic theory is used to calculate total research benefits. Activities with highest research benefits are selected as priorities.

In economic surplus methodology the possible impact of research is explicitly included. The methodology is compatible with most econometric work and allows one distinguish benefits to producers and consumers, thereby being a useful tool for policy analysis.

Economic surplus methodology is a powerful method, with a strong foundation in economic theory. However, it requires elaborate data and rather strong assumptions. It is not very transparent and does not allow much participation of noneconomists. Its application is not simple nor cheap to apply. However it has theoretical appeal and good potential to discriminate promising from poor research options. In situations where economists have good rapport with the rest of the institution, it has been applied with good results (Janssen et al., 1991).

Scoring models are frequently used for setting priorities. In scoring methods, a number of criteria are identified, indicators are established for these criteria, and a score is given that indicates how a certain research activity contributes to it. After an activity has received scores on each criteria, a final score can be calculated once the weight (the relative importance) of each of the criteria is known, and once a method has been chosen for combining scores (e.g., by adding or multiplying). Table 2 provides a simple example.

Often scores on the different criteria can be defined in an objective manner but will be measured in different units. For example the contribution to the diet can be measured by the number of calories supplied per day from a certain commodity. Producer equity can be included by taking the share of small farmers. These measurements are transformed into scores in order to combine the criteria into a final judgment. Using scores rather than direct measurements is done mainly to combine assessments made in different measurement units.

Scoring models are relatively transparent and allow participation of many people, e.g., in discussing the criteria that should be included and their relative weights. It is not very difficult to apply, though the complications in understanding the method should not be underestimated. Its theoretical logic is not high from an economic perspective but it responds to the theories of decision science. Considerable efforts have been made to improve the rigor of scoring models (Saaty, 1980; Dyer and Forman, 1991). The discriminating potential of scoring methods may be affected by the variety of criteria involved. When many criteria are

used, every activity will have something to offer and it may become difficult to exclude activities from the priority list. It is a relatively cheap method though the cost of data collection on the different criteria should not be underestimated.

Within the scoring models advanced measurement methods such as economic surplus approaches can be integrated. Their versatility turns scoring methods into probably the most frequently used priority-setting approach. A disadvantage is that scoring models do not provide a clear translation to budgets.

Another multicriteria method is **multiple objective programming** (MOP). MOP is similar to scoring models in the sense that it combines different objectives. MOP pays more attention to the constraints on research resources, such as human resources, budgets, equipment, and research stations (Romero and Rehman, 1989). For research planning in the short run, MOP may be attractive but in the long run most resource constraints are amenable to change, thereby invalidating the emphasis given to them in MOP. MOP has considerable data requirements and may not be relevant in the long run. Its methodological complexity makes it a poorly transparent and expensive approach with low potential for participation.

A SIX STEP PROCEDURE FOR PRIORITY SETTING

Effective priority setting depends on the participation of many people. For the sake of simplicity four groups of people (or four roles) can be distinguished. We have categorized these as:

1. The decision makers. These are the managers, the board, or the senior government officials that carry the final responsibility for the decisions taken.

2. The economists. They provide the analytical tools and the data required to execute the priority-setting process. They are often responsible for the quality and the progress of the exercise, but not for the final decisions.

3. The researchers. Their future work will be strongly influenced by the priority-setting exercise. They provide information on the technical feasibility of certain research alternatives and they may have a good idea of the possible research alternatives.

4. The users. Priorities should be demand driven and there is no better way of assuring this than by including the users in the priority-setting process (Chambers et al., 1989). Users, however, are not responsible for any single step, rather it is the responsibility of the other groups to involve users in all of the steps.

Table 3 shows the six essential steps in any priority-setting exercise, the responsible group, the type of information required, and an imaginary example.

Step 1: Defining research objectives. Public agricultural research should contribute to the overall development of the country. Often development objectives can be grouped in four categories (see also Janssen, 1994): economic growth, equity (income distribution between social strata, sex, race, or other groups), food security, and environmental maintenance. The relative importance of these categories, as well as the exact interpretation changes from country to country. For the decision makers it should be clear how to interpret and weigh these objectives. It may also occur that the overall development objectives of the countries have already been translated in agricultural development strategies (e.g., increasing rice yields in irrigated areas with 20% over the next five years; developing an oil palm export sector). In that situation, the overall development objectives may be replaced by the agricultural development strategies.

Step 2: Defining the alternative research activities. This step is often poorly executed. A good inventory of the possible types of research is key to making the right choices. For this purpose it is important to maintain good information and documentation on scientific developments, to be in touch with the international community, and to involve people from outside the research system with fresh ideas. It may also be important to decide which research activities have come to a closure, and should not be considered any longer on the research agenda.

Step 3: Deriving measurement standards. From the research objectives measurement standards have to be derived that allow for objective and systematic comparison. When a set of similar research activities is compared (e.g., maize and wheat genetic improvement), appropriate measurement standards can be developed rather easily. The availability of data to apply to these standards is often the key limitation. When very different research activities are being compared, measurement standards are more difficult to derive. For example, how to compare the relevance of a program to conserve and describe forest genetic resources with a program to introduce herbicide resistance genes in tobacco.

Step 4: Performance assessment of research alternatives. Once measurement standards have been defined, the expected performance of the research project should be assessed. This assessment is strongly based on the expected research progress. For activities still to be undertaken this is principally a matter of expert judgment (since priority setting is forward looking), and in the case of biotechnology the possibility to base it on historic evidence (from own or other countries) is reduced. As a result, assessments tend to be optimistic.

Step 5: Comparison of alternatives. The expected performance of different research projects have to be compared on the measurement standards. This may involve considerable economic calculations depending on the approach chosen. When research has to reply to several objectives, it may also be required to know the weights for each objective to arrive at a final conclusion.

Step 6: Approval and implementation. Finally, the best alternatives should be officially approved and implemented. The number of alternatives that can be implemented strongly depends on the available budget. Normally the budget is a given fact, but if the results shows that there are more highly promising alternatives than can be implemented with the budget, the priority-setting exercise may also help to obtain additional funds.

MANAGING THE PRIORITY SETTING PROCESS

Few systematic studies have been done on how to improve priority-setting processes (Javier, 1987, Dagg, 1992), reflecting the fact that process management is an art as much as a science. Here some of the outstanding issues in managing a priority-setting process will be briefly discussed.

Initiation and leadership. Priority setting has to be initiated and has to be led by the person who is directly responsible for the implementation of the results. When we discuss priority setting for an institution, the institution director will have to lead and initiate the activity. If priorities are set for a research program, the program leader is the first person responsible. The director has to define the objectives of the priority setting process: Is it to review existing resource allocations in general? Is it to eliminate certain activities in order to make room for new issues? Or is it to select the best new activity out of a set of possible alternatives?

To develop a methodological approach and to implement this approach, the director will be supported by a team of social and technical scientists. They will consider how to develop an approach that answer the objectives of the exercise in the most efficient way. Actually these scientists will coordinate much of the priority-setting process, nevertheless they are not in charge of it. The approach that will be followed will be designed by this group of scientists, but will be approved by the director.

Participation. Research is a policy instrument, eminently suitable to generate long-term agricultural growth and development. Therefore priorities have to reflect the objectives of the overall agricultural policy. In addition to the four groups mentioned above, priority setting should involve the following:

1. Policymakers, coming from higher hierarchical levels in the public-sector organization. To develop a national agricultural research policy, it is useful to involve high ranking officials from the ministry of agriculture. To set priorities for a research program, it is useful to involve the director of the institution. Normally these people are few in number and well educated. They can be approached to provide their opinion on certain issues and to comment on certain outcomes. Communication with this group is relatively easy, except for the fact that they are short of time.

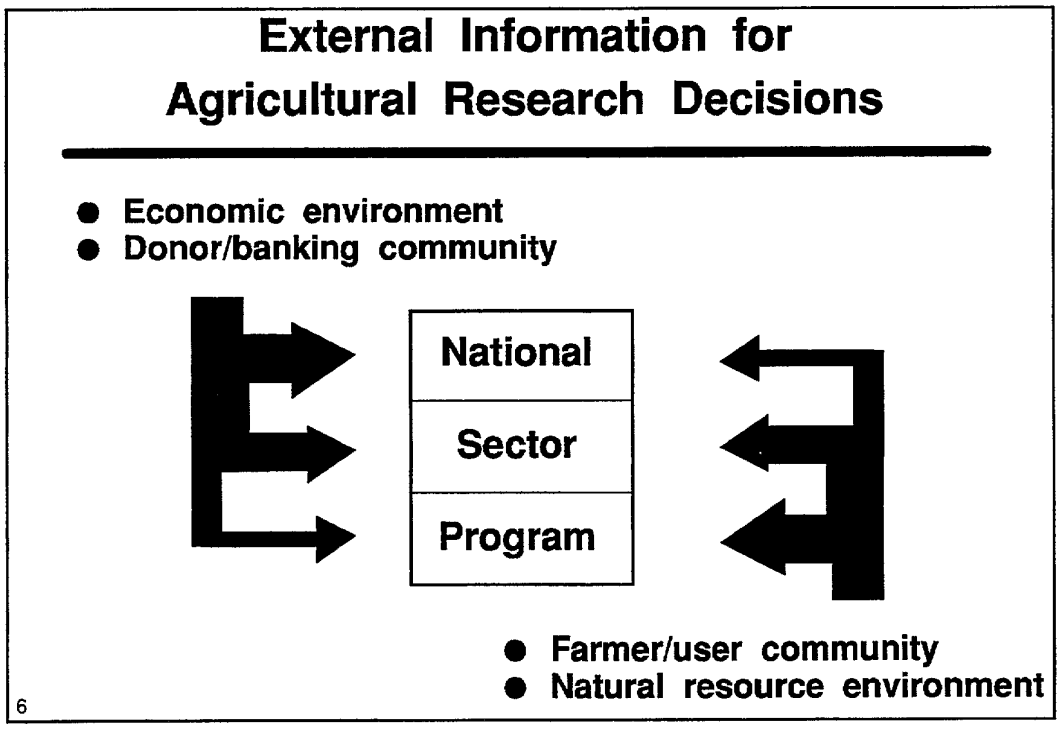
2. Donors. In many developing countries, agricultural research is only partly paid by the country itself and depends to a large extent on external funding. In this case it is not enough to be in line with only the requirements of the agricultural policy, but congruency with the objectives pursued by donor agencies should be assured. The participation of donors should have a more consultative character. Donors do not set the priorities, but the relevance of the priorities should be checked towards donor objectives. This may take the form of some consultative meetings, e.g., a donor support meeting.

Priority setting at different hierarchical levels within the organization. Priorities can be set for the development of the overall agricultural sector, for sectorwide agricultural research, for nationwide research programs on a commodity or factor, and even for projects within these programs. Further complications may arise if a research institution operates with nationwide commodity programs on the one hand and regional research programs or centers on the other hand (as is the case of KARI in Kenya; see Mills et al. 1994). Normally,

priorities are defined at the higher levels in more political terms, e.g., the importance of certain objectives, and at the lower levels in more technical terms, e.g., the expected chance of success of certain research projects.

Priority setting is essentially a centrally-led process. At the level of the director, priorities can be established for program A versus program B. At the level of the program leader, priorities can then be established for project a or project b. The implication is that priority setting is normally best done in a top-down fashion, and should be clearly linked with the allocation of a budget. The problem with this mode of operation is that normally the better information on needs and requirements for agricultural technology is available at the lower levels of the organization. Thus the situation arises where decisionwise a top-down approach is most desirable and where informationwise a bottom-up approach is most useful (figure 1).

Figure 1:



One way out of this dilemma is to consider the lower levels of the hierarchy as stakeholders in the higher level decisions, and to include them in the priority-setting exercise. For example, for decisions on the relative importance of commodities, the leaders of the commodity programs are invited to participate in the process, as well as the leaders of regional programs that may use the results of these commodity programs. At the level of the national commodity program, again the leaders of regional programs are invited.

The practical problem is that the people with the best information have a major interest in the decisions that are being taken. For example, in a priority-setting exercise for commodities, commodity program leaders will try to present their commodities in the best possible way. Breaking the link between personal interests and information is impossible (since the interest has created the information in the first place) and highly unwise (since the interest creates the willingness to execute the proclaimed priorities). However, it is possible to emphasize the general above the specific interest and to make people aware of their role as impartial experts that will all benefit (in the end) by taking the right decisions. It is critical that priority setting is done in an unbiased, open fashion. It is the leader of the exercise who has to set the tone, for example, by explicitly detaching her (or him)self from previous interests.

If within the institution priorities are being set at different levels, it should be assured that technical expertise to lead the process is available at all levels, and that information on the objectives for research is clearly available. Priorities for a regional center cannot be set at the national level, priorities within a commodity cannot be set at the same time that priorities between commodities are being defined. It may be possible that an institution does not have sufficient people available to support priority setting at all levels. In this case it may be useful to attach a social scientist on a temporary basis to a program leader or regional research leader to define research priorities.

Iterative nature. Priority setting is not a process that can be concluded in one session. Normally the priorities that result after the exercise will have to be reviewed by the different stakeholders, leading to critique and suggestions for improvements. These observations may concern the final outcome, but may also concern the measurement methods, the way in which objectives have been operationalized, or the alternative activities that were analyzed. The iterative nature improves priority setting in three manners:

1. It reduces the chance of mistakes, poor judgment, or poor methods, thereby improving the technical quality of the process

2. It increases the commitment of the stakeholders to the outcomes and the chance for consensus, by showing that their observations are being taken seriously and are being used for improving the outcomes

3. It allows for a certain amount of negotiation on the outcomes, thereby making possible unpopular but valid outcomes more easy to swallow. The negotiation process is very important to start the process of change that may follow

Priority setting is also iterative in another way. It is not (or should never be) a one-time activity. All functioning organizations have a set of implicit or explicit priorities, defined by more or less rigorous analytic approaches and decision processes. Priorities will be set for

a certain number of years, but may well change in the future. Priorities should be reviewed periodically, in the view of changing circumstances, thereby allowing a gradual shift of direction for the institution. One implication of the iterative nature is that much can be learned from reviewing earlier priority-setting exercises and the considerations that were expressed at that time. Another implication is that the amount of effort and time required should be reasonable with regards to the expected time frame for which the results will hold. A third implication is that priority setting is often concerned with the most attractive activities (to be added to the research agenda) and the least attractive activities (to be terminated). It is not useful or necessary to review all options.

Priority setting and the planning cycle. Priority setting is part of a planning cycle, where priorities are transformed into plans that are implemented. In turn, these plans are monitored and the progress of the plans is evaluated. Monitoring and evaluation provides very useful information to improve new rounds of priority setting since they allow verification of the hypotheses that have been used in previous predictions of expected research progress. For example, monitoring systems may improve the information on the lead time of research thereby improving estimates of the expected benefits. Also, evaluation studies may improve understanding of which research has the better chance of being successful. Such evidence brings priority setting on a more objective, neutral ground and may temper the exaggerated expectations that often exist.

Implementing priorities. There is no use in priority setting if the priorities are not implemented. Some issues in implementation are the following:

1. Priorities are normally based on an expected rate of progress of research. Progress expectations are a starting point for defining research targets, i.e., the amount of progress to be achieved after a certain number of years

2. If the outcome of a priority setting exercise leads to a shift in resource allocation, this shift has to be translated into the remobilization of people, equipment, or land. This is a very sensitive and difficult process. Because of it certain people will be asked to give up on their principal interests. It is important that priorities do not express any judgements on people, thereby reducing friction in the implementation process. If priority setting can be perceived as an "institutional opportunity search," which leads to new chances, it may actually promote change.

3. Implementation is very much constrained by management capacity. It may be necessary to translate priorities into an implementation sequence. Not necessarily the highest priorities will be implemented first, for example, if they require major investments or human resource development. It is important that the priority setting exercise does not pretend to overhaul an institution completely, but that it has realistic expectations of what it may achieve.

CONCLUDING REMARKS

Priority setting is a management tool and the quality of the tool is not defined by scientific criteria (e.g., estimation methodologies), but by managerial criteria. This tool should respond to the needs and constraints of the research manager. There is a limit to the time that can be put to the process, which has implications for the data collection and analysis. It also implies that transparency and implementation concerns weigh very heavy in the choice of approach and that participation, consensus and commitment are more important than the detail of the procedures being used.

Priority setting often concerns the comparison of activities of a very different nature, with completely different cost and benefit profiles. In such situations, objective measurements are often absent, or hard to come by, and it becomes important to develop solid subjective assessments. It is important that judgments are based on the widest available knowledge, form a reflection of the target groups, and are accepted by all concerned once being obtained.

What is the value of formal priority setting? First of all, it brings the people together that have a stake in the decision, thereby reducing the chance of personal bias. Secondly, it tries to build decisions on actual evidence, rather than on subjective assumptions. Thirdly, it requires clear and concrete thinking on what really matters, on why research is being done. Thereby it allows research managers and others to make up their mind and it provides clarity and transparency to personnel and other stakeholders of the institution. Formal priority setting improves the quality of thinking as much as the quality of the forthcoming decisions.

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Table 1: An Evaluation of Priority-Setting Methodologies

	Transparency	Participation	Simplicity	Theoretical Logic	Discriminating Potential	Cheap to Apply
A: Single Criterion Methods						
Congruency	***	*	***	*	*	***
Economic Surplus	*	*	*	**	***	*
B: Multiple Criteria Methods						
Multiple Models	***	***	**	**	**	**
Objective Programming	*	*	*	**	**	*

*** = Good
** = Intermediate
* = Poor

Table 2: Scoring beans, cassava, and rice research for Latin America on different criteria, 1992				
Criteria	Beans	Cassava	Rice	Criterion weight
Value of production	3	2	5	2
Importance to poor farmers	4	4	2	1
Nutritional	4	2	3	1
Total weighted score	14	10	15	

Note: Scores from 1 to 5
Weights do not reflect the objectives of any particular institution

Table 3: The Possible Different Steps in Agricultural Research Priority Setting			
Step	**Responsibility**	**Data Support**	**Examples of Each Step**
Defining research objectives	Decision makers	Agricultural (sub)sector and policy analysis	1: to increase national income (important) 2: to support poor farmers (secondary importance)
Defining alternative research activities	Researchers	Farming system diagnosis, Scientific literature	A: rice improvement research B: vegetable production research
Deriving measurement standards from objectives	Economists	Priority setting theory, Studies for other situations	1: Net Present Value (NPV) of production increase 2: Share of production from small farms (SSF)
Predicting performance of research alternatives	Researchers	Agricultural statistics, survey information	A: expected impact on production: 8% within 10 years B: expected impact on production: 6% within 10 years
Comparing predicted performances	Economists	Cost/Benefit analysis, Decision Support Theory	A: 1) NPV = US$400 million; 2) SSF = 60% B: 1) NPV = US$150 million, 2) SSF = 58%
Approving and implementing priorities	Decision makers	Management Information System	Program A to be implemented

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AN ANALYSIS OF THE DECISION PROCESS IN AGRICULTURAL RESEARCH

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Introduction

Public agricultural research is one of many policy instruments that influence the size and direction of economic growth. Its impact can be evaluated only in relation to other policies such as education, credit, pricing, infrastructure development, and taxation. To respond in an effective and flexible manner to the requirements, constraints and opportunities posed by the development process it is critical to have an efficient and transparent decision making system.

Why would a country spend money on agricultural research? How should it decide on the type of agricultural research to support? What information is needed to analyze agricultural research opportunities? Can decision making be left to the directors of research institutions or does it require interactions with policy makers and scientists?

Decisions about agricultural research require answers to these and many other questions. Answers must be relevant and credible, since spending public resources is a matter of extreme importance. Here we outline the concepts that are key to understanding decision making for agricultural research.

Decision making relies on the input of many different people. Decision makers from different entities, economic analysts and researchers need to come together and join forces to make the best possible decisions. To execute this process in an efficient and effective manner it is important that the different persons involved in the decisions know what their role and responsibility is. By the proper understanding and acceptance of mutual responsibilities, the quality of decision making for agricultural research can be lifted to a higher level.

The Decision Hierarchy

Decisions about agricultural research are made at three levels: national, sectoral, and commodity. At the **national** level, the ministries of finance, planning, and agriculture decide the funding level for the agricultural sector, and possibly for agricultural research. At this level the relevance of spending money on agricultural research may be compared with, for example, spending on rural infrastructure. Ministries can exert considerable influence by making funds contingent on the direction of research. Policy considerations and negotiations dominate decision making at this level. The outcome for agricultural research depends strongly on decisionmakers' expectations of the impact of research on policy goals.

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At the **sectoral** level, the Ministry of Agriculture and top management of the agricultural research system decide on the relative importance of different research programs. Research programs may concern commodities, agro-ecological regions or agricultural resource management issues. The potential impacts of research on each of the commodities are compared, and correlated with sectoral priorities, that may be modified in the process of structural adjustment. Resource allocations are then made to the various commodity research programs. Political considerations and technical judgements are both very important at this level. At this level the priority of research on, for example, coffee versus cassava will be defined.

At the **program** level, research program leaders and scientists decide on the allocation of resources to specific research activities. Activities are assigned a priority based mainly on a technical assessment of likely progress and magnitude of potential benefits. For example, within the coffee program decisions will be made on genetic improvement strategies versus intercropping research.

While the details of the decision hierarchy will change from country to country, some conditions should be met for rational and transparent decision making. To ensure level-to-level consistency, political considerations should be defined at the top. These are translated into clear and increasingly concrete objectives at lower levels. Technical assessments are made at the base of the hierarchy, and are consolidated into increasingly concise judgements at higher levels. Technical assessments provide policymakers with information with which to work.

To ensure good communication, key players from the ministry and the research system should participate at two levels in the hierarchy and fulfil a bridging function. A decision support unit, linked to the director of the agricultural research system may prove useful to supply adequate information on research programs and progress and to translate policy objectives in terms that can be made operational at the program level.

The decision process should be cyclical, that is, the information flow downwards on objectives and upwards on technical information should be linked and continued until adequate and acceptable decisions have been obtained. Although decisions at the highest level are basically political, within technical constraints, decisions at the lowest level are basically technical, within a predefined political framework. Changes in research priorities may be forthcoming both from policy modifications or from improved technical assessments.

The quality of decision making is dependent on the available information. Four subjects should receive special attention: information on the economic environment and on the donor and banking community should be brought into the decision process principally by the higher levels of the decision hierarchy; information on the natural resource base and on farmer objectives and developments should be brought into the decision process principally through the lower levels of the decision hierarchy. Since farmers make up a large share of population in many developing countries, the opportunity to provide adequate information on their objectives and conditions gives the lower levels of the decision hierarchy a very significant role in the decision process.

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Criteria for Research Decisions

In most situations the political concerns that guide research decisions can be summarized in four categories: economic growth, equity, food security, and ecology.

Economic growth is a measure of the absolute size of the benefits of research, that is, how a certain research activity helps to increase the national income. This can be measured directly, by the expected contribution to GDP (Gross Domestic Product), but may also be assessed indirectly, by means of the contribution to growth promoting strategies such as export (very relevant in structural adjustment programs) or frontier development, or by means of the growth rate for different commodities. Decisions concerning economic growth may also include indirect considerations, for example when research choices are made to increase the appeal of a country to a certain donor, or when they are directed to enhance the long term continuity of the research system. Nevertheless, the extent to which research contributes to economic growth should remain the principle criterion.

Equity relates to the distribution of benefits across society. Benefits are distributed differently, for example, between producers and consumers, among groups of producers, among regions, and among consumer groups. Equity may also include gender aspects, this is, the distribution of research benefits among men, women and children.

The results of successful research tend to increase supply. If this causes a large price reduction, consumers benefit most. If prices do not change much, producers benefit most. However, it should be kept in mind that in many countries producers account for a large share of consumption. Producers that adopt new technology and do so most rapidly, reap the highest benefits. If production is spread over several regions but a new technology is only adopted in one region, that region will benefit, probably at the cost of the others. Finally, certain products are mainly consumed by poor people, others mainly by rich people. If the price of a product important to the poor is reduced, they will reap more benefits than the rich, and vice-versa.

Food security is the ability of a country to feed its population in times of climatic variability or unstable world market prices. These concerns lead them to favor research on food crops rather than export crops, and to prefer research on products with low production variability across years. The cost of such a food security strategy in foregone economic growth may be quite high. Food security may conflict with foreign exchange concerns that favor export crops. In times of structural adjustment, resolving this conflict is critical.

Ecology refers to a range of topics from agricultural resource management and nature conservation, to health considerations. Two concerns are primary:

1. Production increases are not desirable at any cost, but only as long as the quality of the natural resource base and the health of the population is maintained.
2. Short-term production increases should be balanced with long term production potential. If production capacity is increased at the cost of future production potential, the present generation benefits at the cost of later generation. As with food security and equity, it is easy to understand that a wealthy country may be willing to exchange economic growth for an improved environment.

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For developing countries, however, the choice is more difficult.

Deciding the budget allocation for agricultural research and the composition of the research portfolio require clear and concise technical information on alternative research activities. However, such information is often not readily available.

Research Investment Analysis at the Sectoral Level

The precise approach adopted to make decisions about agricultural research will vary within the 3 hierarchical levels. In this paper, we will focus first on the middle (sectoral or agriculture ministry) level, where both political and technical judgements play an important role. Later we will relate this analysis to decision making at both the higher (national) level and the lower (program or site) level.

Agricultural research is a time-intensive process. It takes many years before a research activity results in an applicable technology. Afterwards it may take even longer before the technology is adopted among the target group. Research is best treated and analyzed as an investment activity, with the following characteristics:

1. The development time may be very long.
2. The lag between the successful conclusion of research and the arrival of the benefits may be long.
3. Research may involve risk. Many activities may never be successful, but experience suggests that a few successful activities pay for many failures and the average rate of return is high.
4. Normally the benefits of research are very durable and stretch over a number of years.

With investment processes, we tend to think in terms of infrastructure or other capital goods. With research we invest in the generation of technologies that allow improved use of agricultural resources. Research is a risky, but potentially high pay-off investment[1].

To analyze research benefits, we can use the standard principles of investment analysis. This involves estimating cost and benefit streams over time and using these to calculate and indicator for the attractiveness of the research activity. Some indicators are the net present value (NPV), benefit-cost ratio (B/C-ratio), or the internal rate of return (IRR). The optimum research portfolio contains the activities with the highest indicator values. This portfolio may be modified by equity, food security and ecology considerations. Scoring models that combine (more or less sophisticated) assessments on the outcomes of research with the

[1] Things are further complicated by the fact that one may also invest in research structures and equipment. As for all other activities, research requires buildings, vehicles, and infrastructure to function. In most activities construction and infrastructure would be treated as investments and operating costs as recurrent expenses. For research both groups are best treated as investments. Additional (yearly) production costs should then be seen as the recurrent costs and additional value of production (e.g. through increased yields) as the recurrent benefits.

relative weights of the four principle policy criteria are often applied to modify the outcomes as achieved on the basis of the economic growth criterion (Norton, Pardey and Alston, 1992). When the choice between research activities is straightforward, a well argued comparison may replace formal analysis.

In calculating the economic indicators we have to pay special attention to six issues:

1. **Size of the industry** at the moment that research results will become available. This can be calculated by multiplying the (expected) border price by the (expected) volume of production.

2. **Cost reduction per unit of supply** if research is successful. Estimating the impact that research will have on supply may be very difficult. Empirical information on the impact of research on the supply of other commodities can be valuable. This can be complemented with experimental data and expert judgement.

3. **Probability of success.** The chance of success depends on the complexity of the research problem, the quality of researchers and resources, the state of the art of the research methodologies being applied, and the continuity of funding over the period of research activity. It is difficult to propose any correct formula for estimating the chance of success. By reviewing past research projects, a good estimate may be obtained. Normally researchers tend to overestimate the chance of success.

4. **Rate of adoption by farmers.** This depends on the profitability and the risk associated with the new technology. In turn, these factors are defined by the input costs associated with the new technology; whether the technology can be adopted without major changes in the production system; its suitability within the farm household system; and the agricultural policy environment. The quality of the extension service is another important factor affecting adoption.

5. **Time lag between research and benefits.** This is influenced by the type of research, the diffusion capacity of the extension service and the expected speed of adopting. For example, for most genetic improvement, research time is long (often more than 6 years), diffusion capacity is high for some crop varieties such as rice and maize (high seed multiplication rates), but low for others such as cassava and potato (low seed multiplication rates), but the speed of adoption for all crops can be high, because there are no major capital costs involved. For machinery improvements, research time may be shorter and diffusion capacity higher, but the speed of adoption may be low, due to the costs involved.

6. **Research and diffusion costs of new technology.** The major element here is personnel costs. To function effectively, researchers require a minimal operational budget and research infrastructure. Communication and overhead costs are items that are often forgotten. Normally research leaders will be able to indicate the levels of personnel and support required to pursue a research activity. Costs may be made outside the research system, for example operating the extension system. These costs should be included in the analysis to avoid an inflated rate of return estimate and to distinguish research with high extension costs from research with low extension costs.

Research Investment Analysis and Other Levels

At the highest level of decision making, political issues are likely to be given greater attention. Factors of importance are: 1) The decision to invest in research will need to be compared with non-investment decisions. The outcome of such a comparison will be dependent on the preference for public consumption versus public investment. 2) Attention will focus on the relative importance of the four criteria guiding research decisions, rather than on technical assessment of research activities. However, the expected benefits and costs are likely to be difficult to estimate. In such circumstances, "faith" becomes important relative to "facts". Such faith depends on the credibility of research and will be influenced by solid documentation of the impact of past efforts. Decision making will be facilitated if clear and simple evidence of earlier results can be made available. Such information may be very important in safe-guarding research budgets in times of belt tightening.

Apart from the political issues, some organizational issues will be decided at the higher level. These issues include among others the position of the research institution within the public sector, the incentive structure, and the role of private (or contract) versus public research. Whereas the political issues concern the relevance, the organizational issues concern the effectiveness and efficiency of executing research activities.

At the lower levels of decision making, technical judgements usually prevail since concerns for equity, ecology, and food security should already have been addressed by the choice of commodities and will not need explicit attention within a commodity program.

Research may consist of various types of activities and should not be restricted to experimentation and field testing. Searching and adapting of promising technologies by means of data bases or institutional contacts may be a very efficient way to make new technologies available. Participation in regional networks is another possible activity.

Key issues at the lower program level are:

1. Efficiency becomes the principal criterion for decision making.
2. There are more fixed elements in the decision process, such as the type of (physical, human, and knowledge) resources available.
3. Time frames are generally shorter and more clearly defined.
4. The quality of the decisions depend on the involvement and commitment of the researchers who have to implement the decision.

Overview

- Research is one of a set of policy instruments and may interact and/or benefit from other policy instruments. It is important to review the linkages of research with other activities.

- Research is an investment process, and decision making on research activities should follow the principles of investment analysis.

- Research decisions should be based on the implicit or explicit weighing of contributions to the objectives of economic growth, equity, food security, and ecology.

- A good understanding of the time dimension involved in research is key to proper decision making.

- The impact of research can be measured as the change in production costs. This depends on the size of the industry and the unit-cost reduction that research can help achieve.

- Producers are not necessarily the biggest beneficiaries of research. Depending on market conditions, consumers may reap substantial benefits by means of reduced prices.

- Research decision making depends critically on effective communication between national, sector and program level. It is best done if politicians, administrators, socio-economists, and biological scientists collaborate. All will bring different skills to the process.

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PRIORITY SETTING INTO THE 21ST CENTURY: A POSITION PAPER BY THE PRIORITY SETTING WORKING GROUP

Kenya Agricultural Research Institute
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PRIORITY SETTING INTO THE 21ST CENTURY: A POSITION PAPER BY THE PRIORITY SETTING WORKING GROUP

EXECUTIVE SUMMARY

In this paper we define priority setting as the process of combining institutional structures with information on the potential of research innovations, in order to allocate scarce research resources. Based on our analysis of the current institutional structures and methods for priority setting at KARI, we make the following recommendations.

1) Institutional structures for priority setting:

- ***Priority setting efforts will need to be undertaken at the institute, program, and project levels. A 'Priority Setting Committee', composed of senior management will be charged with overseeing the coordination of these efforts.***

- ***An institute-level priority setting effort, undertaken in 1996 or 1997, should draw mainly on information compiled at the program level.***

- ***Program-level priority setting activities should form the basis for all priority- setting efforts and focus on evaluating the potential contribution of major program research themes to research evaluation criteria.***

- ***Project- level priorities are best set by technical specialists from programs, based on institute guidelines for the development and evaluation of research proposals.***

2) Criteria for priority setting:

- ***The Priority Setting Committee will be charged with specifying the research evaluation criteria to be used in priority setting. These criteria should reflect research's contribution to national development objectives.***

- ***The most commonly used criteria for priority setting are:***

  a. Efficiency - Research's impact on national welfare;

  b. Equity - The distribution of research benefits;

  c. Foreign exchange earnings - Research's impact on the balance of trade;

  d. Food self-sufficiency - Research's contribution to meeting all the country's food needs internally;

  e. Food security - Research's contribution to reducing the variability of food availability; and

  f. Sustainability - Research's contribution to protecting the natural resource base for future generations.

- ***The priority setting working group makes the following specific recommendations on criteria.***

  a. The efficiency criterion and its consumer and producer surplus measures should form the basis of priority setting efforts;

  b. The equity criterion should also be included in priority setting efforts and its measurement should be based on the distribution of efficiency benefits by target groups to be designated;

c. If food security is determined to be an important component of national agricultural development objectives, a measure of this criterion should be included in priority setting exercises. However, the weight given to the criterion should be determined by the quality of the information available on research's contribution to food security objectives.

d. Since sustainability issues are vital to the long-term welfare of Kenyan society, methods and information bases for measuring the impact of research on the sustainability of agricultural production systems are under development. KARI must continue research efforts in this area.

3) Methods for national program priority setting

The specific methods used in priority setting exercises will depend on the criteria specified by the Priority Setting Committee. However, there are four crucial steps to all priority setting exercises.

- *Identification of " homogeneous" technology impact zones;*
- *Elicitation of assessments of the technical potential of research;*
- *Identification of the adoption potential of successful research; and*
- *Evaluation of the economic impact of research through induced changes in commodity supply and demand.*

KARI is currently developing its capacity to undertake each of these steps through a number of program-based priority setting efforts.

4) Plan of Action

The working group proposes the following plan of action to improve priority setting efforts:

- *A Priority Setting Committee should be formed from senior management in the Headquarters, National Research Centers, and Regional Research Centers, (1st quarter 95).*

- *The Priority Setting Committee should review this position paper and decide on the criteria and methods to be used in future priority setting exercises, (1st quarter 95).*

- *The Committee should then oversee the development of an institutional structure to collect necessary priority setting information and implement the chosen method. However, issues of analytical methods and assembly of relevant socio-economic data will be managed by the socio-economics division, drawing on INFORM data and ex-ante assessments of potential research impact formulated by technical specialists. As part of this effort, the specific responsibilities of individuals involved in priority setting efforts must be outlined, (2nd quarter 1995).*

- *The socio-economics division will inform programs with regard to methods and minimum information needs for program level priority setting, (2nd quarter 1995).*

- *Programs are expected to complete their first major cycle of priority setting exercises, in a continuing flow, by the end of 1996.*

- *These program-level exercises will be used as the basis for a comprehensive institute-wide priority setting exercise by early 1997.*

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1. Introduction

KARI has made a strong commitment to set clear and rational agricultural research priorities and to translate those priorities into resource allocation decisions. Fulfilling this commitment is crucial to the Institute's future success. As the resources available for agricultural development become increasingly scarce, it is essential that the Institute can clearly and quantifiably demonstrate the value of agricultural research in promoting national agricultural development objectives, particularly in comparison to competing claims for public and donor resources. Further, the clear and rational presentation of priorities will allow KARI to take a more pro-active approach in soliciting donor support for areas identified as vital to national agricultural development efforts. Such a presentation will, in turn, increase the Institute's control over its research agenda and further increase the flow of innovations with a demonstrable impact on agricultural development.

While the essence of priority-setting is quite simple, its role in agricultural research is complicated by the complex and multi-layered structure of an agricultural research Institute. In recognition of this complexity we define priority-setting in the following broad terms:

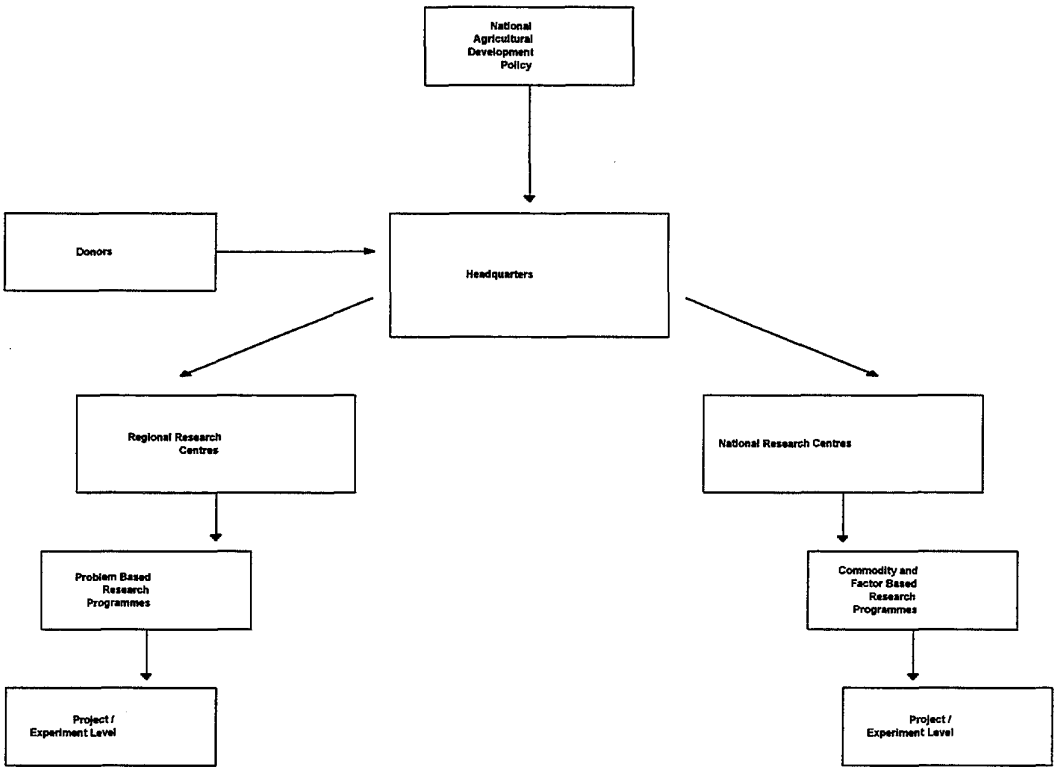
Priority-setting is the process of combining institutional structures with information on the potential of research innovations, in order to allocate scarce research resources.

In the rest of this position paper we examine the specific steps KARI can take to improve the priority-setting process. The next section reviews the structures and information flows used to make resource allocation decisions at different levels within the Institute. Section three discusses appropriate priority-setting criteria that measure the potential contribution of proposed research areas to national agricultural development objectives. Section four then examines the methods and minimum datasets necessary for the measurement of the above criteria. Finally, a 'plan of action' is formulated with recommendations on how KARI should proceed to develop institutional structures, criteria, methods, and information bases within an integrated priority-setting framework.

2. Institutional structure and information flows

In a national research Institute, such as KARI, decisions to allocate resources between competing potential research agendas are made at the Institute, national research program (NRP), and regional research program (RRP) levels, as well as at the project level within programs. The basic structural organization of the Institute is presented in Figure 1. At the national level, an agricultural development policy body is responsible for setting the goals for agricultural research. The Institute then translates those goals into national commodity and factor-based research programs housed at national agricultural research centers (NRCs) as well as problem based regional research programs housed at regional research centers (RRCs). These programs are in turn charged with developing and monitoring agricultural research at the project and experiment level. With this framework, the Headquarters, NRCs, and RRCs provide the structure for administration and infrastructure, while the Institute, programs, and projects provide the actual structure for research activities.

Figure 1: Structure of the Research Institute



Priority-setting efforts attempt to capture the flow of research benefits, efforts to evaluate the potential of research within KARI should be based on the Institute, program, and project structure of research activities.

If information flows smoothly across the Institute, programs, and projects, priority-setting can be done efficiently at the Institute level. However, the flow of information on the potential impact of agricultural research is constrained for a number of reasons and it is, therefore, difficult for decision makers at the Institute level to access the necessary information to set informed agricultural research priorities. This constraint can be partially overcome by mandating research programs within the institute to collect similar information and conduct similar priority setting exercises. Programs then becomes the basis for the generation of information needed for agricultural research priority setting.

Priority setting information can be divided into two component parts: 1) technology needs of program client groups; and 2) the potential for generation and adoption of technologies which address these needs. Information on the technology needs of program client groups is a prerequisite for priority setting activities, but is also needed for a broader group of program activities. Thus, information collection activities in this area should be seen as a continuing part of program activities and not exclusively as a priority setting activity.

The second information component, on the potential for the generation and adoption of technologies, is, however, a key focus of priority setting exercises. Priority setting exercises must explicitly access what technologies can be successfully generated to address client needs, as well as what level of adoption of these technologies can be expected among client groups. Section 4 will further discuss how elicitation techniques can be used to synthesize information through expert opinion on the potential for the generation and adoption of technologies.

Other constraints on the flow of information within KARI include lack of finances for publication and circulation of research results, lack of a routine circulation process; and lack of time, resources, and incentives to write up research results. Given these constraints, the Institute must develop an institutional structure and a method for setting research priorities that elicits information from those with the most knowledge on client groups as well as the feasibility and adoptablity of research innovations. Priority setting exercises will then synthesize this information into measures of research's potential contribution to national development objectives.

Figure 2 identifies the institutional structures needed to support agricultural research priority setting at KARI. The dashed lines represent important flows of information in the national system. The ovals represent institutional structures with important priority-setting and resource allocation functions. We briefly review these structures at the Institute, program, and project levels.

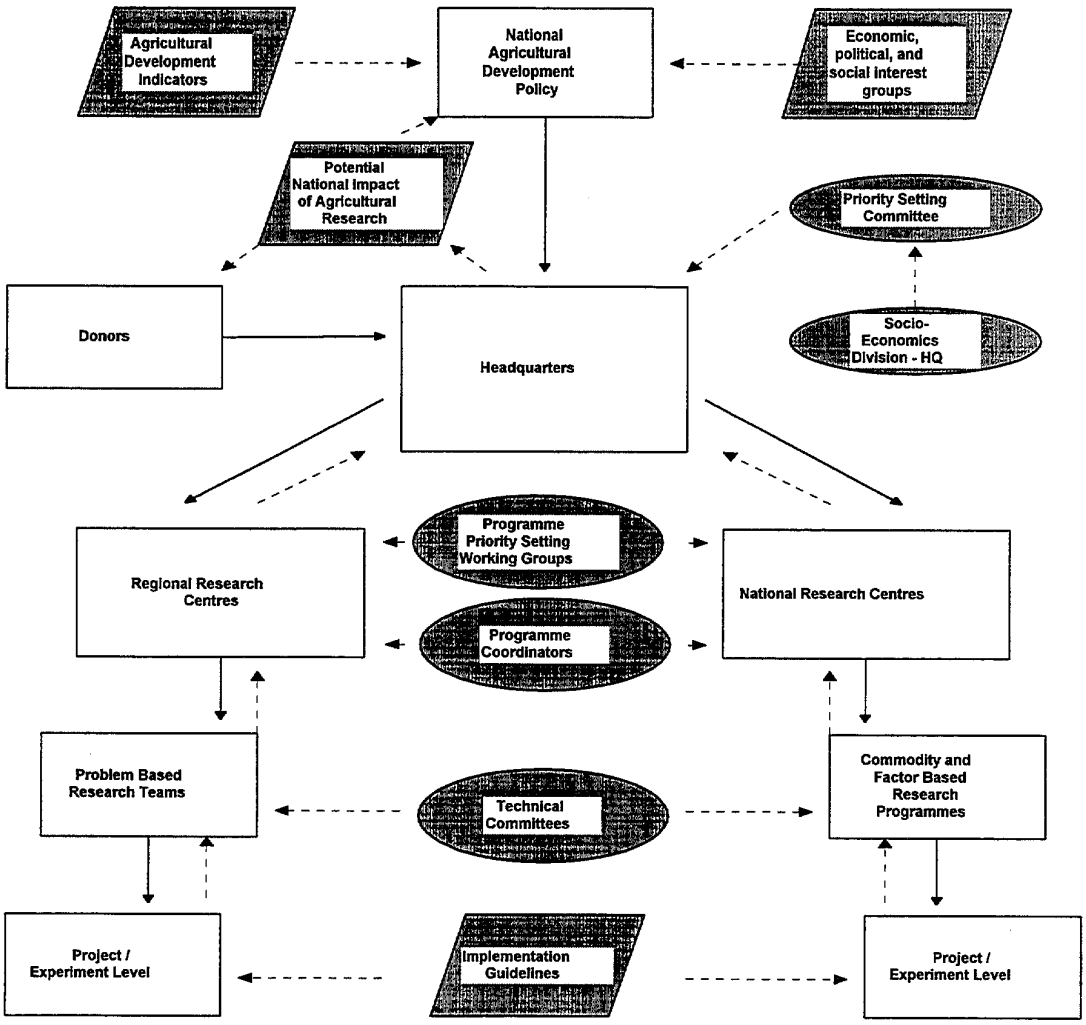
Institute level

National agricultural development policy is primarily influenced by national development indicators and economic, political, and social interest groups. However, the Research Institute can also influence agricultural development policy by providing reliable information on the potential impact of agricultural research. This information

is important in persuading donors to allocate resources to research areas the Institute feels have the highest potential impact for agricultural development.

At the Institute level, clearly reasoned and quantifiable indicators of a prioritized set of potential agricultural research themes increase KARI's ability to set a coherent and stable research agenda with the government and donor community.

Figure 2: Information Flows and Institute Structure



Senior management must play a key role in priority-setting and resource allocation decisions at the Institute level by coordinating priority-setting activities at all levels. However, senior management must also decide how to allocate resources across the administrative structure of the Institute. Priority-setting efforts can provide some guidance on the division of resources between the Headquarters, NRCs and RRCs. However, research benefits accrue only upon the successful adoption of technologies

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by targeted farmers, and it is impossible to cleanly divide these benefits between the different administrative structures involved in the process of technology production.

In order to coordinate priority-setting efforts at the Institute, KARI is in the process of appointing a 'Priority-setting' Committee with the mandate to decide on criteria and methods for priority-setting and to oversee the synthesizing of program-level information for an Institute wide priority-setting exercise. However, the actual synthesizing of program-level information into a form that can be used for Institute wide priority-setting should be the responsibility of the Headquarters Socio-Economics Division, which will report to the Priority-setting Committee. Once criteria and methods are established, the Socio-Economics Division will also need to clearly outline the specific responsibilities of division members with regard to priority-setting activities.

The optimal time-frame for setting agricultural research priorities at the Institute level also needs to be determined. Since agricultural research priorities are meant to steer a stable long-run course for the Institute, including the development of infrastructure and human capital, an Institute-wide priority-setting exercise is undertaken only once every five to ten years. The results, which if the process is properly undertaken are based on quantitative measures and consensus opinion, are then adopted as the official guideline for Institute-wide resource allocation decisions. Since KARI produced a set of Institute-wide research priorities in 1991, it should plan to update and improve on this effort no later than early 1997.

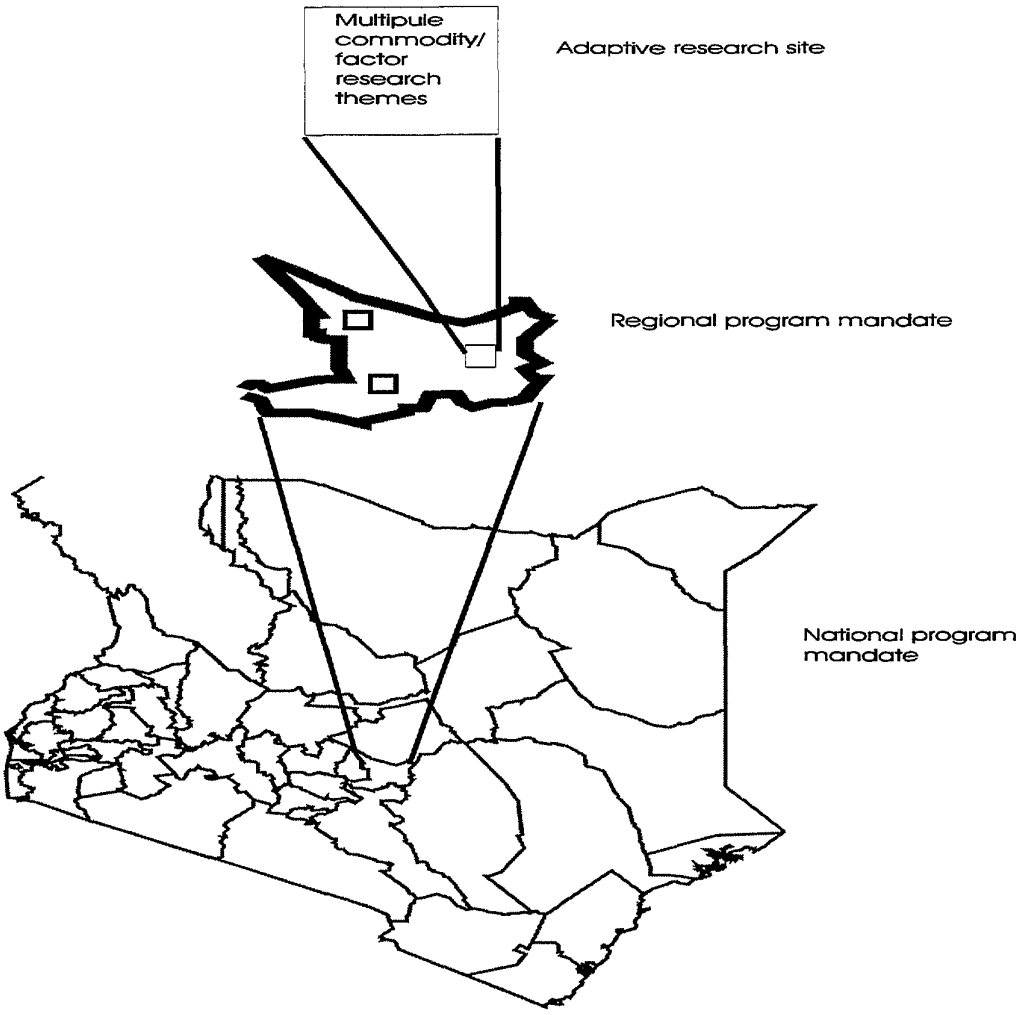
Program-level

As mentioned, the Priority-setting Committee must also outline a process for setting agricultural research priorities within research programs.

Program-level priority-setting should focus on evaluating the potential contribution of major program research themes to national development objectives.

This task is complicated by the fact that different processes will most likely be required for RRP and NRP priority setting exercises, particularly in terms of understanding the needs of client groups. As figure 3 demonstrates, the limited research mandate of RRPs, in terms of geographic area, tends to reduce spatial variability in the resource base of client groups and hence variability of potential research impact. At the same time, RRPs must address research issues related to multiple commodities and factors within those mandates. NRPs, on the other hand, have a mandate to cover the country-wide spatial diversity of a single commodity or factor.

Figure 3: The spatial diversity of research mandates

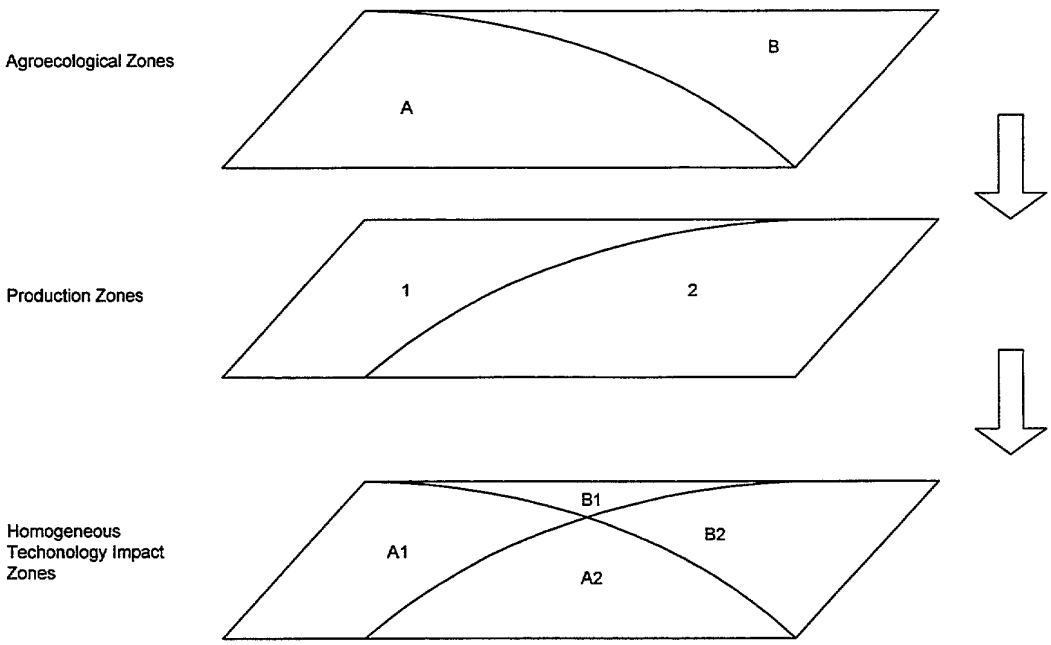


Given their limited spatial mandate, it is feasible for RRPs to work closely with client groups to identify the disaggregated needs for technology generation. Usually this is done through informal survey techniques and participatory rural appraisal methods. However, NRPs must target research technologies over a more diverse mandate area and will need to work at a more aggregate level when targeting client groups for technology development. These more aggregate approaches should incorporate information generated by RRP efforts, but also make greater use of existing sources of quantitative information on key environmental criteria for production of the commodity or use of the factor.

Such classification efforts will often result in a number of diverse agroecological zones and production system zones. When overlayed, these zones produce a complex spatial distribution of potential target research zones within which the impact of generated research technologies will be fairly homogeneous, figure 4. Given human resource constraints, national programs will want to limit the number of program-

specific technology impact zones used in priority-setting exercises. Initial program efforts may wish to focus on defining agroecological zones based on the key environmental determinants for commodity production. However, as additional socio-economic information becomes available on farmer production systems, it can be incorporated to further refine program impact zones. The Maize Program, through the Maize Database project, has attempted to incorporate socio-economic parameters in the specification of program target impact zones and these efforts will provide a useful guideline for other programs. Finally, it is also important to note that national program and regional program linkages play an important role in ensuring an adequate level of information for the identification of client needs at both levels.

Figure 4: Homogeneous Technology Impact Zones



In addition to the identification of target groups, elicitation of information on the probability of generating successful innovations and the potential for their subsequent adoption is needed to evaluate potential research impact. Table 1 indicates some of the features of subjective and spatially diverse information about the potential for the generation and adoption of agricultural technologies. Dealing with these often awkward features to make informed resource allocation decisions is the main challenge of priority-setting activities.

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Table 1: Features of information on the generation and adoption of technologies

Generation of technologies	Adoption of technologies
• **Probability of research success not easy to elicit**	• **Heterogeneity in target groups**
• **Long time lags in technology development**	• **Target systems are dynamic**
• **Technical expertise on feasibility is localized at the project level**	• **Information on adoption potential is specific to farming system**
• **Unbiased evaluations difficult**	• **Unbiased evaluations difficult**

In terms of eliciting information on the potential for generation of technologies, it is difficult to accurately estimate either the probability of success or the time-frame necessary for technology generation. Information on these parameters must be elicited from those researchers with the best information on the scientific feasibility of proposed innovations. Unfortunately, this information is decentralized among those with personal interests in seeing resources allocated to the generation of specific technologies. This makes it difficult to obtain unbiased evaluations.

Similar problems arise in assessing the potential adoptability of technologies. Farmers usually have the best information on the adoption potential of research innovations. However, an efficient mechanism must be developed to synthesize farmer information on adoption into a form that can be used for priority-setting. There are complex aggregation problems due to the heterogeneity of recommendation domains and target groups. Further, given the long time-frame necessary for technology development, it is uncertain if technologies designed to address current agricultural constraints will be applicable in future agricultural production systems. Under these conditions, researchers' and extension agents' "expert" opinions may be the best mechanism for including farmer views on adoption potential in priority-setting exercises. However, as with information on the generation of agricultural technologies, expert opinion on the potential adoptability of technologies tends to be concentrated both regionally and by discipline, creating the potential for biased evaluations.

The key person for coordinating priority-setting efforts at the program level is the program coordinator. The primary activities of the coordinator with regard to priority-setting should be to identify key informants and other sources of information within and outside the Institute which can contribute to the priority setting exercise. The coordinator should then be responsible for constituting a Program Priority Setting Working Group composed of key informants. The working group will need to be assisted by a headquarters based socio-economist who will facilitate the actual program priority setting exercise. The facilitator should have access to available sources of quantitative data, be fluent in priority setting methods, and be able to operate the priority setting applications discussed later in this paper. Finally, a meeting should be held with a larger group of program clients and key stakeholders in order to review and modify Working Group assumptions, as well as build consensus on program priorities.

The facilitator will also play a critical role in ensuring compatible criteria and priority-setting methods are used by all programs. This will facilitate the use of information generated in program-level priority-setting exercises for later Institute-wide efforts. Further, in each NRC with a national mandate, the Centre Research Technical Committee must play an important oversight role by reviewing the validity of assessments of technical feasibility and adoption potential of research themes in programs under its mandate.

Program-level priority-setting efforts should occur more frequently than Institute level efforts to account for constantly improving information on the technical feasibility of research innovations, as well as changing market conditions for agricultural products. However, the timeframe should be sufficiently long for the implementation of strategic program planning and resource allocation activities based on the results of the exercise. Thus, program-level priority-setting exercises probably should be carried out every three to five years

A number of research programs have already instituted program-level priority-setting efforts. The Maize, Millet, Sorghum, and Wheat programs have developed agroecological-zone-based priority-setting approaches. The livestock programs are establishing a database that will facilitate priority-setting efforts within the sector. The Horticulture and Oilseed programs are in the process of planning program-level priority-setting efforts. These efforts should be used as the basis for institutionalizing the process of program-level priority-setting. Towards this end, it is crucial that the activities and positions with responsibilities for setting program-level agricultural research priorities be clearly outlined at the completion of pilot efforts.

Project level

Programs must then decide which projects to fund within prioritized research themes.

The decision on whether to fund specific projects within a program are best made by technical specialists from the program.

The current Centre Research Technical Committee may be the most appropriate forum for project-level resource-allocation decisions. In these committees, specialists will rely mainly on expert opinion and it is not recommended that the committee oversee quantitative priority-setting exercises to rank the potential benefits of every proposed research project. However, there are several simple guidelines technical committees can use to decide if projects support national development objectives, Institute priorities, and program priorities. The following suggestions are elaboration's on concepts presented in the MOALDM (1986) document "Guidelines for Research Project Proposal Formulation".

First, an evaluation of the potential impact of the project should be included in all proposals. The assessment should identify the potential economic impact of the proposed research, including:

- Who are the target groups?
- How large is the target group?
- How will the target group benefit if research is successful?
- What is the probability the research will be successful? and
- What are the costs of the project?

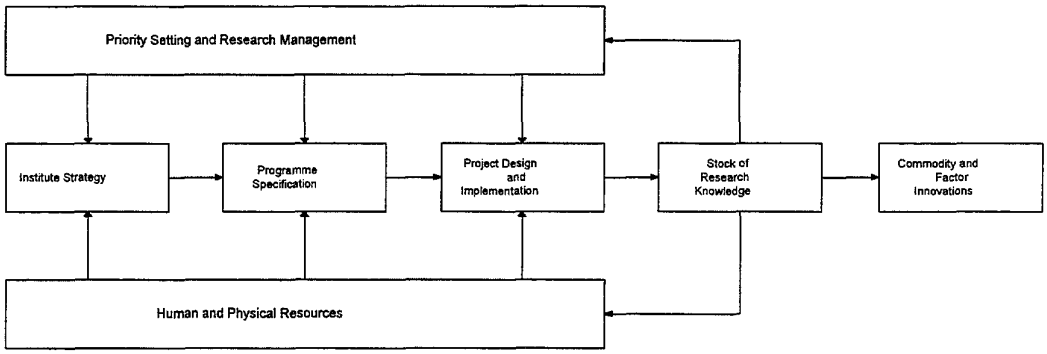
Second, each proposal should be required to explicitly discuss how proposed research will contribute to meeting program-level priorities, Institute level priorities, and national development objectives.

Other Structures

Finally, it is imperative to note that, if the Institute is going to successfully translate priority-setting information into resource allocation decisions, it must also have a mechanism for monitoring changes in the allocation of resources between alternative research areas, not only at the Institute level but also at the program and project levels.

As Figure 5 indicates, priority-setting is only one of a number of research management activities which provided information to research managers in order to more effectively allocate human and physical resources to the production of agricultural research. Other research management activities, particularly resource monitoring activities, are necessary complements to priority-setting efforts.

Figure 5: The Contribution of Priority Setting to Increasing the Productivity of Agricultural Research



KARI is currently developing its capacity to monitor resource-allocation decisions by implementing INFORM, a program-based budgeting system. When fully operational, INFORM will become a useful oversight mechanism at all levels of planning and priority-setting within the Institute.

3. Research evaluation criteria

One of the most controversial components of priority-setting exercises is determining appropriate criteria for ranking alternative research programs or major themes within programs. Ideally the criteria used for agricultural research priority-setting should reflect the potential of research to contribute to national agricultural development goals. However, it is often very difficult to reflect national policies in quantitative measures of the potential of agricultural research. Further, agricultural development objectives are often vague and suggest the simultaneous pursuit of a number of competing objectives.

The most commonly used criteria for priority-setting are:

- Efficiency - Research's impact on aggregate welfare;
- Equity - The distribution of aggregate welfare benefits;
- Foreign exchange earnings - Research's impact on the balance of trade;
- Food self-sufficiency - Research's contribution to meeting all the country's food needs internally;
- Food security - Research's contribution to reducing the variability of food availability; and
- Sustainability - Research's contribution to protecting the natural resource base for future use.

These criteria are reviewed below in terms of both their theoretical justification and empirical measurability. The section then concludes with a recommendation on appropriate criteria for priority-setting efforts in KARI.

Efficiency

Few would argue with the assertion that the primary goal of agricultural research at KARI is to improve the welfare of Kenyan citizens. However, agricultural research resources are limited. Therefore, an efficiency criterion is needed to measure how alternative potential research program themes impact on household welfare. Most economic research in the field of priority-setting has focused on refining the theoretical foundations of efficiency criteria and developing appropriate empirical measures (see Alston, Norton, and Pardey (1994) for a full a complete review).

Since all households are joint producers and consumers of agricultural products, their welfare will be effected by the impact of research on both consumption and production decisions. The most commonly used empirical measures of the efficiency are change in consumer surplus, which measures the welfare benefits to consumers due to research, and changes in producer surplus, which measures the welfare benefits to producers from research. These measures are used as the basis for most priority-setting efforts because they rest on a solid economic foundation and are easily implementable.

Equity

The above efficiency criterion assumes that all households derive equal benefits from an extra unit of production or consumption. Equity criteria go beyond efficiency criteria by placing higher weight on the welfare gains of certain target groups, (e.g., the poor). The justification for this weighting is that changes in consumer or producer welfare to these target groups actually result in greater social welfare gains than the distribution of economic surplus gains to alternative groups.

Most people agree that society has a moral imperative to address equity objectives. However, KARI must decide whether agricultural research is an appropriate mechanism for attempting to modify the distribution of welfare in the society. Three issues need to be addressed. First, efficiency losses result from pursuing equity concerns. The efficiency measure with the greatest value, by definition, yields the distribution of welfare benefits with the greatest value to society. Movement away from this distribution will result in a lower total monetary value of benefits. This tradeoff must be acknowledged when assigning appropriate weights for efficiency and equity criteria. Second, while social welfare could be increased under the equity criterion, it is not possible to quantitatively measure the social welfare distribution arising from agricultural research and choose a mechanism to redistribute that welfare. Finally, even if social welfare is measurable, agricultural research is probably not a very efficient mechanism by which to change the distribution of social welfare. KARI may have a greater impact on the distribution of social welfare by providing policy makers with information on the potential welfare impacts of alternative policy measures, rather than through research.

Regardless of these issues, KARI will certainly be required to address the equity implications of its research within in the political context of ensuring regional equity in the development of the agricultural sector. The next section will discuss potential measures of the regional benefits of agricultural research and how they might be used as the basis for including equity criteria in priority-setting exercises.

Foreign exchange earnings

Perhaps the most confusing of all criteria is research's contribution to increasing foreign exchange earnings. This confusion arises for two reasons. First, it is not clear exactly how, or why, foreign exchange contributes to national development objectives. In fact, criteria aimed at increasing foreign exchange are often really aimed at targeting research benefits to export-oriented farmers. Second, the impact of agricultural research on the balance of trade is not well understood and can be complex.

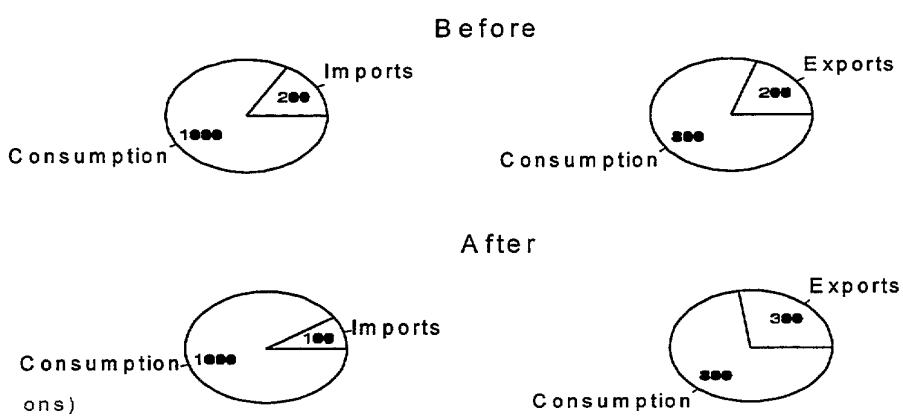
Box 1 gives a brief example of how research on commodities primarily consumed within the country and research on export crops can often have quite similar impacts on foreign exchange. Therefore, one must be careful in estimating the potential impact of research on foreign exchange earnings, particularly when import and export policies have a major impact on the market for the commodity. If the major benefit of

research on an export-oriented crop is to increase comparative advantage or profitability on the world market, the gain will be fully captured in the producer surplus measure of the efficiency criterion. By the same token, if research can have a large impact on a crop that is an import substitute, both the impact on the balance of trade and consumer surplus will also be large. The efficiency criterion may, again, be a better measure of the impact of research on the balance of trade than an export earnings criterion.

BOX 1

Figure 6 illustrates the impact of an overall increase in agricultural production in a commodity due to research, from 1,000 tons per year to 1,100 tons per year under net importer and net exporter scenarios. In the net importer scenario, before increased supply, Kenya produces 1,000 tons of the commodity, but domestic demand is 1,200 tons. Excess demand is met by importation of 200 tons of the commodity on the world market. If increased production has no effect on the domestic price of the commodity or the consumption patterns of Kenyans, the impact of research will be to reduce the country's import requirements by 100 tons*. In the exporter scenario, domestic demand for the commodity is only 800 tons so that a surplus of 200 tons is exported before the increase in supply. After the supply shift, again assuming no price change or other impact on consumption behavior, exports increase to 300 tons. If the commodity has the same price in both scenarios, (assume 1,000 K.Sh per ton), then under both scenarios, it will have the exact same effect on the balance of trade (an increase of 100,000 K.Sh).

Figure 6 - Commodity Uses -Before and After the Impact of Agricultural Research



*** It should be noted that prices do change and the impact of increasing the supply of different crops on foreign exchange, whether through import substitution or export enhancement, will vary. However, the example highlights the complex nature of research's impact on foreign exchange earnings.**

Food self-sufficiency and food security

Food self-sufficiency goals are often confused with food security goals. The underlying objective of food self-sufficiency is to insulate the country from instability

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of world food markets. The pursuit of this objective will often lead to the production of commodities at a level for which the country has no comparative advantage (i.e., the commodity could be imported and an alternative commodity produced in its place at less cost to society). However, trade and liberalization of markets can often buffer swings in domestic production, thus self-sufficiency policies which setup market barriers may actually result in increased variability in the availability of staple foods.

On the other hand, food security goals attempt to lower the variability of the availability of staple foods. There are two important related components to food security goals: Reducing the market variability in the supply of staple foods; and reducing the variability of production of staple foods. While KARI should participate in the policy arena addressing this first component, it also has a mandate to develop technologies that address the second component. A number of research themes specifically attempt to reduce the variability of production, particularly soil and water management and agronomic research in marginal environments. If food security is an important goal of national development policy, KARI must choose what additional weight to give to these efforts relative to general efficiency goals.

Sustainability

Sustainability criteria examine the contribution of research to the protection of the resource base for future use. Since current agricultural production affects the resource base and the potential of future production, sustainability is really a moral question of how society should trade-off present benefits and future benefits. This trade-off is particularly important when evaluating factor-based research that specifically aims at more efficiently using the natural resource base.

There are a number of major methodological difficulties related to developing empirical measures of sustainability. In particular, the information necessary to measure the sustainability of the natural resource base is difficult and costly to obtain because it requires an understanding of the dynamics of the underlying physical processes. However, an understand of farmer behavior and decision making over long time horizons is also needed to properly evaluate the impact of research on the sustainability of production systems. The moral issue of what constitutes a justifiable trade-off between the welfare of present and future generations must also be addressed in the development of a sustainability criteria.

If these methodological difficulties can be resolved it will be possible to incorporate sustainability criteria by adding an inter-temporal framework to traditional measures of efficiency. The KARI/ISNAR priority-setting project is attempting to develop such a method for application to soil and water management program priority-setting. If successful, the method may perhaps be extended to develop a sustainability criterion measure for other commodities and factor research programs.

Working Group recommendations on priority-setting criteria

This section has highlighted the complexity of measuring the potential contribution of agricultural research to national development objectives. However, despite

methodological and measurement difficulties, it has suggested several quantifiable criteria; particularly efficiency and equity. The KARI Priority-Setting Committee must choose appropriate weighting procedures for these criteria, as well as other criteria it believes reflect additional components of national agricultural development objectives. In doing so, the Committee must also assure adequate information and methods exist for the measurement of criteria.

The Priority-Setting Working Group makes the following specific recommendations to the Committee.

1) The efficiency criterion and its expected consumer and producer surplus measures should form the basis of priority-setting efforts;

2) The equity criterion should also be included in priority-setting efforts and its measurement should be based on the distribution of efficiency benefits either regionally or by target groups;

3) If food security is determined to be an important component of national agricultural development objectives, a measure of this criterion should be included in priority-setting exercises. However, the weight given to the criterion should be determined by the quality of the information available on research's contribution to food security objectives.

4) While sustainability issues are vital to the long-term welfare of Kenyan society, methods and information bases for measuring the impact of research on the sustainability of agricultural production systems are currently not available. Current research efforts are attempting to develop these measures.

Finally, it should be reiterated that priority-setting is a political process and KARI must formulate and justify its criteria in such a way as to foster long-term support for the Institute.

4. Methodological issues for priority-setting

As discussed, priority-setting is done within an institutional structure. Methods and information do not "make" decisions; rather they provide the decision maker with a better basis for measuring criteria in the priority-setting process. This section briefly examines the methods needed to improve the measurement of priority-setting criteria at KARI.

Regardless of the criteria chosen, there are four crucial components to priority-setting exercises:

- Identifying program target zones;
- Eliciting assessments of the technical potential of research;
- Identifying the adoption potential of successful research; and
- Evaluating the economic impact of research.

These components, and other related methodological issues are discussed in the rest of this section.

Program target zones

One of the most noticeable features of Kenyan agriculture is the enormous diversity of environmental conditions and production systems. Since few technologies will cover this range of environments, spatial targeting of technology development is essential. KARI has adopted the NRC-RRC linkage approach to address the spatial diversity of its mandate and focus technology development on designated production environments.

The RRC mandate areas are district-based and often encompass several agroecological zones and production systems (see Figure 3). With a limited geographic area it is often possible to characterize program target zones through site-specific results using rural appraisal techniques. However, researchers in programs with national mandates must think more strategically about the target zones of potential innovations. One of the main advantages of the agroecological zone approach to research priority-setting is that it helps researchers to identify commodity-specific target zones by identifying the areas of the country possessing environmental attributes which will cause the physical impact (yield gain or unit cost reduction) of developed technologies to be fairly homogeneous.

The technology for producing these zone mappings with geographic information systems (GIS) is now readily available and GIS facilities as well as databases have become well institutionalized within KARI. The set of available information for the development of commodity-specific homogeneous technology zones includes the country-wide overlays on monthly rainfall, monthly minimum and maximum temperatures, elevation, and integrated information on farmer production constraints related to maize in the KARI/CIMMYT maize database. In addition, the Kenya Soil Survey has a number of overlays on soil parameters and land use types. With these

databases, the KARI/ISNAR Priority-setting Project has developed a GIS classification aid that can be easily used by program scientists to specify commodity or factor-specific homogeneous technology impact zones. Once these zones have been identified, they will serve as the basis for the evaluation of the technical potential of alternative program research areas. Further, as program knowledge of production systems evolves, environmental determinants may be combined with socio-economic characteristics to delineate adoption zones across which the uptake of innovations with relatively homogeneous technical potentials may differ.

Technical potential of research

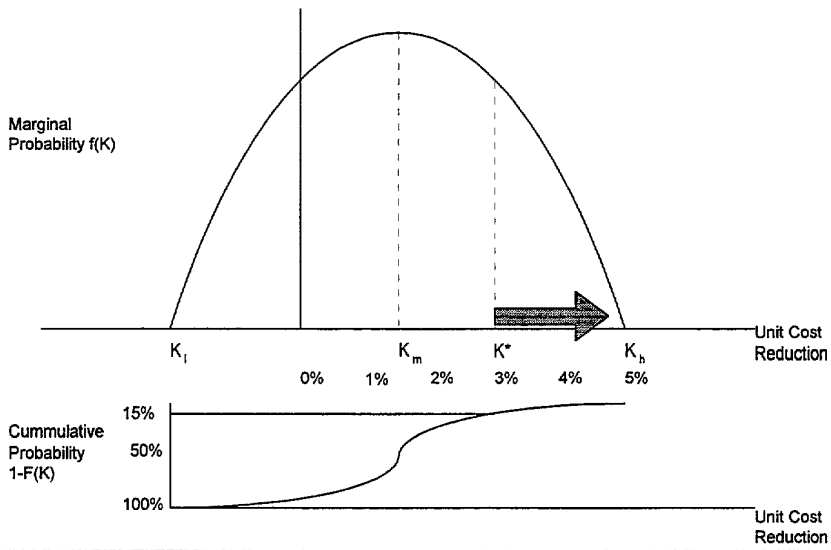
After program target zones have been identified, the potential impact of research within each zone must be determined. This process is perhaps the most subjective element of the priority-setting process. For the reasons listed in Table 1, it is impossible to know the "true" potential of research ex-ante. Therefore, priority-setting exercises often resort to a Delphi method of elicitation of expert opinion on the potential of agricultural research.

There are three main components to the technical potential of research which must be elicited: 1) the distribution of potential research outcomes in terms of unit cost reductions; 2) the probability of a 'successful' outcome, (success is defined as a unit cost reduction sufficient to move the technology into a dissemination phase; and 3) the expected unit cost reduction given the research is successful. These three components are closely related. For each level of unit cost reduction in the production of the commodity, there is a corresponding probability that research can achieve the level. Further, the lower the probability of 'success', the higher the expected unit cost reduction. A more detailed discussion of the relationship between the distribution of potential research outcomes, the probability of success and expected unit cost reduction resulting from research is given in Box 2.

Box 2

Let f(K) represent the distribution of unit cost reductions of a program research theme. Further, let K* (a 3% unit cost reduction in this example) represent research success, or the minimum level of unit cost reduction necessary for an innovation to move from a research to dissemination phase. (Below this level the profitability of the innovation is too low for it to be widely adopted by farmers). What is the probability of achieving K*. If we look at the cumulative density function at the bottom of the example in Figure 7, the probability that the unit cost reduction resulting from the research is above 3% is quite low, approximately 15%. Further, as K* increases, the probability of success decreases. For the evaluation of potential research impact the relevant measure is the expected unit cost reduction, conditional upon a unit cost reduction from research greater than K*, or $(1-F(K^*))E[K|K>K^*]$.

Figure 7: Research Impact, Unit Cost Reduction



In order to specify the distributions of possible outcomes from research, the minimum possible unit cost reduction K_l; most likely unit cost reduction, K_m; and maximum unit cost reduction, K_h must be elicited from experts. For simplicity, priority-setting exercises assume a triangular distribution of outcomes that closely approximates the marginal distribution of research outcomes represented in the upper panel of Figure 7. Then the success level, K*, (the level below which the technology would not be disseminated and no benefits would accrue at the farm level), must be defined. Finally, the potential commodity supply shift, based on the expected unit cost reduction above K*, must be calculated.

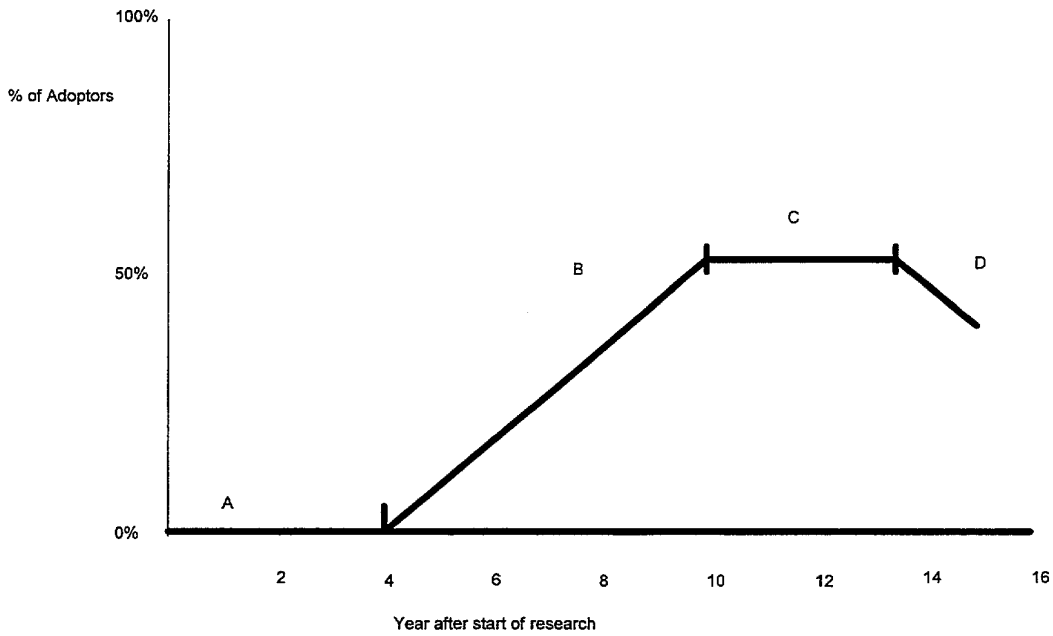
Adoption potential of successful research

The actual level of research impact will depend on the speed and frequency of adoption of the technology. Thus, it is essential to include an assessment of the likely adoption pattern of the innovation based on the expected unit cost reduction given research success. Figure 8 shows a generic adoption profile. Several basic characteristics of the profile should be noted. These are labeled in the figure as:

A) A research development lag at the beginning of the adoption process;
B) An initially increasing adoption rate as an increasing number of farmers in the target area become exposed to the technology;
C) An adoption plateau where most target farmers have been exposed to the technology and have decided whether or not to adopt; and
D) A declining adoption rate as the technology becomes obsolete.

Combined, these components determine the speed and frequency with which research results are translated onto farmer's fields. This information is combined with information on the maximum potential of commodity supply shifts, in order to develop a profile of research-induced commodity supply shifts over time.

Figure 8: Adoption profile of a technology



Like the technical potential of research, the ex-ante specification of adoption profiles are usually best elicited through expert opinions. Accurate elicitation of these parameters is predicated on the assumption that key informants have a good understanding of farmer constraints and how technologies will affect specific agricultural production systems. Since this type of information is gained through the diagnosis and characterization of agricultural production systems, such exercises are a necessary precondition for accurately incorporating farmer demands into priority-setting exercises. However, several additional steps need to be taken to ensure that expert opinion is an efficient mechanism for including farmer constraints and behavior into the priority-setting process. First, it is important that individuals with the best information on probable adoption profiles be identified. Researchers, particularly those with regional research mandates, may have an advantage in specifying the research time lag and time to obsolescence. Correspondingly, extension workers may have an advantage in specifying the magnitudes of segments B and C and should be included in the elicitation process. The adoption profiles of previously released technologies with similar profiles will be helpful as a reference point. The KARI/CIMMYT Maize Database analysis of survey data on the adoption of improved maize cultivars and the KARI/ISNAR/Humboldt University project efforts to examine the adoption profiles of improved dairy packages in the livestock sector should be particularly helpful.

Evaluating the economic impact of research.

The economic impact of research is usually evaluated through its impact on commodity supply. This method can provide accurate measures of both efficiency and equity criteria based on the economic surplus framework. However, if multiple criteria are to be included in the evaluation, a multiple criteria scoring model will be needed. KARI has already implemented a scoring model in its 1991 priority-setting exercise

and is, thus, familiar with scoring methods, KARI (1991). Below we briefly discuss methods for empirically measuring efficiency and equity criteria

In order to correctly measure the welfare impacts from agricultural research, it is necessary to understand how a research-induced supply shift affects commodity market prices. Generally, supply increases affect the welfare of consumers (consumer surplus) by enabling them to purchase more goods at lower prices. Changes in producer welfare, on the other hand, are ambiguous. Producers clearly benefit from lower unit cost of production but are hurt by commodity price decreases accompanying positive supply shifts. The overall magnitude of consumer and producer welfare changes determines the economic impact of research. Box 3 presents an example of economic surplus changes arising from a research-induced supply shift.

While the calculation of research impacts in this framework can be complex, the task is greatly simplified by software programs specifically developed for this purpose. Several other factors may have a substantial impact on research-induced changes in economic surplus: in particular, cross-zone effects for targeted technologies under multiple research zones; price wedges across research zones; exogenous supply and demand growth, (e.g., population growth), by research zone; and market distortions from government policies. DREAM can easily incorporate these factors and dramatically lowers the cost of calculating research-induced changes in economic surplus.

The spatial distribution of benefits - measuring the equity criteria

Consumer and producer welfare measures can also be used to develop equity criteria measures by examining their distribution to selected target groups. Such target groups can be identified by location, using the spatial framework for economic surplus calculation, or even consumption and production characteristics of households, (e.g., poor and non-poor), if disaggregated information on household production and consumption characteristics is available. Further, the (aggregate) efficiency losses from pursuing equity criteria can be identified.

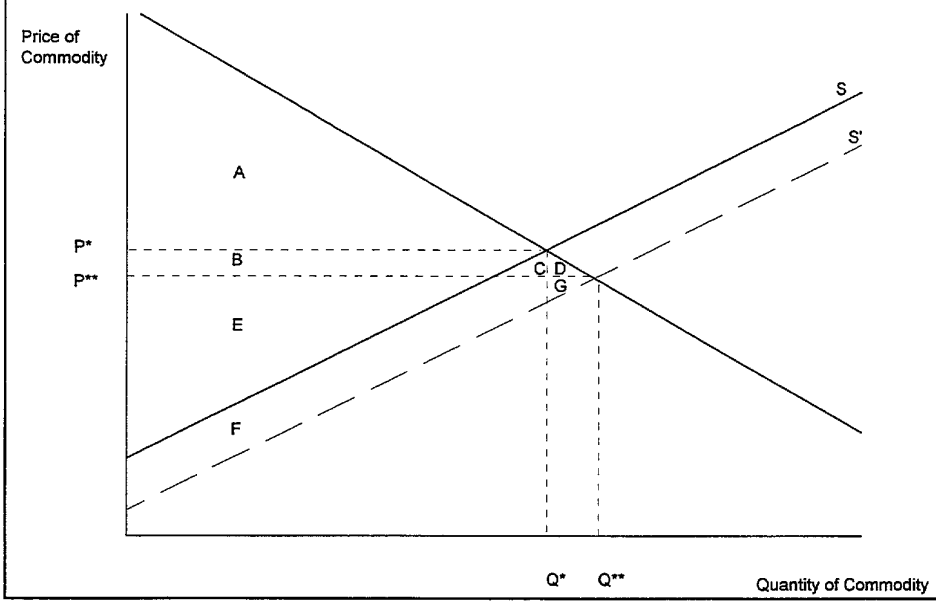
BOX 3

Figure 9 demonstrates the consumer surplus gains of a research-induced supply shift from S to S'. At the original level of supply, consumers receive area A in benefits, (the total area of benefits from the commodity above the price paid). The commodity supply shift then results in a corresponding price decrease and consumers receive welfare benefits equal to area ABCD. Thus, the net consumer surplus gain is the area BCD.

The impact of the research-induced supply shift on producer surplus is more complex. Originally producer surplus gains are represented by the area EB (the area below the commodity price but above the cost of production). After the supply shift, producer surplus becomes the area FEG. Thus, the change in producer surplus is determined by two factors, gains from the unit cost reduction in production, area FG, and losses from commodity supply shifts, area B.

Surprisingly producer welfare may either increase or decrease when confronted with a technical innovation, depending on the relative magnitude of the two effects. However, society as a whole, (the aggregation of consumer and producer surplus changes) unambiguously gains area CDFG.

Figure 9: The Market Impact of Increase Commodity Supply



The measurement of other criteria

As mentioned in the previous section, KARI may wish to include other criteria, such as food security or foreign exchange earnings, as priority-setting criteria. These criteria can only readily be included through a scoring model. Further, since it is virtually impossible to collect quantitative information on the contribution of research to these criteria, rank indicators must be used based on expert opinion. Criteria weighting must also be determined. This is the responsibility of the Priority-Setting Committee.

Other methodological considerations:

Current priority-setting methods can not account for certain research impacts. Calculating the benefits from the expansion of commodity areas due to research is a particular area of difficulty because area-expansion benefits must be measured in relation to the opportunity cost of the commodities previously grown on the same area. In addition, a change in the supply of the commodity being replaced will result in further indirect market impacts. For some commodities, such as wheat, area expansion effects may represent a substantial component of potential research benefits. The KARI/ISNAR priority-setting project is currently attempting to develop a simple method for incorporating area expansion effects into the consumer and producer surplus framework.

A second methodological difficulty in the current priority-setting framework is measuring the potential benefits from factor based or natural resource management research. The major difficulty lies in adequately measuring the physical stream of research benefits from factor based and natural resource management research and translating this stream of benefits into economic values. Many of the issues related to measuring factor and natural resource management research benefits are already mentioned in the previous section's discussion of sustainability criteria. Additional methodological research will be carried out in this area as part of priority-setting efforts within national soil and water management research programs.

A final issue frequently mentioned in priority-setting discussions is the need to ensure that the client, particularly the small-scale farmer, is represented in priority-setting efforts. Certainly the process of diagnosing farmer constraints and developing problem-based research programs to address those constraints, is an important component of the KARI research mandate. The magnitude and incidence of farmer constraints also figures heavily in the calculation of research benefits though the impact of farmer demand for technologies on program target zones and the development of adoption profiles. As such, priority setting exercises are necessary complements to more outward looking efforts to diagnose farmer constraints and potential research solutions. The methods discussed above implicitly assume that expert opinions from researchers and extension agents are the most efficient means of including farmers' demands in the priority-setting process. Therefore, it is essential that researchers and extension workers have strong linkages with farmers, including farmer participation in RRPs. More quantitative measures of farmer demands, if available, can also be used to improve the quality of the elicited parameters.

Information needs

In the long term, information bases will needed for all major commodities and factor programs. Information needs, as directly related to priority-setting, are discussed briefly below. However, the development and maintenance of information bases is a crucial component of future activities in the Socio-Economics Division and needs a systematic study beyond the specific needs of priority-setting activities.

Currently, a technical database has been developed by the maize program and an information base is being developed for livestock. Initiatives for other commodities may be established in the next several years, but coverage will not be complete before the next round of Institute wide priority-setting proposed for early 1997. Therefore, the components of the minimum information base for priority-setting will need to be clearly identified. This minimum information base will include:

* A GIS with basic environmental themes for the identification of homogeneous technology impact zones and, to the extent possible, distinct production zones;

* Quantitative information at the zone or district level, including output production quantities and prices, consumption quantities and prices, inputs used, and distribution of specific production systems within zones as this information is available;

* Qualitative information on crucial production constraints such as marketing, credit, delivery systems, and pricing policy.

* Research management indicators on human and financial resources assigned to research; locations where research is carried out; and types of research done.

Fortunately, much of this information is already available in Kenya. However, information is often scattered, making collection activities an important component of priority-setting exercises. Passing from the project, to the program, to the Institute level, more aggregate levels of information are needed, suggesting a major overlap in information collection requirements. Since it would be inefficient to collect this information two or three times, the Priority-Setting Committee must clearly define which level is responsible for the collection and storage of various types of information within KARI. In particular, the requirements for a minimum database for priority-setting activities will need to be circulated to program leaders once priority-setting criteria and a methodological framework are agreed upon.

The Socio-Economics Division should be responsible for database coordination since it is in a unique position of working with all commodity and factor programs. Further, it currently manages the INFORM research management database. This does not mean that Socio-Economics should collect all of the information or dictate what will be collected. However, the Division can provide guidance on information formats to support the wider goal of ensuring individual program priority-setting efforts can be integrated into the planned Institute-wide priority-setting effort.

Socio-Economics headquarters staff can also assist program efforts by assembling secondary data available across a number of commodities. Programs, on the other hand, generate primary data as part of their routine work and must assume the responsibility of collecting primary data needed for priority-setting efforts. Some primary data can be obtained by collaborating with other governmental and non-governmental institutions and it is important that KARI judiciously uses its resources to undertake only essential primary data-collection activities.

5. Plan of action

The crucial steps KARI needs to undertake to improve the institutional structures, criteria, and methods for agricultural research priority-setting are outlined in the KARI corporate plan. We conclude the paper by briefly presenting the individual steps and their accompanying time-frame.

1) As agreed in the March 1994 seminar on the findings of the Priority-Setting Working Group, a Priority-Setting Committee will be formed from senior management in the Headquarters, National Research Centers, and Regional Research Centers, (1st quarter 95).

2) The Priority-Setting Committee will review this position paper and decide on the criteria and methods to be used in future priority-setting exercises, (1st quarter 95).

3) The Committee will then oversee the development of an institutional structure to collect necessary priority-setting information and implement the chosen method. However, day-to-day operations in this area will be managed by the Socio-Economics Division. As part of this effort, the specific responsibilities of individuals involved in priority-setting efforts will be outlined, (2nd quarter 1995).

4) The Socio-Economics Division will inform programs with regard to method and minimum information needs for program-level priority-setting, (2nd quarter 1995).

4) Programs are expected to complete the first round of priority-setting exercises by the end of 1996.

5) These program-level findings will then be used as the basis for an Institute-wide priority-setting effort by early 1997.

References:

Alston, J., G. Norton, and P. Pardey, 1995. *Science Under Scarcity: Principles and Practices for Agricultural Research Evaluation and Priority-setting*. Cornell University Press, Ithaca.

Kenya Agricultural Research Institute, 1991. "Kenya's Agricultural Research Priorities to the Year 2000". KARI Kabette.

Ministry of Agricultural and Livestock Development - Scientific Research Division, 1986. "Guidelines for Research Project Proposal Formulation". KARI Kabette.

Annex 2: Overheads

Priority Setting for Agricultural Research Programs

Workshop Goal

To provide program leaders and scientists with a systematic approach to developing priority setting, which ensures improvement of research performance to attain national objectives

Major Objectives

Participants to be able to:

- discuss the process of setting priorities in your organizations
- discuss the need to set priorities
- identify existing structures and mechanisms for resource allocation within their institutes, discuss appropriate institutional structures, and level for priority setting
- identify criteria for choosing priority-setting methods
- indicate the use of spreadsheets in priority setting
- implement the congruency model
- identify major constraints in priority setting and allocate the constraints to major research themes
- explain the scoring method, the criteria used, and data requirements
- describe a protocol of approval and implementation of priority-setting duties
- plan actions for future activities in priority setting

Expected Outputs

- Improve priority-setting skills among agricultural research managers
- Improve commitment among agricultural research managers
- Design action plans to implement activities related to priority setting in your organization

Workshop Duration - Five Days

Background - Why Priority Setting?

- Selects best portfolio of research activities for a research system, institution, or program
- Makes effective use of resources available for research
- Allows for review of resource allocations to research
- Clarifies opinions in organizations on research programs
- Promotes an environment of consensus in research programs
- Identifies key persons responsible for prioritization of research allocation
- Helps to make institutional management transparent.
- Provides guidance to management, clarifies expectations of personnel and stakeholders

Workshop Flow

Session	Sequence	Content
2	*Why* P.S.?	Rationale
3	*Where* P.S.?	Locations
4, 6, 8	*How* P.S.?	Process, Methods, Tools
5, 7, 9, 11, 12, 15	*What* P.S.?	Objective, Zones, Themes Information/Data
10, 13, 14	*How* P.S.?	Congruency Analysis Economic Surplus Benefit Scoring
16, 17	*Managing* P.S.	Institutions

Objectives of Day One

1. Discuss background, rationale, objectives, and schedule
2. Explain the use of the participant action plan approach (PAPA)
3. Identify trainers and trainees
4. Discuss the process of setting priorities in your organizations
5. Discuss the need to set priorities
6. Explain why formal priority-setting methods are necessary

Objectives of Day One

7. Explain that a formal priority-setting process does not replace personal judgement, knowledge, and experience

8. Identify the existing structure and mechanisms for resource allocation in your institutes

9. Discuss institutional structures and levels for priority setting

10. Assist in developing an internal priority-setting process for your institutes

11. Identify key processes that should guide any priority-setting exercise

Schedule of Day One

08:30 – 09:00	Welcome
09:00 – 10:30	Session 1. Introduction to the Workshop
	Tea/Coffee Break
10:45 – 13:00	Session 2. Importance of Priority Setting in Agricultural Research
	Lunch
14:00 – 15:30	Session 3. Institutional Structures and Levels of Priority Setting
	Tea/Coffee Break
15:45 – 17:00	Session 4. Basic Processes in Priority Setting
17:00 – 17:30	Feedback on the Day's Activities and PAPA

Participant Action Plan Approach

Why PAPA?

- Systematic and continuous planning of future activities by trainees as training evolves

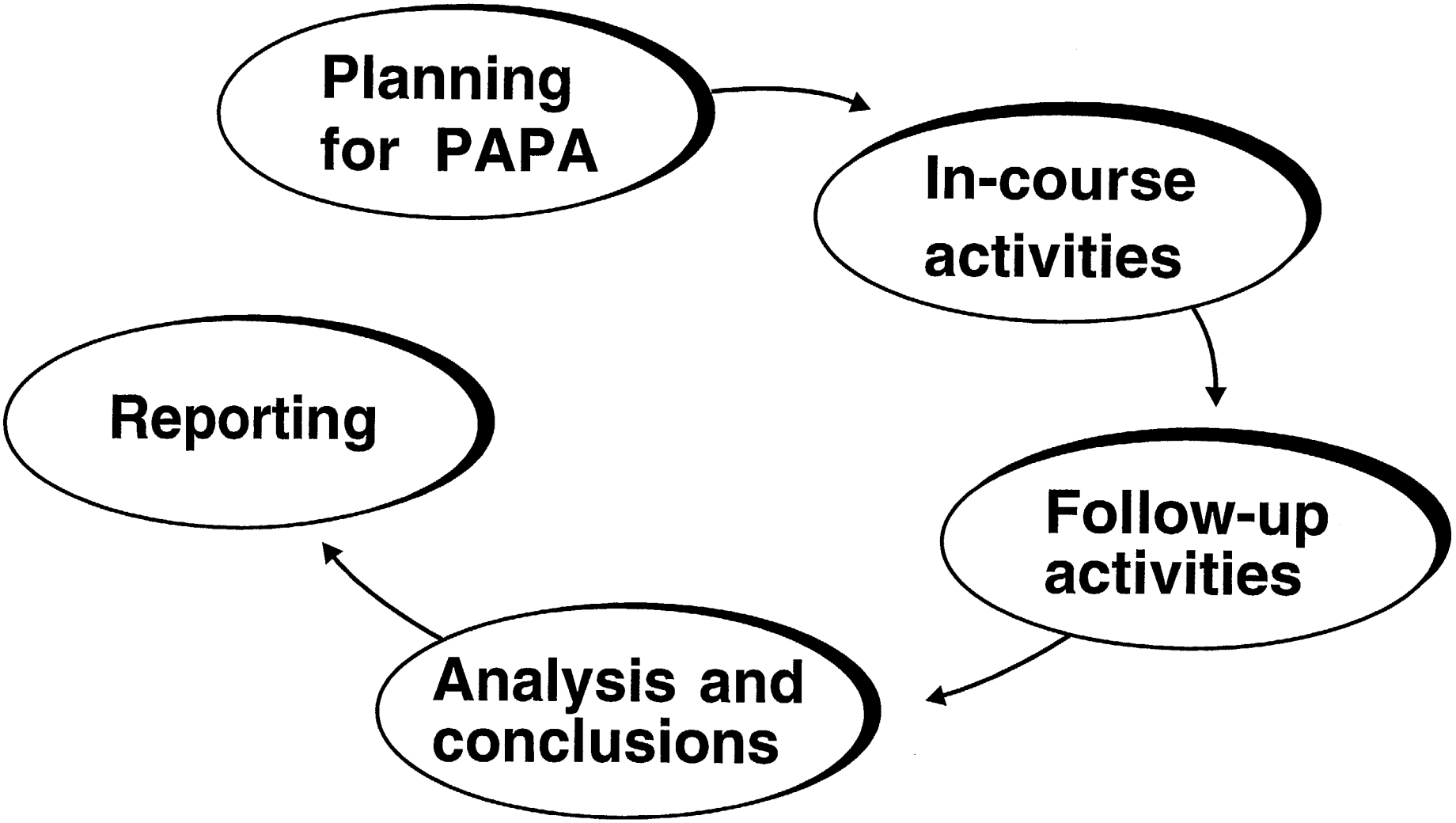
- Formal link between trainees and trainers for follow-up activities: which skills have been used in the job?

- Further involvement of trainee in improving the training material after training event

Uses of PAPA

- Assess the transfer of skill to work place
- Determine the impact of change introduced
- Identify problems of implementation
- Decide how to modify the course
- Evaluate the most useful parts/quality of training

Steps in PAPA



Step 2: In-course Activities

Stage 1

Objectives:

- introduce PAPA to participants
- identify possible action ideas to be tried on the job

Procedure:

Jot down action ideas during the training

- use format provided (annex 1)
- do it at end of last session each day
- confer with other participants/trainers periodically

Step 2: In-course Activities

Stage 2

Objectives:

- develop action plan

Procedure:

- prepare preliminary list of action items
- confer with partner
- finalize and prioritize list of action items
- report individual action plans
- make copy and submit to trainer

Step 3: Follow-up Activities

Trainers	Participants
• Formulate and send questionnaire →	• Fill out and return questionnaire
• Analyze and interpret data	
• Prepare report →	• Receive report and send feedback
• Modify course content	

PAPA Questionnaire, First Stage
Ideas for action items

Date : _____

Workshop title : _____

Date/Venue : _____

Name : _____

Organization : _____

Ideas I would like to try when I return to work at my research institute, based on what I have learned in this training workshop

_____

_____

_____

_____

_____

Note: You can use the workshop objectives, what you learn during the workshop, handouts, conversations with participants and trainers, etc, to come up with ideas.

Objectives of Session 2. Importance of Priority Setting in Agricultural Research

4. Discuss the process of setting priorities in your organizations

5. Discuss the need to set priorities

6. Explain why formal priority-setting methods are necessary

7. Explain that a formal priority-setting process does not replace personal judgement, knowledge, and experience

Definition of Priority Setting

A process of choosing between alternative sets of research activities

Why Set Priorities?

- Make most effective use of resources
- Help in planning
- Help to reach consensus on objectives
- Renovate and modernize research agenda
- Provide guidance to management
- Increase credibility
- Control research agenda

Priority Setting: A Structured Analysis

- What is needed, in terms of
  - people
  - resources
  - information
  - time
- How is it done?
- What are the results?
- How are results used?

Why Use Structured Methods?

To help:

- Organize information to ensure logical consistency
- Resolve often-conflicting demands

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However

- Does not substitute for judgement, but makes systematic use of experience
- Depends on quality of inputs

When to Use Priority Setting

- ❒ Before any planning is done
- ❒ Before re-planning
- ❒ Frequency must be weighed against costs

Objectives of Session 3. Institutional Structures and Levels of Priority Setting

8. Identify the existing structure and mechanisms for resource allocation in your institutes

9. Discuss appropriate institutional structures and levels for priority setting

10. Assist in developing an internal priority-setting process for your institutes

External Versus Internal Priority-Setting Process

	Advantages	Disadvantages	Main constraints
External process	- Quick - Minimal human resources	- Lack of ownership - No learning	Funds
Internal process	- Ownership - Learning by doing	- Long process - Human resources intensive	Human resources

Priority Setting in Agricultural Research

Decision Level:		Guidelines:
cabinet		national development goals
	top down	
ministry of agriculture/research system		agricultural sector objectives
		Agricultural sector Operational Targets (programs)
research institute		institute mandate
	bottom up	
program		contribution to institute mandate

At Cabinet (Policy) Level

- Based on political dialogue
- Broad, noble, and ambitious goals (development goals)

At Sectoral (Ministry) Level

- Priority based on contributions to national goals
- Priority gives clear indicative directive to research (operational targets)

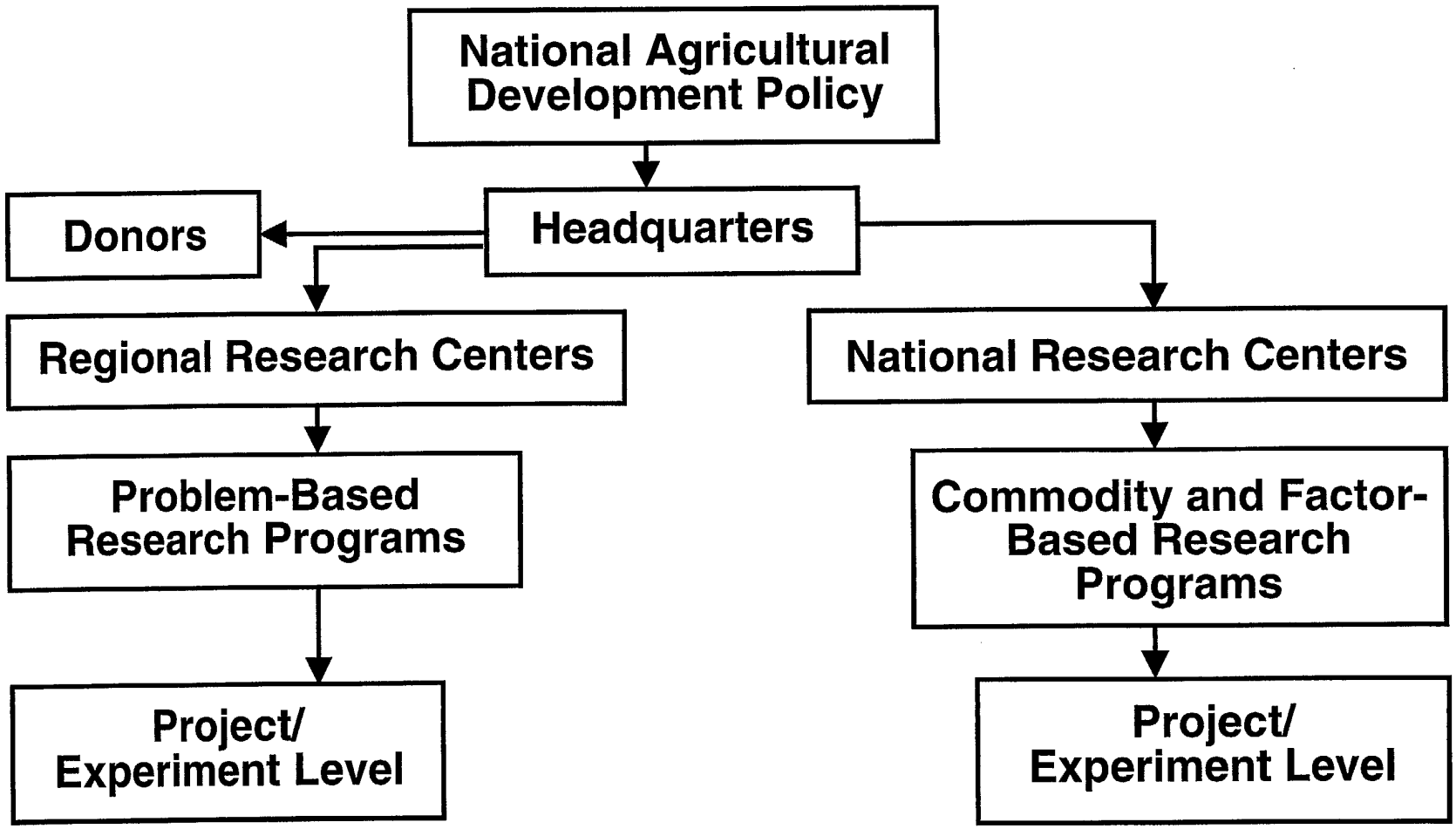
At Program Level

- Priority based on contribution to institute mandate
- Influence of technical know-how and information
- Client constraints
- Potential for generation of adoptable technologies

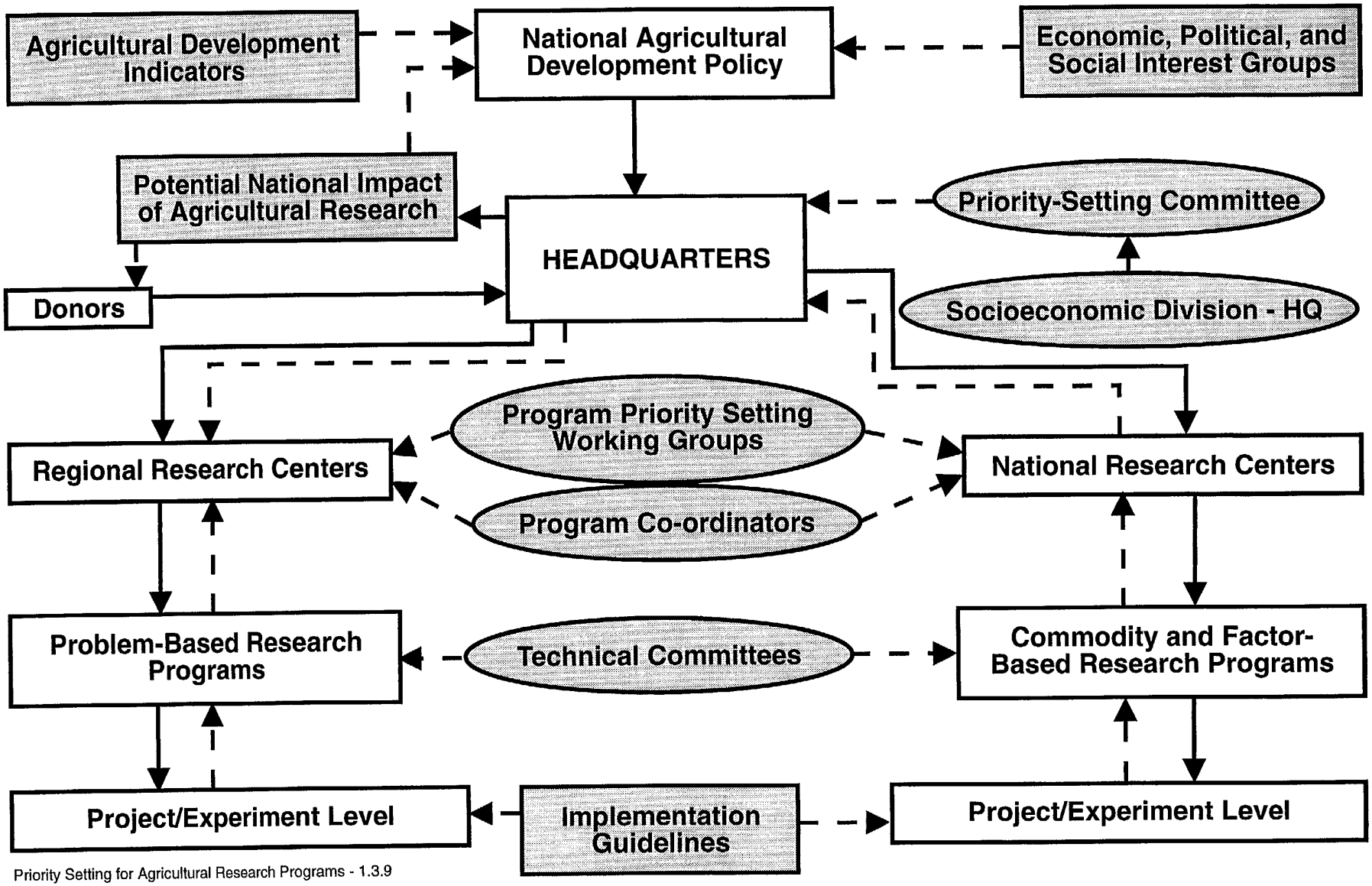
At Project/Institute Level

- Contribution to program priorities
- Technical soundness

Structure of the Research Institute



Information Flows and Institute Structure



Priority Setting for Agricultural Research Programs - 1.3.9

Objective of Session 4.
Basic Processes in Priority Setting

11. Identify key processes that should guide any priority-setting exercise

Principles of Priority Setting

Priority setting is a process

for improving resource allocation decisions

Developing a Priority-Setting Process

Identify:

1. objectives, at each level
2. options
3. information needed to measure contribution to objectives
4. methods for measuring contribution
5. ways to present results

1. Identify Research Objectives

- Research is one of many means for meeting societies' objectives
- Agricultural research contributes most effectively to sector production and efficiency

2. Identify Options for Research

- The level and scope of priority setting must be clearly defined;

  - commodities
  - locations
  - major research themes

3. Information Needs

- **Objectives**
  - research directors and policymakers

- **Technical potential**
  - scientists
  - extension workers

- **Client constraints and adoption potential**
  - baseline information
  - clients' opinions

- **Economic analysis**
  - economic information
  - priority-setting methods

4. Identify Methods to Measure Contribution

- Expected benefits are most common measure of research contributions
- Benefits can have economic as well as non-economic components

5. Translate Results into Decisions

The value of priority-setting analysis is greatly reduced if not directly tied to resource allocation decisions

Exact Method may vary, but Principles do not

- Do not treat research as only means of agricultural development
- Separate value judgements from technical and economic questions

Implementation Example

- **Facilitator**
  - *identified benchmark data*
  - *operated priority-setting applications*
  - *ensures cross-program compatibility in priority-setting exercise*

- **Working Group**
  - *key-program experts*
  - *initial assumptions*
  - *responsible for write-up of program exercise*

- **Stakeholder Group**
  - *review/modify initial assumptions*
  - *build program consensus*

- **Data Needs**

Objectives of Day Two

1. Identify objectives that are operationally meaningful for priority setting
2. Identify methods in priority setting
3. List criteria to consider when choosing a priority-setting method
4. Describe methods for identifying research program target zones
5. Identify key environmental determinants for research program target zones in national and regional programs
6. Describe what a spreadsheet is and its possible uses
7. Indicate how spreadsheets can be used in priority setting

Schedule of Day Two

08:30 – 09:00	Opening of the Day's Activities
09:00 – 10:30	Session 5. Identifying Research Objectives
	Tea/Coffee Break
10:45 – 13:00	Session 6. Methods to Define Research Priorities
	Lunch
14:00 – 15:30	Session 7. Research Alternatives: Identification of Research Target Zones
	Tea/Coffee Break
15:45 – 16:15	Session 7. (Continued)
16:15 – 17:00	Session 8. Using Spreadsheets in Priority Setting
17:00 – 17:30	Feedback on Day's Activities and PAPA

Objective of Session 5.
Identifying Research Objectives

1. Identify objectives that are operationally meaningful for priority setting

Identifying Research Objectives

- Who sets research objectives?
  - National agricultural development policies
  - Institute mandate
  - Clients
  - Senior management

Six Steps in Priority Setting

6 **Approve & implement priorities** (discuss, refine results)

5 **Compare measurements** (process information)

4 **Predict performance** (compile information)
Identify information needs, sources

3 **Derive measurement standards** (choose measures of research contributions)

2 **Define alternatives** (define programs, agroecologial zones)

1 **Define objective** (identify research system objective)

Step 1: Identify Objectives

Research System Objectives

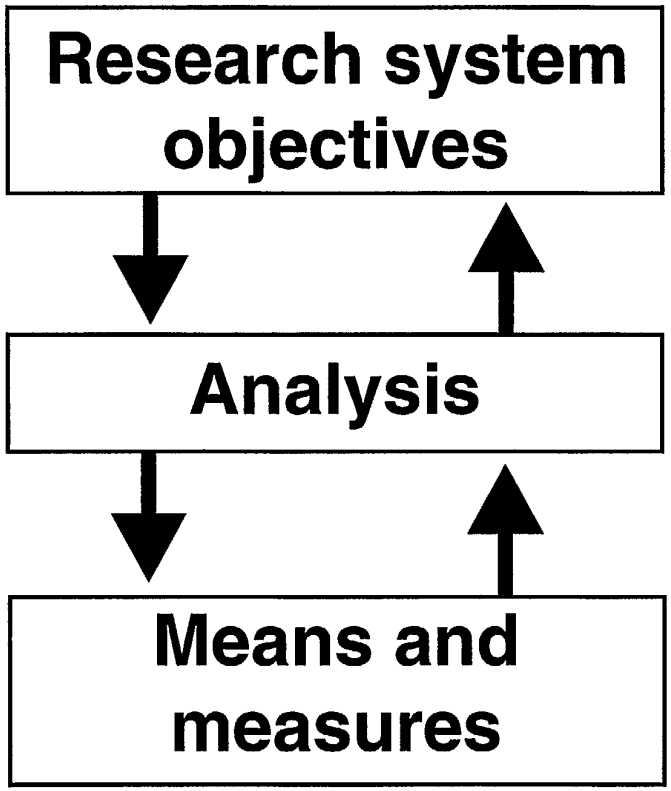
Published sources:

- mission statements

Interview with:

- research directors
- policymakers
- client groups

Step 1: Identify Objectives



Translate
Stated Objectives into *Underlying* Objectives

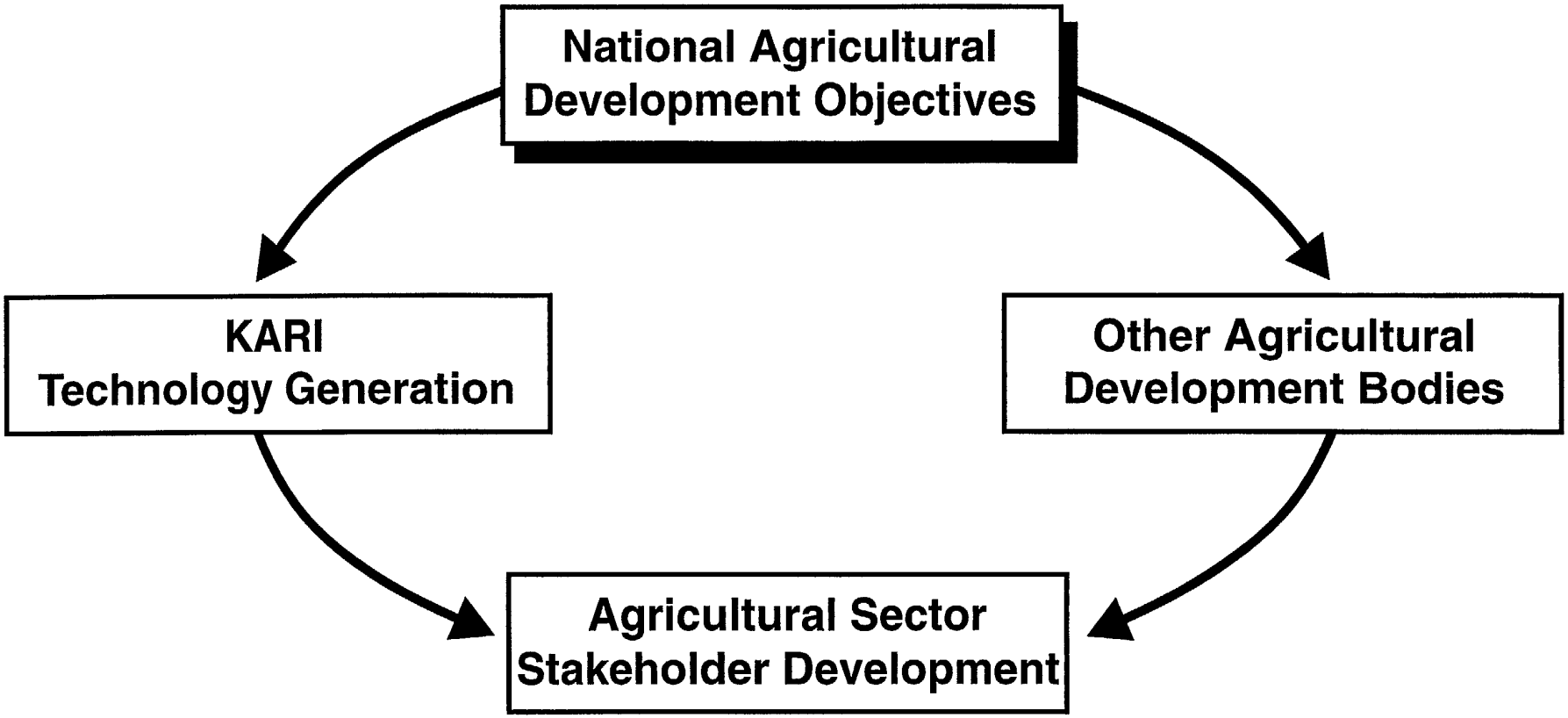
Stated Objectives	Underlying Objectives
- Increased agricultural productivity	- Increased economic and physical well-being for all citizens
- Increased foreign exchange	
- Improved nutrition	- Increased economic and physical well-being of the poor

Developmental Objectives

- Economic growth (efficiency)
- Equity
- Security
- Ecology (resource sustainability)

Research Evaluation Criteria

Criteria should measure KARI contribution to agricultural sector stakeholder development



National Agricultural Development Objectives

Sessional Paper No. 1 of 1986

to:

- ensure the nation's food security
- contribute to export earnings
- promote higher farm incomes through off-farm employment

Achieved by:

- reallocation of land activities with higher returns per hectare
- increased productivity through better seeds and cultivation techniques

Sessional Paper No. 1 of 1994

- self-sufficiency in basic foods
- increasing food production and inter-district trade

Achieved by:

- development and diffusion of technical innovations to enhance yields
- increased availability and efficient use of labor, fertilizer, and other inputs

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National Agricultural Development Objectives

Development Plan 1994-1996

- agricultural development = growth

Required areas of growth

- basic foods (and strategic reserves)
- exports
- vertical industries
  - primary processing
  - agroindustry

Criteria

The KARI Priority Setting Committee reviewed the following objectives:

Efficiency	Impact of research on aggregate welfare
Equity	Distribution of research benefits
Foreign exchange earnings	Impact of research on balance of trade
Food self-sufficiency	Contribution of research to meeting all the country's internal food needs
Food security	Contribution of research to reducing the variance in food availability
Sustainability	Contribution of research to the protection of the natural resource base for future use

Criteria

The KARI Priority Setting Committee recommends:

- The efficiency criterion and its consumer and producer surplus measures should form the basis of priority-setting efforts

- The equity criterion can be included in priority-setting efforts based on the distribution of efficiency benefits. However, target groups must be clearly defined

Objectives of Session 6.
Methods to Define Research Priorities

2. Identify methods in priority setting
3. List criteria to consider when choosing a priority-setting method

Types of Priority-Setting Methods

- Single-criterion methods
  - checklist
  - congruence analysis
  - economic surplus model

- Multiple-criteria methods
  - scoring model
  - mathematical programming model
  - checklist

Priority-Setting Methods

Framework for analysis:

Identify research alternatives:

- what are the target zones?
- what research alternatives (commodities/ disciplines/themes) are to be analyzed?
- what is the potential of each alternative for contributing to identified research objectives?

Congruence Analysis

- Single-criterion method
- Allows budget allocation
- Simple, cheap, transparent
- Poor theoretical logic - doubtful results

Economic Surplus Model

- Powerful method
- Economic-based information
- Data intensive
- Strong assumptions
- Expensive and complicated

Scoring Models

Advantages

- Time
- Transparent
- Can rank all research areas
- Multiple goals and objectives

Disadvantages

- Easy to abuse
- Lack of discounting
- Crude estimates of efficiency and distributional effects of research

Mathematical Programming

- Rather complicated
- Multiple-criteria method
- Select best but no ranking
- Not transparent

Checklist Method

- Simplest
- Cheap
- Historically-based
- Understanding of agriculture not necessary

Criteria for Selecting Methods

- Data
- Skill level
- Time and resources
- Rigor
- Transparency

No Right or Wrong Tool

Only the right tool for specific context

Choice depends on:

- Accuracy of available data
- Time for making decisions
- Resources available
- Degree of participation required and other factors

"Consensus on priorities is more desirable than rigorous results on which interested parties do not agree"

Information for decision making more important than methods for priority setting

Objectives of Session 7. Research Alternatives: Identification of Research Target Zones

4. Describe methods for identifying research program target zones

5. Identify key environmental determinants for research program target zones in national and regional programs

Research target zones will form the basis for evaluation of potential research impact

Environmental criteria are often the basis for defining research target zones

Agroecological Characterization

- The fundamental difficulty in agroecological characterization is the trade-off between scale and accuracy

Solution to Characterizing Environments in Ranges

(a) Appropriate to the natural resource variability within the geographical area of interest.

e.g. group all areas having similar thermal and moisture regions

(b) Appropriate to the specific use of land for which the charaterization is being made.

e.g. delineation of areas physically suited to smallholder coffee production

GIS give user much greater choice about *when* and *how* to classify — including the option not to classify at all.

There are a growing number of widely available, spatially referenced, global and regional databases of topography, climate, land resources, and vegetation.

Zones can be readily redefined to correspond to current foci of a research program.

Zones that are likely to exhibit a homogeneous *physical* response to the application of a new technology.

For this reason, INTER ALIA is becoming more usual for incorporating adoption-related characteristics into the spatial zoning process.

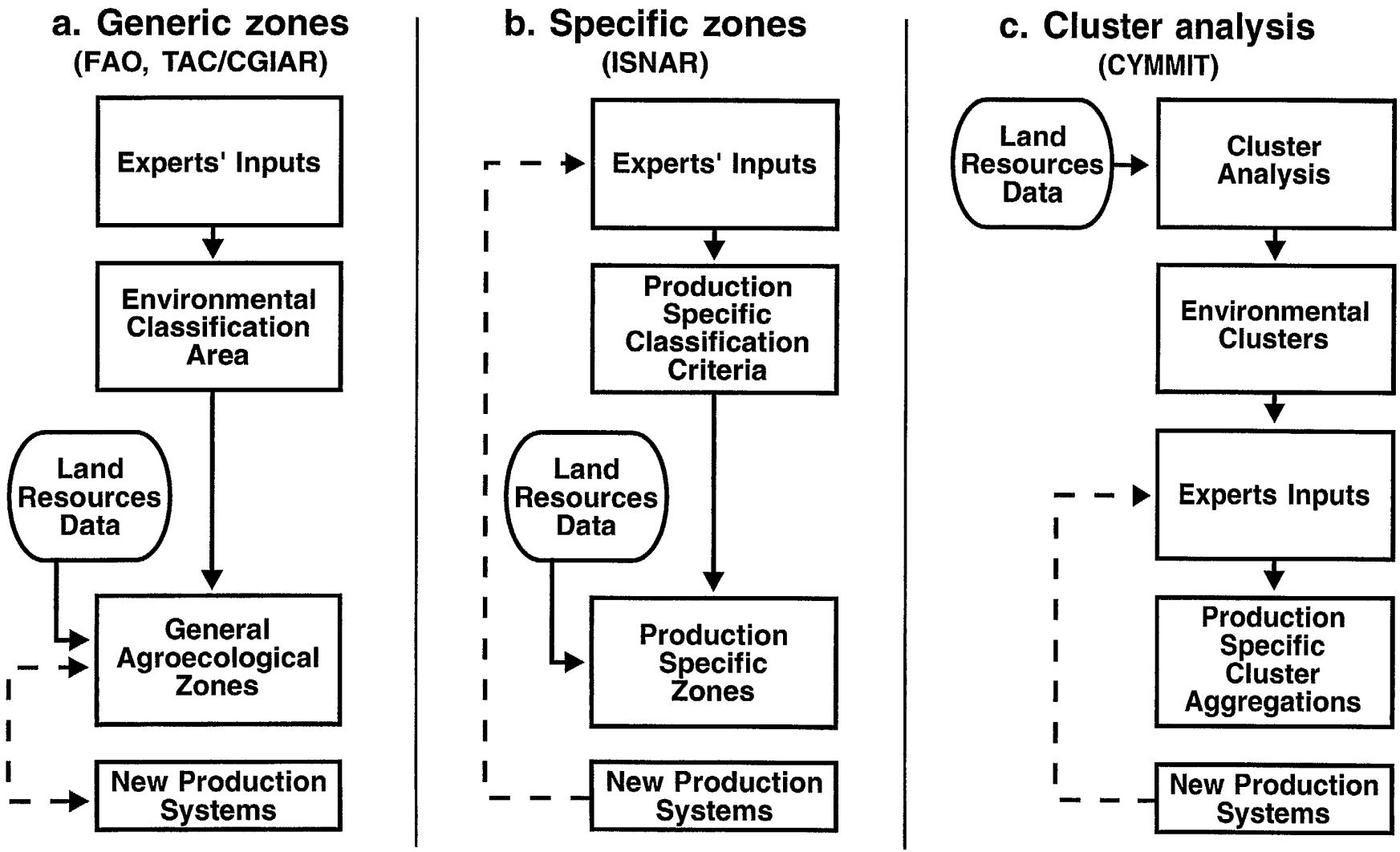
i.e. Attempting to deliniate combined ecologic-economic zones.

Selection of Methods

These are several approaches to agroecological classification and zoning, but for application at the regional level, four specific methods are:

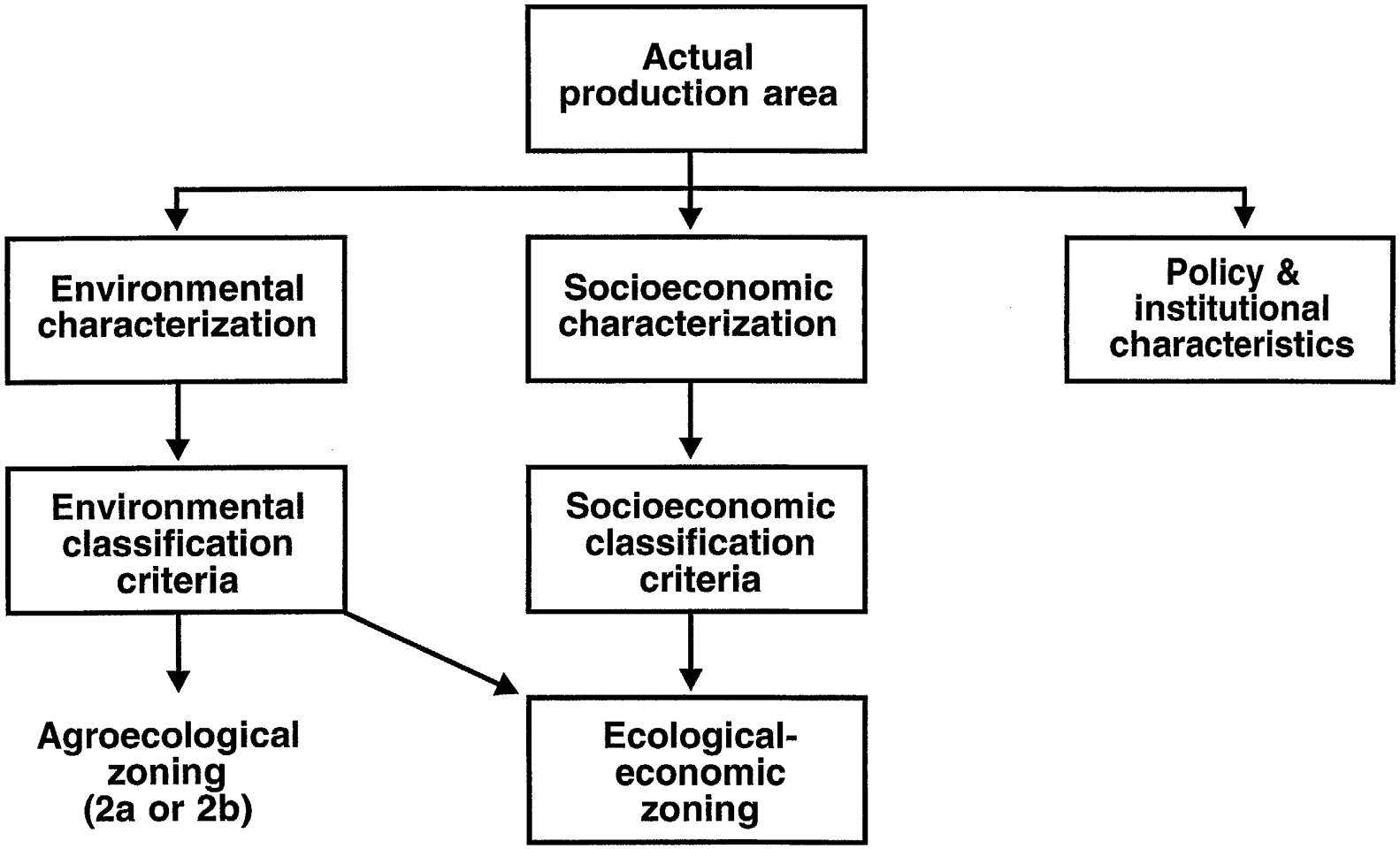
1. Generic zones
2. Specific (Dynamic) zones
3. Cluster analysis
4. Production geography

Some Approaches to Agroecological Zoning in the CGIAR System



Some Approaches to Agroecological Zoning in the CGIAR System (continued)

d. Crop geography (CIAT)



Objectives of Session 8.
Using Spreadsheets in Priority Setting

6. Describe what a spreadsheet is and its possible uses

7. Indicate how spreadsheets can be used in priority setting

What is a Spreadsheet?

- An electronic version of an accountant's ledger book
- Used to record figures and other information
- A computer program and has great advantages over an old-fashioned ledger

Advantages of a Spreadsheet

- Spreadsheet size
- Automatic calculation
- Easy editing
- Instant graphs

Spreadsheet is Divided in Cells

- Each cell can contain a separate value
- Use the arrowkeys to move the highlighted cell selector around the spreadsheet
- Move the selector to the cell, then type the information
- The characters you type are displayed above the spreadsheet on the input line
- To enter the data into the spreadsheet, press "Enter" or any of the arrow keys

Press the HELP Key (usually F1)

- Any time you are confused or
- Need assistance

Spreadsheets

- Offer hundreds of commands for manipulating and displaying data
- If you are not sure what a command does, highlight it
- A short description of the command on a status line below the spreadsheet
- Press HELP key for further details

Always remember

to save all your work from the computer's memory to a file on disk before you exit the program.

OTHERWISE, all information will be lost!

Microsoft Excel as a Spreadsheet

- Start the examples and demos in the HELP menu to see demonstration of the program
- HELP menu explains HOW TO work with Excel. Then, USE IT. It is the guideline to this session

Objectives of Day Three

1. Discuss maps of research target zones
2. Report on new tables developed by the working groups during exercise 7 (session 7, previous day)
3. Implement a congruency model which prioritizes by magnitude of production
4. Identify major constraints and then allocate those constraints to major research themes

Schedule of Day Three

08:30 – 09:00	Opening of the Day's Activities
09:00 – 10:30	Session 9. Maps: Identifying Research Target Zones (part 2 of exercise 7)
	Tea/Coffee Break
10:45 – 11:00	Session 9. (Continued)
11:00 – 13:00	Session 10. Application on Congruency Methods
	Lunch
14:00 – 15:30	Session 11. Identification of Major Research Themes through Constraints Analysis
	Tea/Coffee Break
15:45 – 17:00	Session 11. (Continued)
17:00 – 17:30	Feedback on the Day's Activities and PAPA

Objectives of Session 9.
MAPS: Identifying Research Target Zones

1. Discuss maps of research target zones
2. Report on the new tables developed by the working groups during exercise 7 (session 7, previous day)

Note to Trainers

Make overheads of NEW MAPS to support presentation

Objective of Session 10.
Application of Congruency Methods

3. Implement a congruency model which prioritizes by magnitude of production

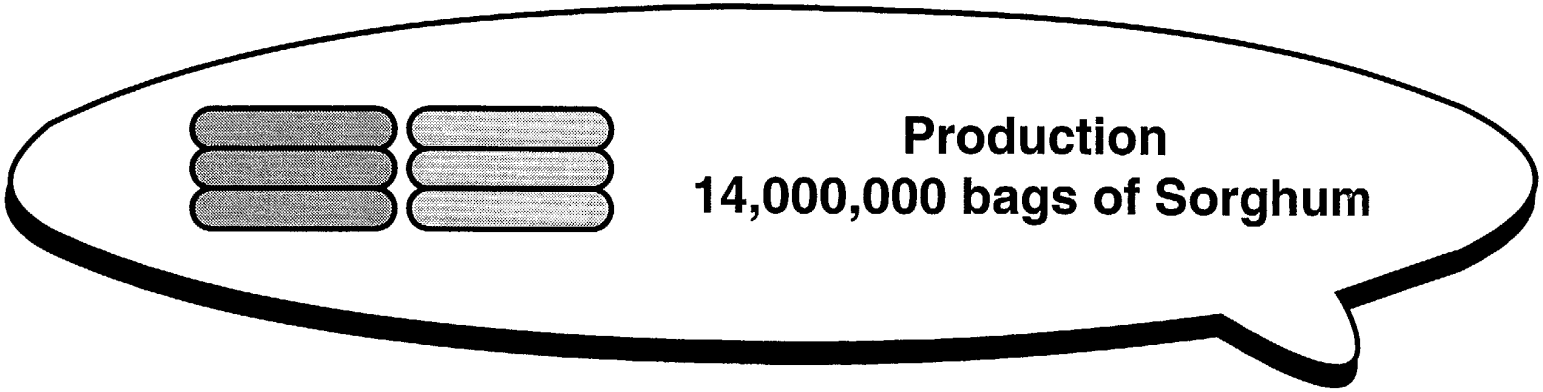
Congruency

In congruency analysis, research priorities are linked directly to an indicator; (e.g. value of production, area planted, or number of farmers affected)

A Congruency Example

Maize Zone	Production (000 mt)	% of Total	Priority Ranking
1	200	20.0	3
2	50	5.0	4
3	470	47.0	1
4	280	28.0	2

What is in a Criterion?



1. What is the yield?
2. Input levels used
3. Amount of rainfall
4. Type of farmers
5. Infrastructure
6. Transporters
7. Agricultural credit (access to)
8. Solar radiation
9. Soil type
10. Farm implementation

Resource allocations may be proportionally to size of indicator or to several highest ranking indicators

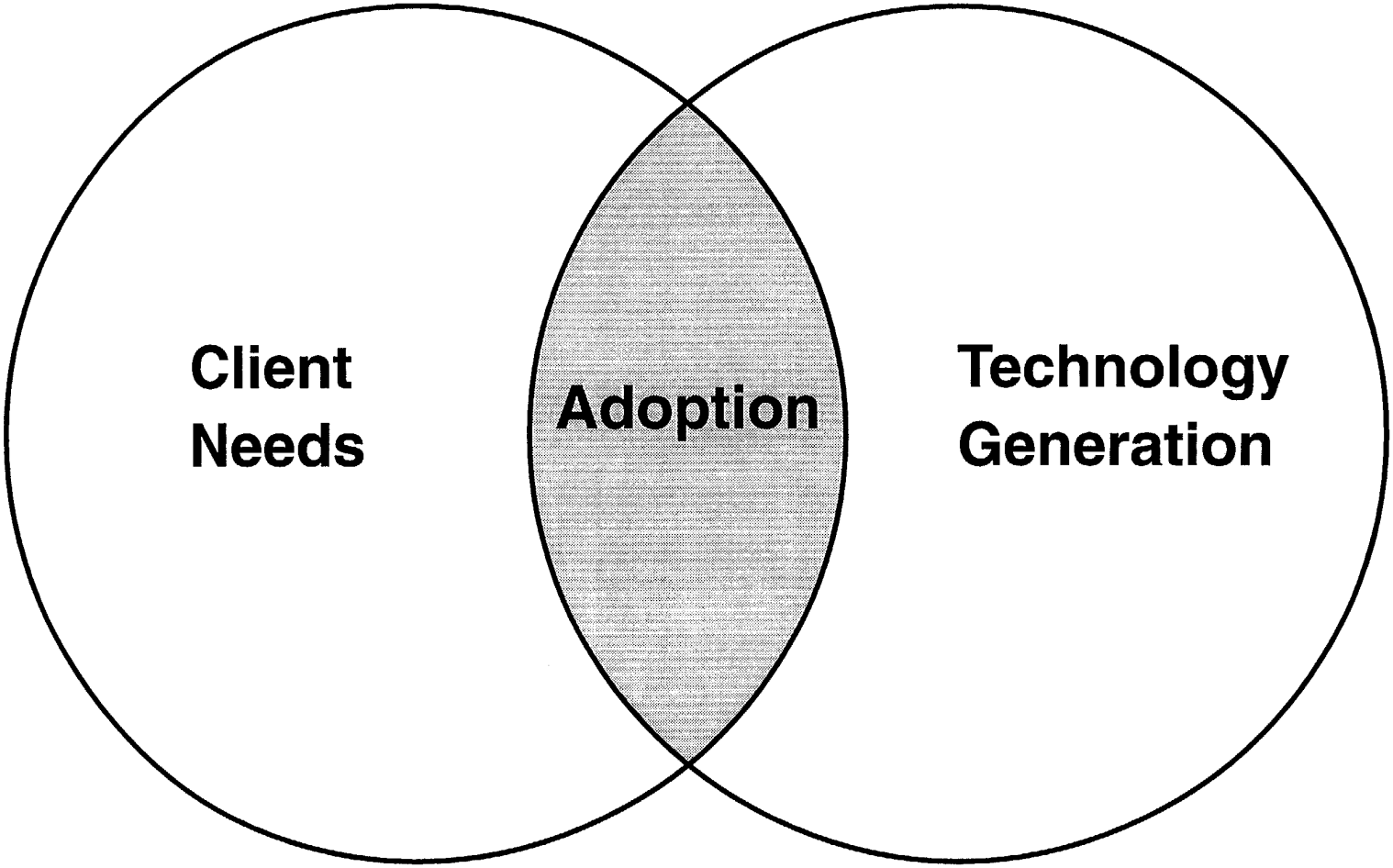
Objective of Session 11. Identification of Major Themes Through Constraints Analysis

4. Identify major constraints and then allocate those constraints to major research themes.

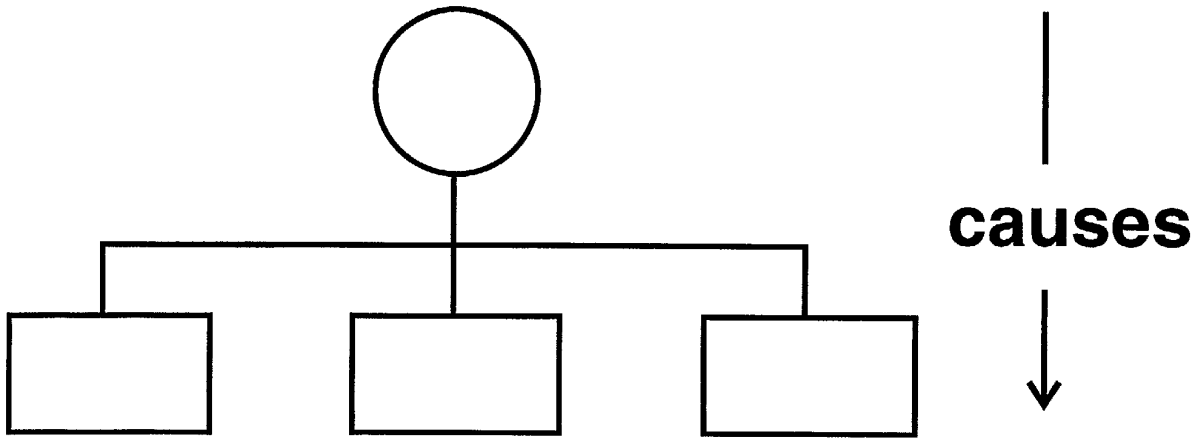
Define a List of Alternatives

Methods:

- **Brain storming**
- **Problem-tree analysis**
- **Exhaustive listing**

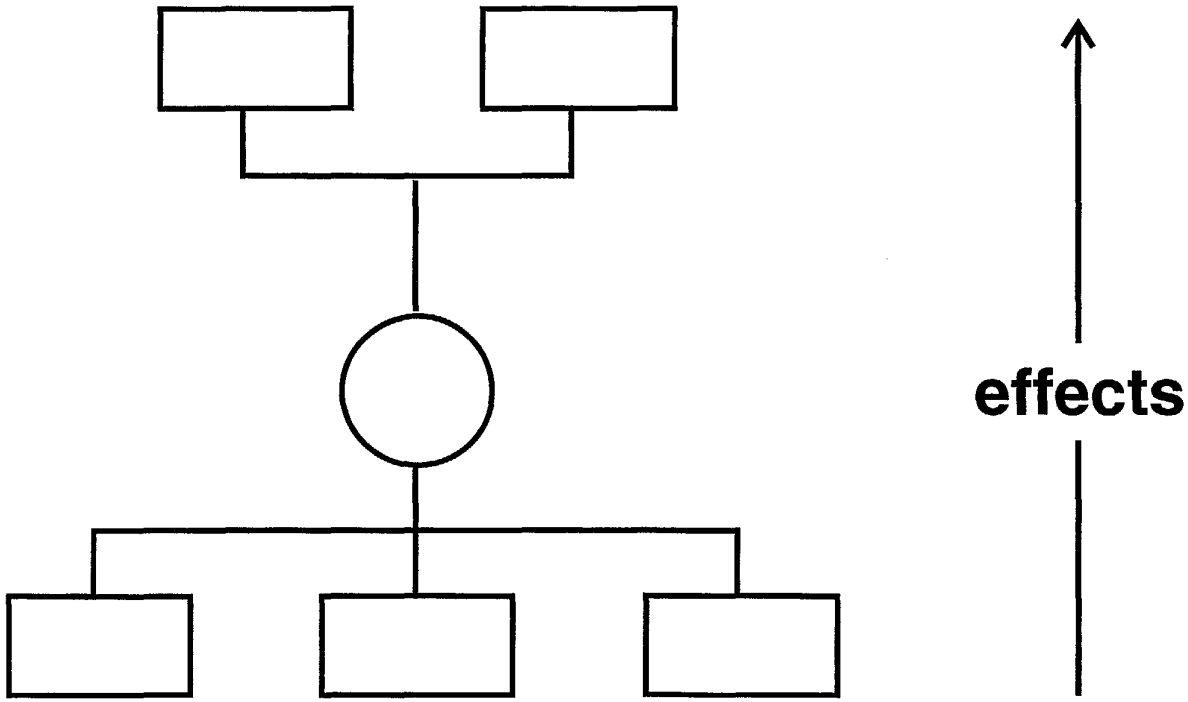

Client
Needs
Adoption
Technology
Generation

Problem Tree Analysis

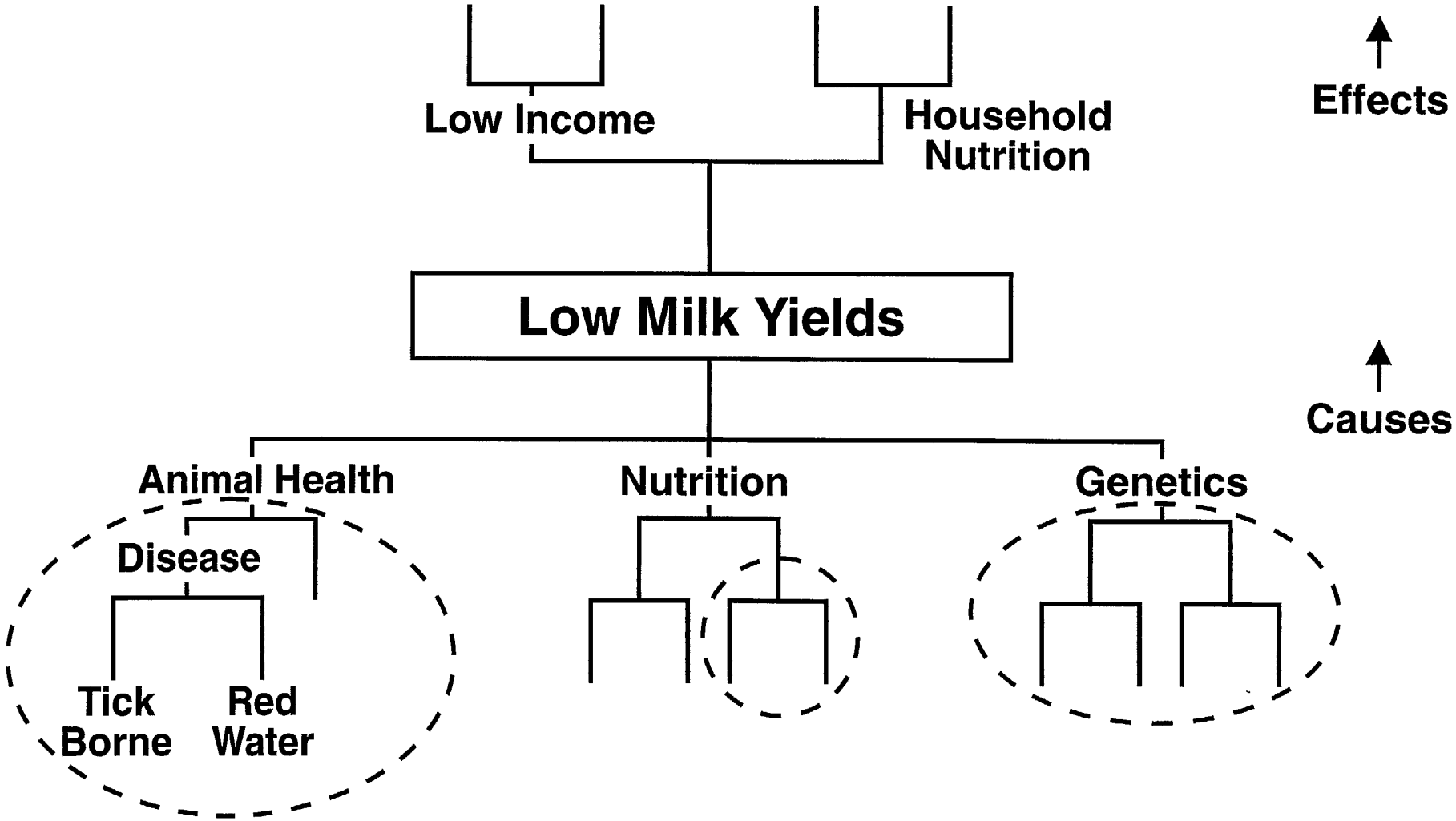


The substantial and direct *causes* of the core problem are placed parallel to each other *underneath* the core problem

Problem Tree Analysis



The substantial and direct *effects* of the core problem are placed parallel to each other *above* the core problem


Effects
Low Income
Household Nutrition
Low Milk Yields
Causes
Animal Health
Nutrition
Genetics
Disease
Tick Borne
Red Water

An Example of Research Theme Identification

Crop: Maize

Zone: Low-land tropics

Theme: Crop management

Constraints (ranked):
- Weed control under high rainfall and temperature
- Poor fertility on sandy soils
- Poor stand establishment (in intercrop)

Objectives of Day Four

1. Systematically identify the potential for generation and adoption of technologies in major identified research themes.
2. Implement an economic surplus analysis of agricultural research benefits.
3. Explain the basic principles of the scoring method, the criteria used, and the data requirements.
4. Explain how to integrate all the criteria to calculate a project score.
5. Identify priority themes among a ranked list.

Schedule of Day Four

08:30 – 09:00	Opening of the Day's Activities
09:00 – 10:30	Session 12. Research Alternatives: identification of the potential generation and adoption of technologies
	Tea/Coffee Break
10:45 – 13:00	Session 13. Estimating economic surplus benefits
	Lunch
14:00 – 15:30	Session 14. Scoring: Inclusion of Multiple Criteria in Priority Setting
	Tea/Coffee Break
15:45 – 17:00	Session 14. (Continued)
17:00 – 17:30	Feedback on the Day's Activities and PAPA

Objective of Session 12.
Research Alternatives: Identification of Potential Generation and Adoption of Technology

1. Systematically identify the potential for generation and adoption of technologies in major identified research themes.

The potential for the generation and adoption of technologies, must be examined by major program research themes and zones.

- The information on the potential for the generation and adoption of technologies can only be provided by program experts

- Benchmark data on historical trends can usefully orient expert opinion

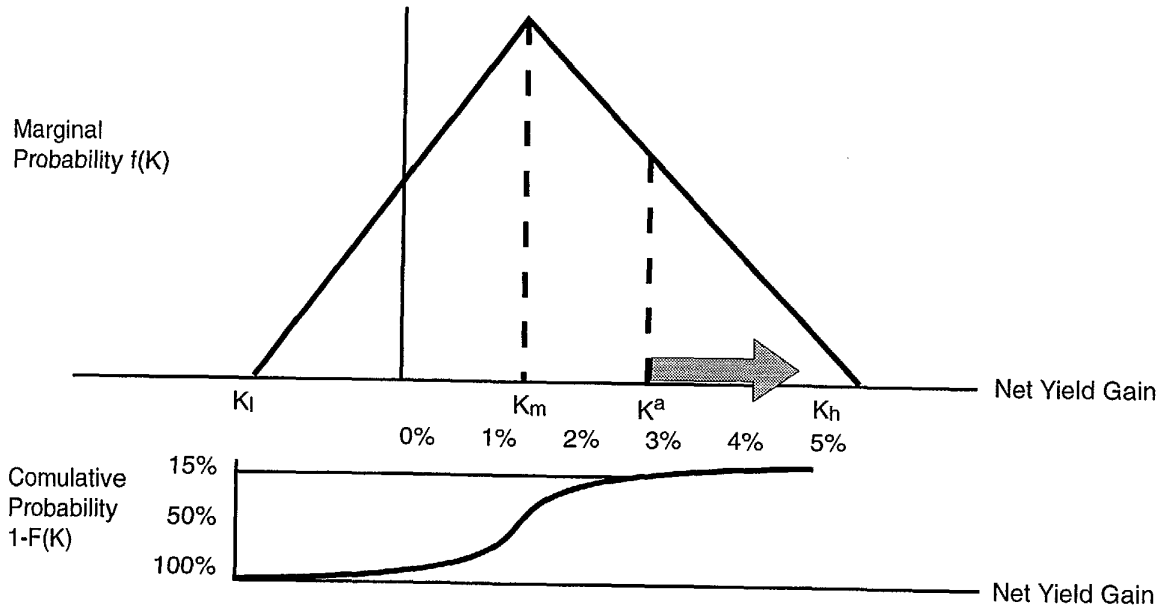
Potential for Technology Generation

- Technology generation is best represented by a distribution of possible outcomes

- Relevant measures are usually minimum, and most likely and maximum net yield gains

Modeling the Probability Distribution of Research Outcomes

The distribution of expected net yield gains



Let K represent the net yield gain of an innovation. The maximum possible yield gain is K_l; the most probable net yield gain is K_m; and maximum net yield gain is K_h. The minimum net yield gain necessary for an innovation to be released for dissemination is K^a, (a 3% gain in this sample). For every K there is a corresponding probability f(K) which is assumed to follow a triangular probability distribution. The probability of achieving an increase in yields that is greater or equal to K^a, $Pr(K \geq K^a)$, is given be the cumulative density function (1-F(k)) in the figure. In the example, the probability of a net yield gain from research above 3% is quite low, approximatly 15%. The expected net yield gain is simply the expected value of K, conditional on K^a being achieved: $E[K|K \geq K^a]$.

Potential Adoption Profiles

- The adoption profile determines the speed and magnitude by which research results are translated into an impact on farmers' fields

Based Characteristics of a Profile

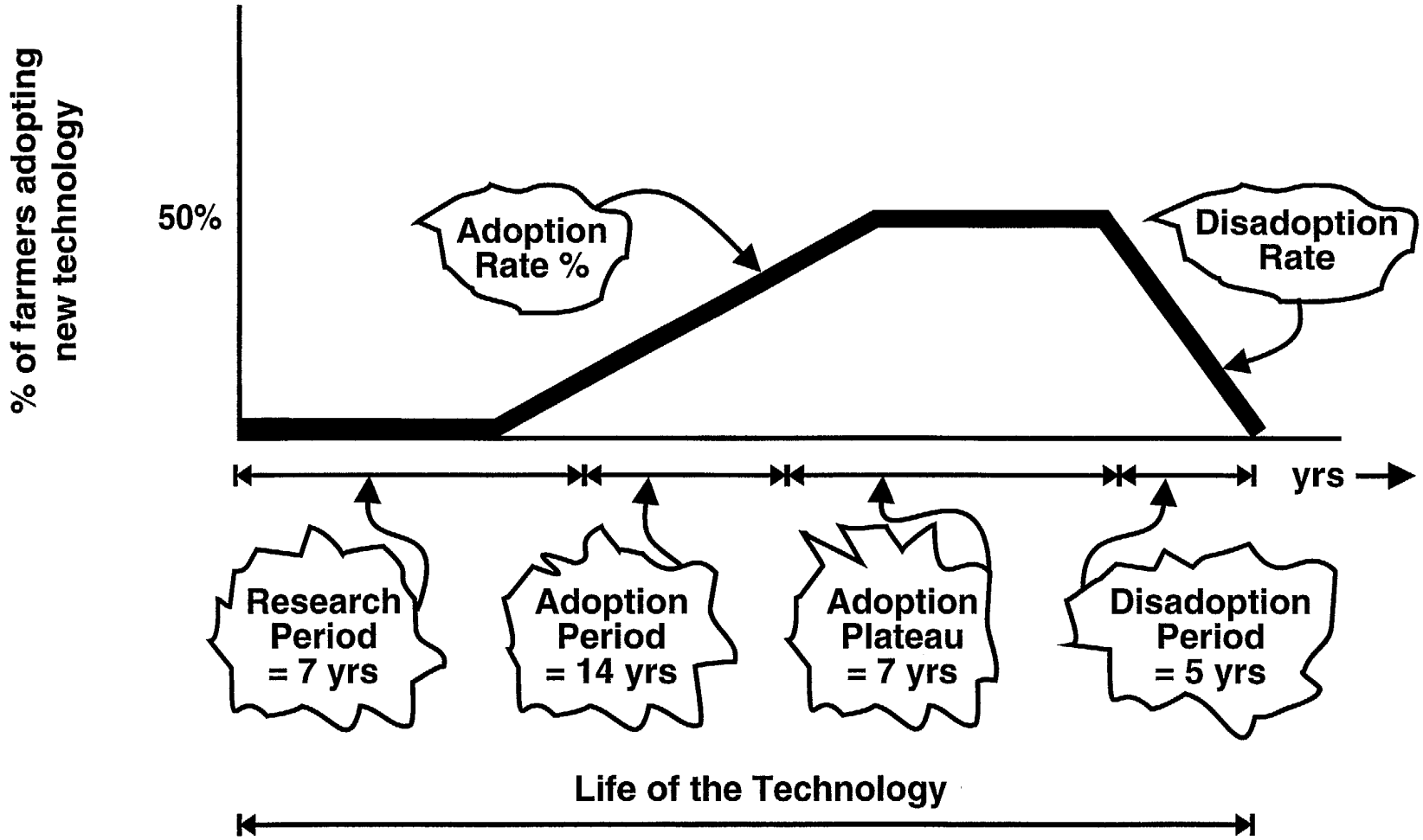
a. The research development phase.

b. A phase of increasing adoption.

c. Adoption plateau.

d. A declining adoption phase.

Technology Adoption Profile

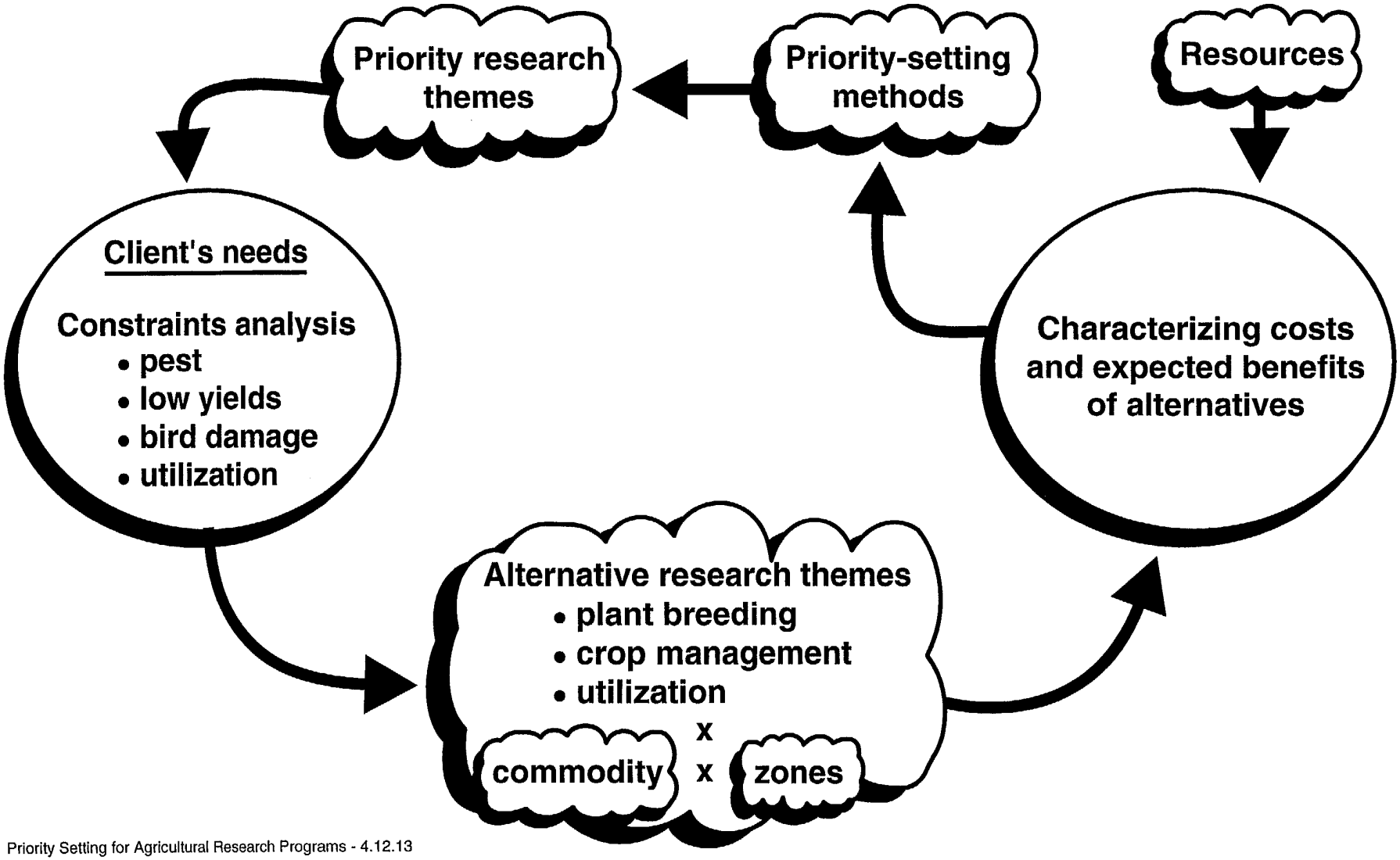


Exercise 12a: Potential for Technology Generation						
	Estimated Net Yield Gain			Estimated	Probability of	Conditional
Theme/Zone		%		Dissemination	Exceeding	% New Yield
	Minimum	Likely	Maximum	Threshold	Threshold	Gain
	K_l	K_m	K_h	K_a		
Theme 1						
Zone 1	6.75	40.50	54.00	15.00	0.96	34.71
Zone 2	5.25	37.50	49.50	15.00	0.93	32.11
Theme 2						
Zone 1	22.50	45.00	75.00	25.00	0.99	47.62
Zone 2	15.00	37.50	45.00	30.00	0.67	36.25
Theme 3						
Zone 1	0.00	75.00	100.00	13.30	0.98	59.74
Zone 2	0.00	100.00	250.00	20.00	0.98	118.56

Exercise 12b: Potential Adoption Parameters

	Research & Development Lag (years)	Maximum Adoption (years - cumulative)	Naximum Adoption Rate (%)	Start of Disadoption (years - cumulative)	Complete Disadoption (years - cummulative)
Theme 1					
Zone 1	6	22	5	29	44
Zone 2	7	16	20	22	32
Theme 2					
Zone 1	4	19	20	na	na
Zone 2	4	14	25	na	na
Theme 3					
Zone 1	7	19	21.7	na	na
Zone 2	5	13	28.3	na	na

Review


Priority research themes
Priority-setting methods
Resources
Client's needs
Constraints analysis
• pest
• low yields
• bird damage
• utilization
Characterizing costs and expected benefits of alternatives
Alternative research themes
• plant breeding
• crop management
• utilization
x
commodity
x
zones

Objective of Session 13.
Estimating Economic Surplus Benefits

2. Implement an economic surplus analysis of agricultural research benefits.

Investing in Research is an Economic Problem as:

- Research must compete with other activities for scarce resources

- Choices must be made:
  - about resources to devote to research
  - how to allocate them to alternative programs or themes within programs

The main objectives of agricultural research are economic efficiency and equity.

Evaluating Economic Effects of Agricultural Research Involves Central Elements

(a) Relationship between size of the investment in research and output or productivity

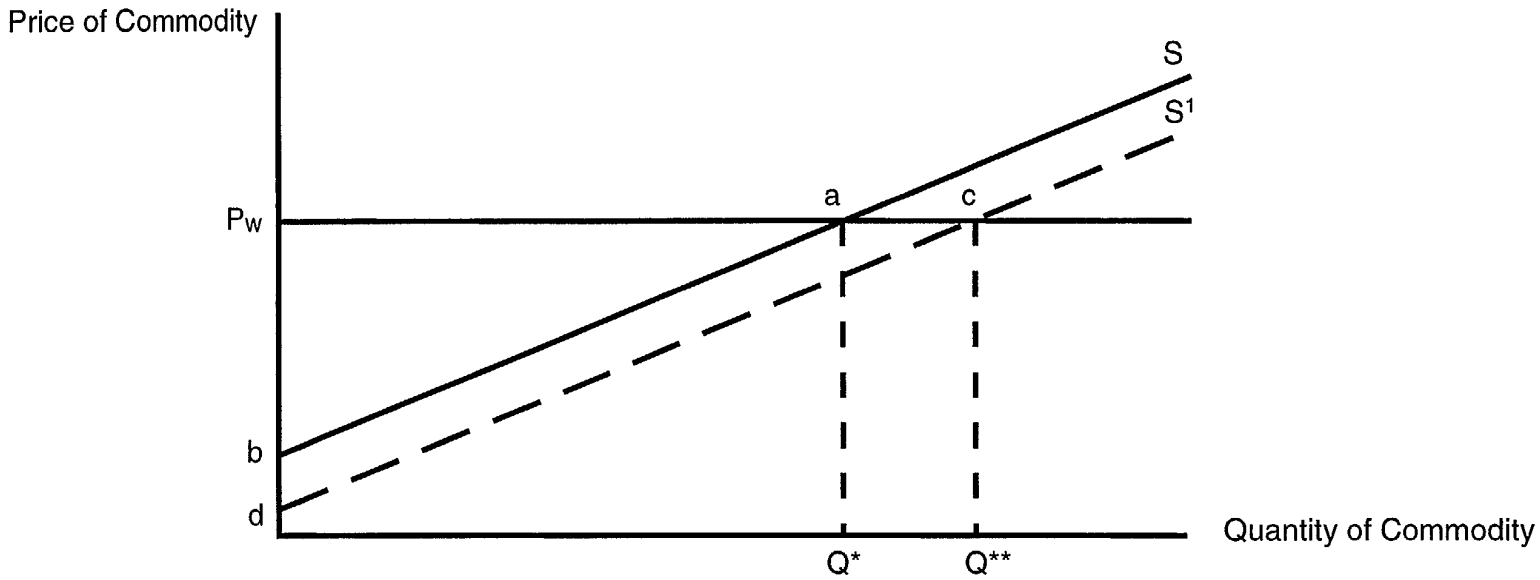
(b) Relationship between increases in productivity and flows of economic benefits

(c) Procedure to account for the timing of benefits and costs

Economists usually conceptualize economic effects in terms of supply and demand for goods and services.

Modeling Research Impact in a Small Open Economy

The market consequences of technical innovations

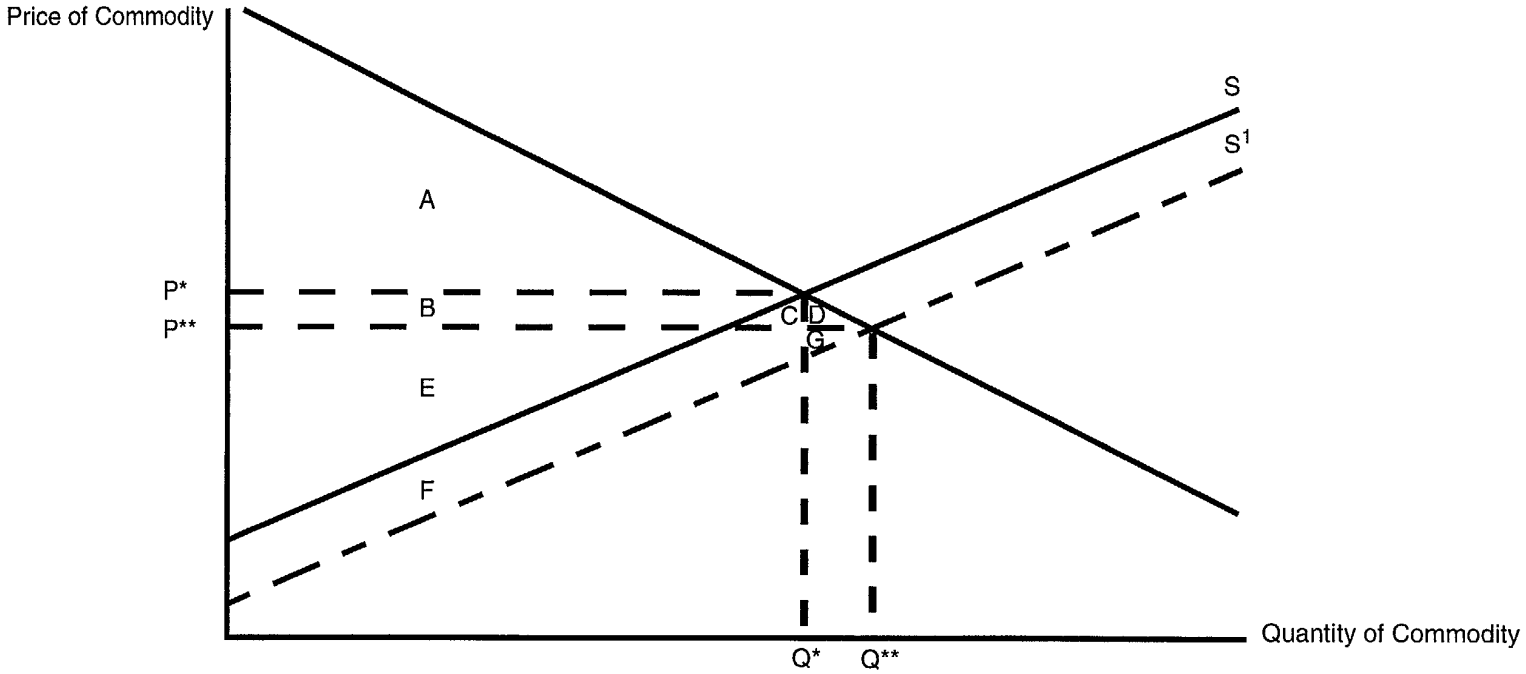


In a small, open economy, the aggregate demand curve for wheat is horizontal (see figure). Consumers can get all the wheat desired without changing the world price of the commodity. However, the supply curve is upward sloping as producers are willing to devote additional resources to wheat production at higher prices or lower costs. The slope of the supply response curve is determined by the supply elasticity and, in the absence of any information to the contrary, the shift in supply due to research here (as in most similar applications) to be parallel.

When measuring the economic surplus gains from research, the impact of a unit cost reduction will increase the profitability of wheat production and shift the supply curve downward. In the'without research' case producer surplus is represented by triangle $P_w$ab (the summation of the area above the supply curve and below the world price). With the research-induced supply shift, producer surplus increases to triangle $P_w$cd. Thus, producer surplus gains due to research is equal to the area $P_w$cd - $P_w$ab = acdb. Because the derived demand curve is horizontal, consumers neither gain or lose from the research-induced supply shift.

Modeling Research Impact in a Closed Economy

Measuring the economic benefits from research



Above figure demonstrates consumer and producer surplus changes from a research-induced parallel supply shift from S to S'. On the preresearch supply curve, consumers receive area A in surplus. The commodity supply shift then results in a price decrease from P* to P and consumers now receive economic surplus equal to the area A+B+C+D. Thus, the consumer benefit from research is given by area B+C+D.**

The impact of the research-induced supply shift on producer surplus is more complex. Originally producer surplus is represented by area E+B (the area below the commodity price but above the cost of production). After the supply shift, producer surplus is given by area F+E+G. Thus, the change in producer surplus is determined by two factors, gains from the unit cost reduction in production, area F+G, and losses from commodity supply shifts (through lower price), area B. Producer welfare may either increase or decrease as a result of technical change, depending on the relative size of the gains and losses. However, society as a whole (the aggregate of consumer and producer surplus changes) unambiguously gains (area C+D+F+G).

The supply curve slopes upward because producers will supply more at a higher price.

Adoption of new technology shifts the supply curve to S^1

The economic surplus measure can be modified to account for effects of

- trade
- pricing policies
- demand shifts, etc.

The economic surplus can be apportioned into the benefits that accrue to different groups in society.

The K Shift is Calculated from the Following Components

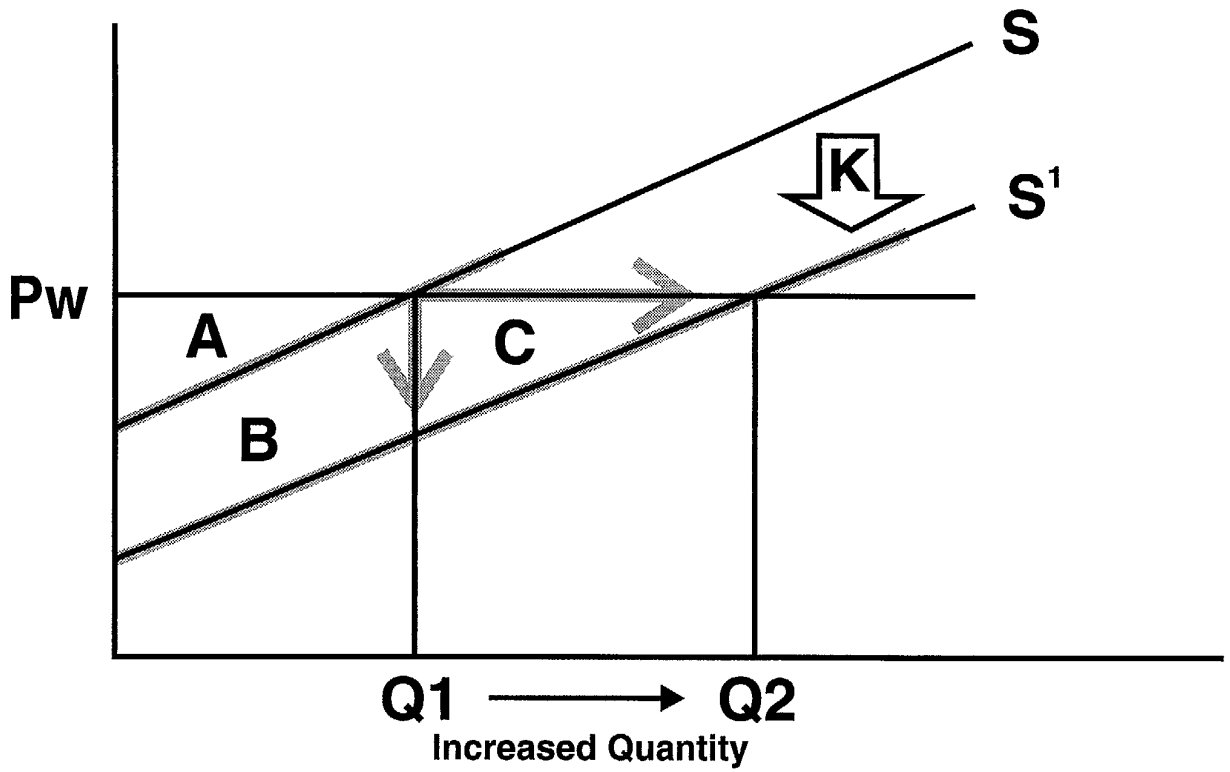
- **Net expected yield gain**
  (calculated as the probability of exceeding the dissemination threshold * the conditional expected yield gain) (times)

- **Period specific adoption rate (divided by)**

- **Supply elasticity**

  The supply elasticity translates the yield increase into a unit cost reduction

Economic Surplus Generated as a Result of Research



Net K shift: the proportional downward shift in the supply curve in each year

Producer surplus (profits) increases from area 'A' to area 'A+B+C'

A series of calculations of shifts in supply curves and of economic surplus changes can be made over 15 to 20 years, tracing the effects of a research expenditure.

Net Present Value (NPV)

$$\sum_{0}^{T} \frac{B^t}{(1+r)^t}$$

Time Period	Gross Benefits	Discounted Benefits
0	100	100
1	100	95
2	100	91
3	100	86
4	100	82
5	100	78
6	100	75
7	100	71
8	100	68
9	100	64

NPV = 811

Conclusion

Total economic benefits of research and their distribution to different groups can be approximated by measures of changes in economic surpluses.

- time lags
- adoption patterns
- research depreciation, and
- uncertainty

should be considered in the calculations.

Exercise 13a: Sorghum Programme Research in an Open Market with 5% Real Discount Rate.

Zone: Humid Coastal

Theme: Varietal Development

Adoption Profile (in cummulative years)			
Research Lag	Maximum Adoption	Start of Dis-Adoption	Complete Dis-adoption
7	22	29	44

Maximum Adoption Rate (%): 5

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Net Yield	Dissemination		Adoption		Sorghum	Quantity	Change in
	Supply	Gain	Threshold	Adoption	Rate	Net K	Price	Metric	Total
Year	Elasicity	(%)	Pr(K>=K*)	Phase	(%)	Shift[a]	(K.Sh/Ton)	Tonnes	Surplus[b]
1995	0.5	34.71	0.96	RESEARCH LAG	0	0	10730	20	0
1996	0.5	34.71	0.96	RESEARCH LAG	0	0	10730	20	0
1997	0.5	34.71	0.96	RESEARCH LAG	0	0	10730	20	0
1998	0.5	34.71	0.96	RESEARCH LAG	0	0	10730	20	0
1999	0.5	34.71	0.96	RESEARCH LAG	0	0	10730	20	0
2000	0.5	34.71	0.96	RESEARCH LAG	0	0	10730	20	0
2001	0.5	34.71	0.96	RESEARCH LAG	0	0	10730	20	0
2002	0.5	34.71	0.96	INITIAL ADOPTION	0.333333333	0.001111	10730	20	238.4266999
2003	0.5	34.71	0.96	INITIAL ADOPTION	0.666666667	0.002221	10730	20	476.9857758
2004	0.5	34.71	0.96	INITIAL ADOPTION	1	0.003332	10730	20	715.6772275
2005	0.5	34.71	0.96	INITIAL ADOPTION	1.333333333	0.004443	10730	20	954.5010552
2006	0.5	34.71	0.96	INITIAL ADOPTION	1.666666667	0.005554	10730	20	1193.457259
2007	0.5	34.71	0.96	INITIAL ADOPTION	2	0.006664	10730	20	1432.545838
2008	0.5	34.71	0.96	INITIAL ADOPTION	2.333333333	0.007775	10730	20	1671.766793
2009	0.5	34.71	0.96	INITIAL ADOPTION	2.666666667	0.008886	10730	20	1911.120125
2010	0.5	34.71	0.96	INITIAL ADOPTION	3	0.009996	10730	20	2150.605832
2011	0.5	34.71	0.96	INITIAL ADOPTION	3.333333333	0.011107	10730	20	2390.223915
2012	0.5	34.71	0.96	INITIAL ADOPTION	3.666666667	0.012218	10730	20	2629.974374
2013	0.5	34.71	0.96	INITIAL ADOPTION	4	0.013329	10730	20	2869.857208
2014	0.5	34.71	0.96	INITIAL ADOPTION	4.333333333	0.014439	10730	20	3109.872419
2015	0.5	34.71	0.96	INITIAL ADOPTION	4.666666667	0.01555	10730	20	3350.020006
2016	0.5	34.71	0.96	INITIAL ADOPTION	5	0.016661	10730	20	3590.299968
2017	0.5	34.71	0.96	MAX. ADOPTION	5	0.016661	10730	20	3590.299968
2018	0.5	34.71	0.96	MAX. ADOPTION	5	0.016661	10730	20	3590.299968
2019	0.5	34.71	0.96	MAX. ADOPTION	5	0.016661	10730	20	3590.299968
2020	0.5	34.71	0.96	MAX. ADOPTION	5	0.016661	10730	20	3590.299968
2021	0.5	34.71	0.96	MAX. ADOPTION	5	0.016661	10730	20	3590.299968
2022	0.5	34.71	0.96	MAX. ADOPTION	5	0.016661	10730	20	3590.299968
2023	0.5	34.71	0.96	MAX. ADOPTION	5	0.016661	10730	20	3590.299968
2024	0.5	34.71	0.96	DIS-ADOPTION	4.666666667	0.01555	10730	20	3350.020006
									NPV
									$20,389.64

Note: a- Net K shift is the proportional downward shift in the supply curve for each year. The shift is calcualted as (Column 6) = (Column 2)*(Column 3)*(Column4/100)/Column1).

b- The change in total surplus (in Kenya Shilling) is calculated for each year as (Column 9) = (Column 6)*(Column 7)*(Column 8)*(1+0.5*(Column 6)*(Column 1))).

Exercise 13b: Sorghum Programme Research in an Closed Market with 5% Real Discount Rate.

Zone: Humid Coastal

Theme: Varietal Development

Adoption Profile (in cummulative years)			
Research Lag	Maximum Adoption	Start of Dis-Adoption	Complete Dis-adoption
7	22	29	44

Maximum Adoption Rate (%)
5

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Demand	Supply	Net Yield Gain	Dissemination Threshold	Adoption	Adoption Rate	Net K	Sorghum Price	Net Price	Quantity Metric	Change in Total	Change in Consumer	Change in Producer
Year	Elasicity	Elasicity	(%)	Pr(K>=K*)	Phase	(%)	Shift[a]	(K.Sh/Ton)	Decrease	Tonnes	Surplus[c]	Surplus[d]	Surplus[e]
1995	1	0.5	34.71	0.96	RESEARCH LAG	0	0.000	10730	0.000	20	0.00	0	0.00
1996	1	0.5	34.71	0.96	RESEARCH LAG	0	0.000	10730	0.000	20	0.00	0	0.00
1997	1	0.5	34.71	0.96	RESEARCH LAG	0	0.000	10730	0.000	20	0.00	0	0.00
1998	1	0.5	34.71	0.96	RESEARCH LAG	0	0.000	10730	0.000	20	0.00	0	0.00
1999	1	0.5	34.71	0.96	RESEARCH LAG	0	0.000	10730	0.000	20	0.00	0	0.00
2000	1	0.5	34.71	0.96	RESEARCH LAG	0	0.000	10730	0.000	20	0.00	0	0.00
2001	1	0.5	34.71	0.96	RESEARCH LAG	0	0.000	10730	0.000	20	0.00	0	0.00
2002	1	0.5	34.71	0.96	INITIAL ADOPTION	0.3333333	0.001	10730	0.000	20	238.40	79.4682124	158.94
2003	1	0.5	34.71	0.96	INITIAL ADOPTION	0.6666667	0.002	10730	0.001	20	476.90	158.965842	317.93
2004	1	0.5	34.71	0.96	INITIAL ADOPTION	1	0.003	10730	0.001	20	715.48	238.492888	476.99
2005	1	0.5	34.71	0.96	INITIAL ADOPTION	1.3333333	0.004	10730	0.001	20	954.15	318.049351	636.10
2006	1	0.5	34.71	0.96	INITIAL ADOPTION	1.6666667	0.006	10730	0.002	20	1192.91	397.635231	795.27
2007	1	0.5	34.71	0.96	INITIAL ADOPTION	2	0.007	10730	0.002	20	1431.75	477.250528	954.50
2008	1	0.5	34.71	0.96	INITIAL ADOPTION	2.3333333	0.008	10730	0.003	20	1670.69	556.895241	1113.79
2009	1	0.5	34.71	0.96	INITIAL ADOPTION	2.6666667	0.009	10730	0.003	20	1909.71	636.569372	1273.14
2010	1	0.5	34.71	0.96	INITIAL ADOPTION	3	0.010	10730	0.003	20	2148.82	716.272919	1432.55
2011	1	0.5	34.71	0.96	INITIAL ADOPTION	3.3333333	0.011	10730	0.004	20	2388.02	796.005883	1592.01
2012	1	0.5	34.71	0.96	INITIAL ADOPTION	3.6666667	0.012	10730	0.004	20	2627.30	875.768264	1751.54
2013	1	0.5	34.71	0.96	INITIAL ADOPTION	4	0.013	10730	0.004	20	2866.68	955.560062	1911.12
2014	1	0.5	34.71	0.96	INITIAL ADOPTION	4.3333333	0.014	10730	0.005	20	3106.14	1035.38128	2070.76
2015	1	0.5	34.71	0.96	INITIAL ADOPTION	4.6666667	0.016	10730	0.005	20	3345.70	1115.23191	2230.46
2016	1	0.5	34.71	0.96	INITIAL ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2017	1	0.5	34.71	0.96	MAX. ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2018	1	0.5	34.71	0.96	MAX. ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2019	1	0.5	34.71	0.96	MAX. ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2020	1	0.5	34.71	0.96	MAX. ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2021	1	0.5	34.71	0.96	MAX. ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2022	1	0.5	34.71	0.96	MAX. ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2023	1	0.5	34.71	0.96	MAX. ADOPTION	5	0.017	10730	0.006	20	3585.34	1195.11196	2390.22
2024	1	0.5	34.71	0.96	DIS-ADOPTION	4.6666667	0.016	10730	0.005	20	3345.70	1115.23191	2230.46
											NPV	NPV	NPV
											20,368	6,789	13,578

Note: a- Net K shift is the proportional downward shift in the supply curve for each year. The shift is calcualted as (Column 6) = (Column 2)*(Column 3)*(Column4/100)/Column1).

b- Net proportionate price decrease is calculated as (Column 9) = (Column 7)*(Column 2)/((Column 2)+(Column 1))

c- The change in total surplus (in Kenya Shilling) is calculated for each year as (Column 11) = (Column 7)*(Column 8)*(Column 10)*(1+0.5*(Column 9)*(Column 1))).

d- The change in consumer suplus is calculated as (Column 12) = (Column 8)*(Column 9)*(Column 10)*[1+(0.5*(Column 9)*(Column 1))]

e- The change in producer surplus is calculated as (Column 13) = (Column 11) - (Column 12)

The benefits of research programs can be disaggregated by type of technology or disciplinary as well, e.g.

- crop protection
- plant breeding
- crop management
- animal nutrition, etc.

Objectives of Session 14. Scoring Inclusion of Multiple Criteria in Priority Setting

3. Explain basic principles of scoring method, criteria used, and data requirements.
4. Explain how to integrate all the criteria to calculate a project score.
5. Identify priority themes among a ranked list.

Scoring

Chooses projects on basis of their contribution to efficiency and other criteria such as equity and sustainability

Basic Principle of the Scoring Approach

To integrate criteria representing multiple objectives into a simple indicator.

Major Steps: Scoring Approach

1. Identify and weigh research system objectives
2. Measure standards

Major Steps: Scoring Approach (continued)

3. Assessment of alternative research activities. The score (measure of objectives) will combine criteria, usually by summing them

4. Ranking of research activities (comparison of alternatives)

Advantages of Scoring Approach

- Easier than economic surplus models

  less:
  - data
  - time
  - skill

- Participatory process

Allows for Consensus

Without consensus, there is no point in having more rigorous results.

Limitation of Scoring Approach

- not rigorous

Exercise 14a: A Three Scorning Model												
Zone:	Humid Costal			Zone:	Humid Costal		Zone:	Humid Costal		Zone:	Humid Costal	
Theme:	Varietal Development			Theme:	Crop Management		Theme:	Technology Dissemination		Theme:	Technology Dissemination	
	Criteria 1	Criteria 2	Criteria 3	Criteria 1	Criteria 2	Criteria 3	Criteria 1	Criteria 2	Criteria 3	Criteria 1	Criteria 2	Criteria 3
	Efficiency	Equity	Environment	Efficiency	Equity	Environment	Efficiency	Equity	Environment	Efficiency	Equity	Environment
Raw Score	50,000			370,000			440,000			100,000		
Standardized Score (0 - 5)	1	1	1	4	2	4	5	5	3	5	5	0
Weight (%)	50	30	20	50	30	20	50	30	20	50	30	20
Weighted Score	1					3.4	4.6			4		

Objectives of Day Five

1. Describe a protocol for approval and implementation of priority-setting results.
2. Identify sources of information needed for different priority-setting methods.
3. Identify available data in your country.
4. Suggest appropriate methods for your country.
5. Draft a plan for a priority-setting exercise in your country.
6. List short-term actions to implement your action plan designed in session 17.
7. Evaluate and provide feedback on the workshop.

Schedule of Day Five

08:30 – 09:00	Opening of the Day's Activities
09:00 – 10:30	Session 15. Managing the Priority-Setting Process
	Tea/Coffee Break
10:45 – 11:10	Session 15. (Continued)
11:10 – 13:00	Session 16. Data Collection
	Lunch
14:00 – 15:30	Session 17. The Priority-Setting Process
	Tea/Coffee Break
15:45 – 16:15	Session 17. (Continued)
16:15 – 17:15	Session 18. Participant Action Plan Approach (PAPA) and Workshop Evaluation
17:15 – 17:30	Final Remarks and Closing

Objective of Session 15.
Managing the Priority-Setting Process

1. Describe a protocol for approval and implementation of priority-setting results.

Priority Setting should be

- ***Participative***

  so as to build consensus at the level where priority setting is being done

- ***Approved by a committee***

  composed of a cross-section of major stakeholders in the research results

Process of Priority Setting should be

- *Interactive*
  in order to accomodate changing environments

- *Initiated*
  by the person who is directly responsible for the implementation of the results

Those responsible should clearly understand how the results will be translated into resource allocation decisions.

A Participative Process

Priority setting requires that

- all stakeholders play a part and be involved in the consensus building, i.e.

  - policymakers
  - research clients
  - researchers
  - donors

- this stakeholder group should establish medium-term resource allocation guidelines based on identified priorities

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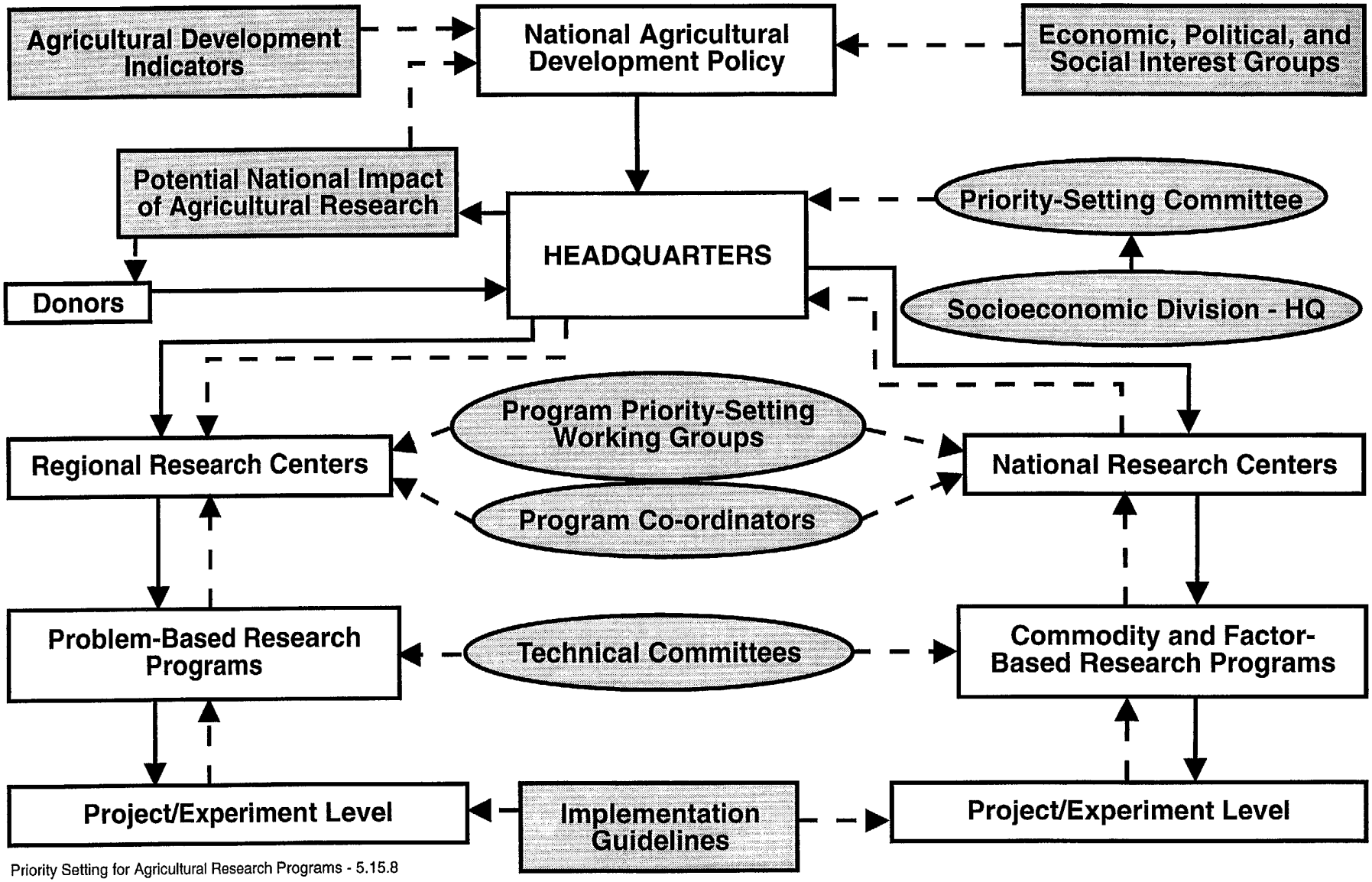
Information Flows and Institute Structure



Priority Setting for Agricultural Research Programs - 5.15.8

Implementation

Facilitators	- identify benchmark data - operate priority-setting applications - ensure cross-program compatibility in priority-setting exercises
Working groups	- consist of key-program experts - provide initial assumptions - are responsible for write-up of program exercise
Stakeholder groups	- review/modify initial assumptions - build program consensus

Objectives of Session 16. Data Collection

2. Identify sources of information needed for different priority-setting methods.

3. Identify available data in your country.

4. Suggest appropriate methods for your country.

Data Collection

To collect data, it is necessary to link information needs and information availability.

Basic Recommendations to Collect Data

(a) Determine information needs for chosen priority-setting criteria and potential methods

Basic Recommendations to Collect Data

(b) Identify available sources of information

Basic Recommendations to Collect Data

(c) Identify areas where information is poor.

- can the information base be improved?
- can alternative methods be used which do not rely on missing information?

Basic Recommendations to Collect Data

(d) Information may be required to measure efficiency (economic growth), equity (distribution of growth), food security, sustainability, and other objectives

Data come from

(a) public sources

(b) research leaders and policymakers

(c) economists

Data/Information can be

- market related
- research related
- quantitative or qualitative

Economic Surplus Analysis

Market-related data include:

(a) quantities produced

(b) prices

(c) policies

(d) elasticities

(e) discount rate

(f) population growth rate

(g) income growth rate

Research-Related Data are

- based on expert opinion
- obtained from research leaders, researchers, and extension workers
- focused on the potential for generation and adoption of technologies

Research-Related Data

- require a good disciplinary, and
- regional mix of opinions

Meaningful Priority-Setting Exercise

- Information on research client constraints is a prerequisite for an effective priority-setting exercise

Checklist

Sample list of data and other information needed for research priority setting using the scoring model (with economic surplus measures of efficiency) to rank commodities.

	Congruency	Needed for economic surplus	Needed for scoring	Available in country
I. Information from research directors and policymakers				
1. List of commodities to include in the analysis.				
2. List of research programs to include in the analysis.				
3. Objectives for the research system.				
4. Weights on objectives for the research system.				
5. Estimates of current research expenditures or scientist years by commodity.				
II. Published data				
1. Quantity of production for each commodity for the previous three to five years by zone.				
2. Prices of products for the last three years by zone.				
3. Proportion of each commodity produced on small-holder farms.				

	Congruency	Needed for economic surplus	Needed for scoring	Available in country
III. Information from scientists and extension workers (by theme and zone)				
Technology generation				
1. Anticipated net yield increase.				
2. Dissemination net yield gain level.				
Technology adoption				
1. Research development lag.				
2. Period of increase adoption.				
3. Anticipated peak level of adoption.				
4. Period of dis-adoption.				
IV. Economic data				
1. Elasticities.				
2. Discount rate.				
3. Population growth rate.				
V. Information on client needs				
1. Informal surveys.				
2. Formal surveys.				

Objective of Session 17.
The Priority-Setting Process

5. Draft a plan for a priority-setting exercise in your country.

Major Elements of Your Scheme to Carry Out Priority Setting at Your NARS

- Institutional structures for priority setting
- Criteria
- Methods for national program
- Plan of action

Objectives of Session 18.
PAPA and Workshop Evaluation

6. List short-term actions to be taken to implement your action plan designed in session 17.

7. Evaluate and provide feedback on the workshop.