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Data Collection Strategies for Small-Scale Industry Surveys

by

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Although there are several strategies to collect survey data, only two basic data collection methods have been used to generate survey data on small-scale industries in developing countries. The two methods are the one-shot business survey and the multiple-visit (cost-route) survey. This paper reviews the way these two methods have been used and the central issues that must be considered when choosing which data collection strategy to employ.

HISTORY OF SURVEY METHODS USED

The vast majority of small-scale industry inquiries have used the one-shot business survey method. With this method, the survey data are obtained **at a single point in time** by means of either self-enumeration (in other words, mailed questionnaire) or one or two personal interviews with the proprietor.

The one-shot business surveys of small-scale industry have long historical roots. In the earliest business surveys undertaken in both the industrialized and the developing countries, an attempt was made to enumerate all firms of all sizes.[1] Subsequently, these general business surveys began to exclude the small firms or enumerated them in separate, special business surveys "because of the work and problems that small units contribute to basic industrial inquiries."[2] Indeed, the United Nations' 1973 World Program of Industrial Statistics recommended that different survey procedures should be considered when obtaining data from small-scale firms engaging less than five workers.[3] Specifically, the U.N. program proposed that for the smaller firms government censuses could be based on sample rather than on a complete coverage of enterprises and that shorter, less comprehensive, questionnaires might be

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[1] See United Nations (1953) for a discussion of the history of industrial censuses.

[2] United Nations (1953, p. 108). Egypt attempted to cover all manufacturing in 1937, for example, but included only large-scale firms after 1944.

[3] United Nations (1971, p. 31).

used. The data however — even those relating to the flow variables such as inputs, outputs, profits, and sales values — were still to be obtained at a single point in time.

Separate, one-shot business surveys of small-scale industries have been undertaken in a number of developing countries.[4] These surveys have been conducted by government statistical agencies, such as in India (1965) and Ghana (1965); university research units, such as the Industrial Research Unit of the University of Ife in Nigeria (1972), the Institute for Small-Scale Industry of the University of the Philippines (ILO, 1974), and the small enterprise group at Michigan State University (Liedholm and Mead, 1987); individual researchers, such as Kilby in Nigeria (1963), or Steel in Ghana (1977); and international agencies, such as the International Labour Organization (Sethuraman, 1981) and the World Bank (Little, Mazumdar, and Page, 1987). The geographic coverage and the kinds of data collected in these one-shot surveys vary widely from country to country.

The multiple-visit (or cost-route) survey technique, on the other hand, has not been widely used for collecting small-scale industry data. This method, in which firms are interviewed **repeatedly** for a crop season or even a year or more, has been employed largely in farm management and production studies.[5] It was extended to the industrial sector by researchers at Michigan State University in such countries as Sierra Leone (Chuta and Liedholm, 1985), Bangladesh (BIDS, 1981), Jamaica (Fisseha and Davies, 1981), Honduras (Stallmann and Pease, 1983), Thailand (Narongchai, 1983) and Egypt (Davies, et al., 1984).

CRITERIA FOR CHOICE OF METHOD

This choice of which data collection strategy to employ in small-scale industry inquiries depends on a number of factors. A key element in the decision, however, centers on the relative amount of sampling and nonsampling errors generated by the two techniques. If resources for

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[4] See Liedholm and Mead (1986) for a review of those surveys undertaken in Africa and United Nations (1975) for a review of government surveys in all regions.

[5] See, for example, Spencer (1972), Norman (1973), and Tollens (1975).

investigation are fixed, increasing the frequency of interviews will necessitate reducing the sample size and consequently tend to increase the sampling error. On the other hand, reducing the frequency of visits may tend to increase the amount of nonsampling errors, such as those due to measurement and response inaccuracies, particularly if significant amounts of memory recall are involved.

The exact nature of the trade-off between these two sources of error cannot be specified with complete certainty. Casley and Lury (1981) contend that, in developing countries, nonsampling errors are relatively more important than the sampling ones. Reinterview studies have shown the presence of "alarmingly high levels of response errors even on the simplest of survey questions" (Scott, 1985, p. 15), and in some Indian surveys nonsampling errors were probably six times the sampling errors (Casley and Lury, 1981, p. 87).

Concern for nonsampling errors in small-scale enterprise surveys is of particular importance because most small firms do not keep written records or books. In Sierra Leone, for example, only 17 percent of the small industry proprietors keep even a minimal set of records (Chuta and Liedholm, 1985). In Jamaica, the percentage drops to 9.8 (Fisseha and Davies, 1981), while in rural Bangladesh the percentage is only 6 (BIDS, 1981). In view of the lack of written records, the interviewer must rely on the respondent's memory for obtaining the required information. Memory recall is thus critically important when collecting data from small-scale industries in developing countries.

The memory performance of respondents, and consequently the amount of measurement error, depends importantly on the length of the recall (or reference) period. Since memory errors tend to increase as the length of the recall period increases,[6] the most accurate observations can be obtained from those activities that took place or can be measured on the day of the inquiry. In this regard, one can usefully distinguish between the relative measurement accuracy of current stock and annual flow data. Since current stock data, such as the number and kinds of workers or the number and kinds of capital stock, relate to the day that the inquiry

[6] See, for example, Zarkovich (1966). Collinson (1972) has argued, however, that memory recall may be improved, in some cases, as the reference period increases.

takes place, this type of information can be expected to possess a relatively low degree o measurement error even when obtained in one-shot business surveys. Data relating to the flow of activities over a period such as annual labor hours, profits, income, output, and sales might, on the other hand, be expected to be subject to much higher measurement error, since longer periods of memory recall are required.

A one-shot business survey may thus be a suitable vehicle for small-scale inquiries if only stock-type data were required. Stock data can be useful, for example, in providing an idea of the extent and composition of small-scale activity in a country or for providing the initial sampling frame for subsequent, more detailed inquiries. Kilby's study of Eastern Nigeria's small-scale industrial sector (1963), the Fisseha and Davies small enterprise study in Jamaica (1981), and Chuta and Liedholm's study of manufacturing enterprises in Sierra Leone (1985) are examples of the use of one-shot business surveys to provide stock data for one of these purposes.

If annual flow data are required, however, an alternative data collection strategy may be needed. The ability of respondents to recall accurately flow-type activities that have taken place previously depends importantly on the regularity and frequency of the flows to be measured.[7] Events that occur regularly over a period create a pattern of experience for the respondents and enable the respondent to remember these events more easily. Moreover, events that occur infrequently over the period will also tend to be remembered individually. The regularly and frequency of small-scale industrial flow variables will thus provide important clues to the most appropriate data collection strategy.

The available evidence for the small-scale industry surveys indicates that the flow of activities over the year is irregular both daily and weekly as well as seasonally. The majority of the small-scale firms, for example, respond to individual orders whose magnitude varies daily (see Liedholm and Mead, 1987). There are also large seasonal variations in the level of inputs and outputs of small-scale industry in both urban and rural locations. In the larger urban areas, for example, the mean output in the peak month in the Sierra Leone study was twice that in the

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[7] See Collinson (1972) for a discussion of these two characteristics.

lowest month; in the rural localities, the corresponding variation was four times (Chuta and Liedholm, 1985). Moreover, the seasonal pattern of activity varies from industry to industry. The irregular nature of the activity will thus tend to make it difficult for the respondent to remember the individual flow activities over the entire year. The daily and seasonal variations also make it dangerous to impute the total yearly flows from data covering only a small portion of the year.[8]

The Sierra Leone study also reveals that a large number of the flow variables occur with great frequency over the year. Labor is used and output is produced daily, for example, while other inputs may be purchased somewhat less frequently. It is thus unlikely that all these individual flow activities will be remembered accurately over the entire year. In view of the irregular yet continuous nature of the flow data to be collected, the one-shot business survey appears to be an inappropriate vehicle for collecting these types of data. Consequently, some form of multiple-visit survey technique is needed if flow data are to be collected without unduly large amounts of measurement error.[9]

The results of two tests of the memory recall accuracy of small-scale proprietors tend to support the contention that annual flow data cannot be generated accurately from one-shot surveys. In Honduras, detailed input and output data were collected twice-weekly from December 1979 until December 1980 from 81 randomly selected entrepreneurs. The entrepreneurs were then asked at the end of the period to provide their best estimate of their total sales, costs, and profits for that one-year period. When these one-shot estimates were compared

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[8] See, for example, Child (1973), who has attempted to estimate yearly flows from monthly flow data.

[9] Collinson (1972) has argued that "end period effects" and "conditioning effects" could cause measurement errors to be high in multiple-visit surveys. The "end period effect," in which respondents tend to include items from earlier periods in their reporting for the current period, can be minimized by relating the reference period and frequency of interviews to the frequency of transactions; thus, labor reference period would be short while purchased inputs reference periods would be longer. "Conditioning effects," which might negatively influence such surveys if respondents gradually lose interest and drop out of the survey, did not appear to be a serious problem in the Sierra Leone survey. Indeed, less than 5 percent of the sample dropped out because of the unwillingness to continue to cooperate.

with the actual sales, cost, and profit information provided during the twice-weekly enumeration, the divergences were marked. The estimated mean value of sales, for example, based on the one-shot memory recall, was 85 percent higher than that derived from the twice-weekly enumerations. Moreover, there was a high degree of variation in these responses; only 25 percent of the entrepreneurs' one-shot responses were within 25 percent of the enumerated values. The one-shot estimates of costs and profits exhibited similar divergences. The mean value of profits was overestimated by 47 percent and only 21 percent of these one-shot estimates were within 25 percent of profit figures collected twice weekly.

In Jamaica, a similar test was conducted on a random sample of 80 respondents who had also been enumerated twice-weekly for one year (May 1979-April 1980). Forty-five percent of the respondents said they could not recall any of the requested information. For the remaining 55 percent, their one-shot recall greatly overestimated cost, but, contrary to the Honduras experience, their sales were underestimated by over 20 percent (Fisseha, 1982).

The results of these two tests indicate that the measurement errors associated with one-shot surveys of flow variables are extremely high. Flow results generated from such one-shot studies should thus be treated with extreme caution and healthy skepticism.

How accurate are the flow data collected once or twice a week? Although there have been no rigorous tests of this aspect of memory recall for small-scale proprietors, this question was examined before the start of the Sierra Leone small-industry study. Most proprietors could provide reasonable estimates of output, sales, labor, and inputs for four days, after which the accuracy appeared to drop. Transactions involving purchased inputs were remembered for much longer periods. Thus, twice-weekly visits may be required if measurement errors for the key labor and output variables are to be kept within reasonable limits.[10] Accurate data on purchased inputs, on the other hand, can be obtained with weekly or even, in some cases,

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[10] The need for twice-weekly enumeration of some variables parallels the practice recommended by researchers who have engaged in farm management and production surveys in developing countries. Spencer (1972), Norman (1971), and Tollens (1975), for example, all argue that twice-weekly interview intervals probably are required if reasonable estimates of certain variables are to be obtained. Only Spencer (Kearl, 1976), however, has rigorously tested for the accuracy of memory recall.

monthly interviews. Finally, stock data probably should be gathered only twice, at the beginning and end of the survey period, while entrepreneurial data should be collected only once, preferably at the end of the survey period. Thus, the frequency of interviews should vary depending on the kinds of data being collected. These interviews should ideally be conducted over the entire year, however, to capture seasonal variation in activity.

In conclusion, if only stock-type information on small-scale industries is required, a one-shot data collection strategy is quite appropriate. A multi-visit survey strategy must be given serious consideration, however, whenever annual flow-type information is needed, particularly if the potentially significant measurement errors are to be kept within tolerable limits. Further studies are needed to determine if the frequency and length of such multiple-visit surveys can be reduced without markedly increasing the measurement error.

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1 INTRODUCTION

The purpose of this paper is to present a method and process for program planning. In the first section, the need for improving program planning is highlighted, based on ISNAR's experience in more than 40 agricultural research systems. The second section situates long-term program planning within the overall context of agricultural research planning and establishes a framework for priority setting. The third section presents the method itself, illustrated by the example of Morocco's olive program. The fourth section explains the process of program planning as it would unfold using the proposed method. Finally, the last section provides brief guidelines for managing the process.[5]

[5] These guidelines will be expanded in a training manual, forthcoming.

2 THE NEED FOR IMPROVING PROGRAM PLANNING AND KEY ISSUES ADDRESSED BY THE METHOD

A number of deficiencies in program planning are common to many national agricultural research systems (NARS). Reviews by ISNAR of some 40 NARS since 1980 have highlighted some of these recurrent weaknesses. The program planning method presented in this paper stems from these earlier diagnoses and attempts to address these deficiencies systematically.

1. Research objectives are often not well linked to economic and agricultural development objectives. At the policy level, development objectives and the means of obtaining those objectives are often confused.

   The first step involves reviewing stated development objectives for particular commodity or theme programs. These usually appear in National Development Plans or other policy statements.

2. Program activities are not relevant to the needs of the research users, nor are they geared to producing technologies easily adopted by them. A basic principle of the method is that, in its efforts to serve its clients, a research institute should not differ fundamentally from the private sector. A private firm will always study the market before developing and commercializing a new product. Hence, a preliminary step is to analyze the farmers' production potential by agroecological zones or production systems. The farmers' constraints on reaching this potential should also be analyzed.

   Development objectives are evaluated against farmers' constraints and potentials. This helps to determine how realistic and feasible the objectives are, and to see what contribution research can make to their attainment.

3. Regular evaluation/review of research activities is lacking. Too often, research results that could be tested and adapted are not disseminated; unproductive research activities that should be discontinued are not; activities that are promising but insufficiently funded are overlooked. As a result, the basic information on the state of present research -- information that is needed to design future activities -- is missing.

   The method includes a review of in-country research in order to highlight promising results and to point to underexploited opportunities and inefficient use of scientists' time.

4. Not enough is known about the technology available from external sources, resulting in missed opportunities for borrowing technology. A brief account of outside agricultural research that may be relevant for addressing the constraints identified is included in the program planning method. This analysis helps determine a research strategy for the program. In effect, it pinpoints the extent

to which the country can rely on borrowed technology. This in turn affects decisions on whether to do applied research or only testing and adaptive work.

If basic knowledge is unavailable elsewhere, and the extra resources can be secured, the country can then consider undertaking strategic research. By so doing, it can capitalize on key opportunities for economic development.[6]

5. Research activities are often proposed without reference to the resources they demand. The method calls for a determination of the time and expertise needed to carry out the proposed activities. This leads to an analysis of the gap between existing and desirable levels of resources for the program.

6. Scarce resources are dispersed among too many activities. The resources available to each program, especially human resources, are limited. Attempts to implement all the research activities necessary to address the multitude of identified constraints leads to a dispersion of resources. This undermines a program's productivity. Research needs a minimum level of resources -- mainly researcher, technician, and support staff time -- to produce significant research results.

   To increase the efficiency of resource use, the method calls for a calculation of the minimum scientist time needed per year to produce significant results. It also requires that the necessary mix of disciplinary expertise be specified. Then, a procedure for ranking all potential research activities by priority is proposed.

7. Researchers and producers' interests are potentially divergent. Left on their own, researchers tend to work on the most scientifically interesting problems and constraints. Unfortunately, neither these nor the technologies emanating from such research may be very relevant to farmers. As a result, the adoption rate may be low.

   Under the method, a major criterion used in ranking proposed research areas is the estimated rate of adoption of the resulting technology.

8. Research programs are often made up of a hodgepodge of projects, activities, and experiments. The method promotes the definition of coherent research areas within programs. This is done by linking each activity, experiment, or study to an overall problem-solving objective.

9. Researchers tend to overlook socioeconomic and institutional constraints on the adoption of their research results. The method helps to highlight these problems. It encourages managers to do one of two things: either question seriously research proposals that will produce results unlikely to be adopted for socioeconomic reasons; or alert decisionmakers to the economic and institutional changes needed to make the environment more conducive to technology adoption.

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[6] A review of the literature is often carried out by scientists in the framework of their individual projects. It is seldom practiced systematically as recommended here at the program level to determine a research strategy for the program.

3. PLACING PROGRAM FORMULATION IN OVERALL AGRICULTURAL RESEARCH PLANNING AND PRIORITY SETTING

3.1 Three Steps in Agricultural Research Planning and Priority Setting

It is important to first define the part of agricultural research planning that the method purports to assist. Three distinct steps usually can be distinguished in agricultural research planning,[7] dealing with the design of:

1. A national agricultural research policy and strategy.

2. A long-term plan (10 to 15 years) in three components -- long-term programs; human resources development; and physical resources development.

3. An action plan, often referred to as a medium-term plan (three to five years). This translates the long-term plan into operational terms for direct implementation.[8]

The planning activities needed to design each of these components occur at different levels in the structure of the agricultural research system, and they involve different participants.

1. **The national agricultural research policy and strategy** are formulated at the policy/interministerial level. They deal with decision-making on such issues as:

   - the mandate of the system;
   - the overall level of investment in agricultural research;
   - priorities among broad research areas (commodity groups, production systems or production factors) and their resource allocation;
   - organizational structure for the system;
   - linkages between the system and the users and between the system and other sources of knowledge.

   At this interministerial level, priority setting (based mainly on socioeconomic and political considerations) helps to determine:

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7 For the detail of these sequences, see Collion (1989) and Dagg (1988).

8 The terminology used for these different levels of planning can vary. "Medium-term plan" is often used instead of "action plan", highlighting that the period is of concern. The term "action plan" emphasizes instead the purpose of this plan, which is implementation. Master plan, or "plan directeur" in French, has also been used to indicate a type of planning which combines elements of a long-term plan and an action plan.

a. the resource allocation to research, compared with resource allocation to other sectors contributing to agricultural development such as extension services, input delivery services, feeder roads, and the like;

b. the main programs defined by commodities, factors of production or systems of production.

2. **The long-term plan** is formulated by the institute or department using the agricultural research policy as a framework. Its seminal component is the long-term programs. This means the scientific research activities must be organized in programs, either by commodities, themes, production factors, or systems.[9]

A program groups all the research activities needed to produce the information required by the clients of research in an area.[10] A multidisciplinary team of scientists is attached to a program.

At the program level, priorities are set among subprograms[11] and research areas (themes or projects) based on a combination of socioeconomic and technical criteria. This provides the link with priority setting at the policy level.

3. The third planning step is **the translation of the long-term plan into an action plan** (or medium-term plan) for direct implementation. Like the long-term plan, it has three parts: one program and two resource components.

The program component consists of formulating research projects that correspond to the areas identified in the long-term program. For the action plan, scientists prepare project documents which include the problem analysis, research hypothesis, description of the methodology (experiments, studies, etc.), expected results year by year, schedule of activities, and necessary resources (human as well as financial and equipment).

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9 Commodity programs can group several commodities (i.e. cereals, livestock, or vegetables) or only one commodity (depending on the importance of the commodity).
Production factor programs comprise activities related to individual or interrelated production factors, such as a soil-water-plant relationships program, or a natural resource management program.
Systems-based programs involve activities which are specific to an agro-ecological zone (for example, Aridoculture or Saharian Agricultural System) or to a type of production (rainfed farming systems, irrigated farming systems). In addition, farming-system research often constitutes a program.
For the organization of research into programs, we refer the reader in particular to Dagg and Hayworth (1988), Nickel (1989: 59-65), and Arnon (1989:387-391).

10 The clients of research are the various groups that can use research results directly; that is, not only farmers, but agro-industrial firms, processing enterprises, policymakers, and extension services.

11 A program can have subprograms, which is often the case when a program is a group of commodities. Then the subprogram is an important commodity within the group of commodities. For example, a cereal program can have a rice subprogram. Subprograms may also correspond to different agroecological zones, if they are varied enough to warrant a different research strategy. For example, a natural resource management program may have as one of its subprograms a zone where desert encroachment needs to be controlled, and another subprogram for a zone where management of natural resource should be the focus.

Priority setting is also necessary at this level. For each research objective, several research strategies can be designed, as there are different ways to address constraints or take advantage of opportunities. To set priorities, the criteria should be scientific (which strategies are scientifically valid for the problem at hand and which ones have the highest probability of success), and socioeconomic (which experiment will lead to component technology that can be adopted by farmers).

3.2 Fitting Program Planning into Three Steps

The method presented in this paper has three objectives:

1. To help design long-term programs as part of the preparation for the long-term plan.

2. To describe a procedure for setting priorities among subprograms and areas, as described above.

3. To complete the technical information needed for priority setting and resource allocation at the policy level.

This third objective of program planning is often overlooked. Priority setting at the policy level needs a combination of socioeconomic and technical information. While socioeconomic information can easily be generated at the policy level, the technical information is best provided at the program level. (Technical information would include, for example, the potential productivity increases by commodities and agroecological zones, the potential rate of adoption of new technologies, and the probability of research success.)

In order to allocate resources among programs, it is also necessary to determine the minimum amount of resources (mainly human) required by each program for a good chance of achieving useful results. The minimum amount of scientists' time necessary will vary from program to program, depending on the urgency and difficulty of the problems to be solved, the state of relevant research in the domain, and the country's objectives. This cannot be determined at the policy level, but comes from a careful program design.

Once this information is obtained from the programs, priority setting at the policy level can be finalized. The iterative process of planning and priority setting is recapped below.

1. First, the policymakers define the mission of the agricultural research system, the broad areas research must address, and the development objectives for these areas. As far as resources are concerned, only the overall level of human resources for the entire agricultural system is known.

2. The long-term programs are designed with the above taken into account.

3. In the long-term programs, the policymakers must obtain from the scientists the information they need to finalize priority setting and resource allocation among programs. In particular, which research areas are mandatory and which could be delayed if resources are not available? And how many scientists and other resources are needed for each research area, in order of priority?

4. Once the resources have been allocated among the programs, and the priorities have been set among research areas, then the number of research areas that can be addressed is known.[12]

3.3 Program Planning Output

A document is designed for each program for the long term. In some countries, the structure of the agricultural research system is fairly complex with a number of research institutes, university departments, and parastatals involved. The research programs can either be national, bringing together several of these institutions to carry out parts of an overall research program, or institutional, with each institution carrying out its own research programs independently.

Thus, the synthesis of all the program documents leads to either a National or Institute Long-Term Program depending on the organizational structure of the NARS.

Under the long-term program formulation, areas are identified only by their objectives. The detailed design of the projects corresponding to each area belong to the third step of planning, that is, preparation of an action plan (medium-term plan) as outlined above. The present method does not deal with this aspect.[13]

3.4 Priority Setting at the Program Level

Priority setting at the program level has many similarities with priority setting at the policy level, especially in relation to the efficiency objective. But in other ways it is unique.

In most countries, the development objectives to which research is expected to contribute can be grouped under three categories:[14]

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12 The iterative characteristic of the priority-setting process has been highlighted earlier by Contant and Bottomley (1988: 9-10), who distinguish the same three levels of priority setting and flows of information.

13 This will be the subject of another paper in preparation.

14 The classification of a country's goals in three main categories (efficiency, social equity and security) has been suggested by Pardey and Norton (forthcoming: chap. 4).

1. Increase agricultural productivity and efficiency to produce more products of better quality in order to attract more foreign exchange and raise income. This objective is referred to as the efficiency objective.

2. Improve the well-being of some groups in society more than others, that is, a distribution objective.

3. Reduce the annual variability of production and income and/or increase self-reliance, that is, a security objective.

Setting priorities among research areas requires an evaluation of their potential contribution to each development objective. The criteria used to measure the contribution of research to the achievement of these objectives are outlined in the discussion that follows.[15]

3.4.1 Efficiency objective

Standard criteria are used to evaluate the contribution of research to the efficiency objective. These do not depend on a particular country's policy, but they can be formulated differently from one country to another. All countries should use criteria similar to those described below to set priorities for their programs.[16]

a. Importance of the problem that research proposes to address

The problem's importance is gauged by estimating:

1. the area affected by the problem, or the area for potential gains; and

2. the potential yield gain or per-unit cost reduction for the areas concerned.

The area, times the potential yield gain, times expected producer price for the commodity gives an economic measure of the benefit to be obtained from alleviating the problem. This criterion combines technical factors (potential yield increase and area affected) with economic ones (expected producer prices).

b. Adoption rate of the technology to be developed

The total potential benefit from alleviating the problem will be obtained only if the technology is adopted. A technology is never adopted by all producers. Which producer

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15 The discussion of the criteria borrows from earlier work on priority setting. See in particular Contant and Bottomley (1989) and Norton and Pardey (forthcoming).

16 It is possible to add to the list. However, one needs to exercise caution because criteria are often not independent. For example, if both value of production and number of hectares planted with a crop are taken as criteria, it amounts to double counting. In addition, if too many criteria are taken into account, combining them becomes cumbersome.

groups will adopt the technology to be developed, and among these groups, what percentage?

Technology adoption will depend on:

- net benefit for the producer;
- managerial complexity of the technique;
- necessary initial capital outlay;
- change in risk involved (due to yield fluctuation and/or to financial risks, following from increased involvement in the market coupled with potential price fluctuations and marketing problems);
- availability of inputs and credit facilities;
- effectiveness of extension services;
- suitability of the innovation with regard to social and cultural factors.[17]

c. Probability of obtaining research results

This refers to the probability of obtaining results at the end of the research activity period, assuming the minimum amount of resources deemed necessary to carry out the activities are obtained. This depends on:

- complexity of the research;
- availability of research results from external sources of knowledge relevant for the agroecological conditions of the country;
- state of previous research on the subject;
- skills and motivation of the researchers.

d. Potential effect of the technology generated on the environment

Certain technologies may increase production in the short term at the expense of destabilizing already fragile agroecological systems. Production increases may not be sustainable and may therefore have undesirable side effects. In the long run, there may be less benefit from adopting the technology than was estimated for the short term.

Similarly, if controlling environmental degradation is a concern, then technologies that help achieve that goal should be given special attention, even though their immediate productivity gain may not be substantial.

e. Saving of scarce resources

Economic efficiency is improved when research results make best use of the country's most abundant resources and save on the scarcest.

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[17] In most cases, adoption probability and the importance of the constraint are related: adoption rate will depend on the farmers' net benefit from technology adoption, which in turn depends on the importance of the constraint alleviated by the technology.

With this in mind, the scarcest resources are first identified: land, labor, capital, water, or managerial capabilities. Then, the technology which will be generated by the research must be evaluated according to its use of the scarcest production factor. For example, if capital is scarce, which is often the case in developing countries, a capital-intensive technology is less desirable than a labor-intensive one.

f. Research cost

Cost is an important element in choosing among areas of research. If two areas present the same potential benefit, the area which costs the least should obviously be considered first.

3.4.2 Distribution objectives

For various political and social reasons, a national government may decide that the well-being of certain groups in society must take precedence over others. For agricultural research, the groups under consideration are:

- consumers versus producers;
- different groups of producers, identified by their relative resource endowment (land, capital, labor, water, and managerial capabilities);
- producers from different agroecological zones.

If there are any such political decisions, most of the distributional objectives between these three groups will be taken into account at the policy level when deciding on resource allocation between commodities. For example, the decision to favor poor consumers will be translated into more resources being allocated to research on commodities consumed by the poor. Similarly, a concern for the development of particular regions in the country will result in more resources being allocated to research on commodities grown in those regions.
If the decision is made to help certain groups of producers, then both the policy and the program level may have to be involved. A typical example is the decision to help small farmers, who are likely to have less land and less capital than large farmers. If the small farmers grow different crops than the large farmers, then those commodities can be emphasized in the allocation of research resources -- again, a policy-level decision.

If, however, the large and small farmers are growing the same crops, then suitable technologies for small farms (meaning scale-neutral and not capital-intensive) must be developed. This political decision will be taken into account at the program level, in choosing which technologies to develop to reduce production constraints. Thus, the only distribution objective the program would have to implement would be the political decision to favor certain groups of producers.

However, biasing technologies to favor certain producer groups is a tool that should be used with caution. First of all, research may not be the most efficient policy measure to address social inequalities. As Mellor puts it, "to attempt to meet distributional objectives through research allocation rather than redistributing the land is analogous to moving the piano to the piano stool (Mellor 1977:482)."

In addition, even if a particular producer group does not have the resources to adopt a specific technology, it may still benefit by the technology's introduction and adoption by other groups of producers, through indirect, nationwide effects on employment and income.

3.4.3 Security objectives

Most security concerns may have been already addressed at the policy level through research allocation to commodities. This certainly would be true for the objective of making production more secure for certain commodities.

If the objective is to limit the year-to-year production fluctuations for a specific commodity, then development of technologies designed precisely to increase yield stability must be emphasized. Once again, a concern expressed at the policy level is made operational at the program level.

Keep in mind that the most important objective for priority setting at the program level is, by and large, the efficiency objective. Distribution and security objectives are chosen at the policy level. The policy decisions are then considered at the program level, where decisions are made on how to lessen constraints.

4. PROGRAM PLANNING METHOD

The proposed method for designing a long-term program entails seven steps, each step building on the previous ones in a logical and systematic fashion. The seven-part method tries to address the deficiencies in program planning outlined above and evidenced throughout ISNAR reviews.[18] These seven steps are:

1. Diagnose the commodity situation, production systems or factors targeted by the program, and review the development objectives.

2. Analyze the constraints that impede the achievement of these objectives.

3. Review research results (national, external).

4. Determine research opportunities and define research objectives.

5. Identify research areas.

6. Determine human resources by areas and regional centers.

7. Set priorities among research areas.

4.1 Step 1. Review of the Commodity Situation (or Production Systems or Factors) and Development Objectives

There are two parts to this review: (a) the national economy, including development objectives, and (b) the producers and their production systems.

a. The national economy. Development objectives

A review of the national commodity situation, production systems or factors and their development objectives serves as a bridge between planning at the macro or interministerial level and planning at the institute level.

This information usually has been previously analyzed in the course of setting agricultural research policy. As such, it already includes a determination of priority research directions. If this is the case, this first step can be limited to using the same information and data.

If this is not the case, various reports and policy documents from the ministries of Agriculture, Planning and/or Economics and Finance will provide the information needed, including:

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18 As mentioned earlier, this method for program planning draws from earlier ISNAR planning documents (see footnote 2).

- quantities of commodities produced, area of production, prices, and trends for these factors;
- nutritional value and relative importance of the commodities for target groups (the most vulnerable producers or poorest consumers); importance for food security policy;
- relative importance of the commodities for cash income for target producers;
- importance of the commodities for foreign exchange earnings, either through exports or import substitution;
- potential future demand: population growth, income and price elasticity of demand;
- development targets for production as set at the inter ministerial level.

b. Producers' situation

Each production system is characterized by the following criteria:

- agroecological characteristics;
- contribution of each of the systems to national production;
- socioeconomic characteristics of the producers (number, size of farm, managerial capabilities);
- farmers' production strategy (commercial/subsistence strategy) for the commodities;
- economic agents, other than producers, that may be relevant to understand the production system;

Then, the potential sustainable increase in productivity for each of these systems is determined.

Figures 1 and 2, and Tables 1 and 2 in the Annex, summarize some of the outputs of the review of the information and development objectives for the Olive Sector in Morocco. Three systems were identified, with different characteristics and productivity potentials: traditional, extensive, and irrigated systems. In the traditional system, productivity per ha can increase from 500 to 600 kg on 60,000 ha. In the extensive system, it can increase from 1,000 to 1,250 kg on 260,000 ha, and in the irrigated system, from 2,200 to 3,500 kg on 37,000 ha.

With this potential taken into account, development targets were established beforehand to:

1. increase total production from 370,000 t of olives to 486,000 t;

FIGURE 1a: PRESENT PRODUCTION AND OBJECTIVES

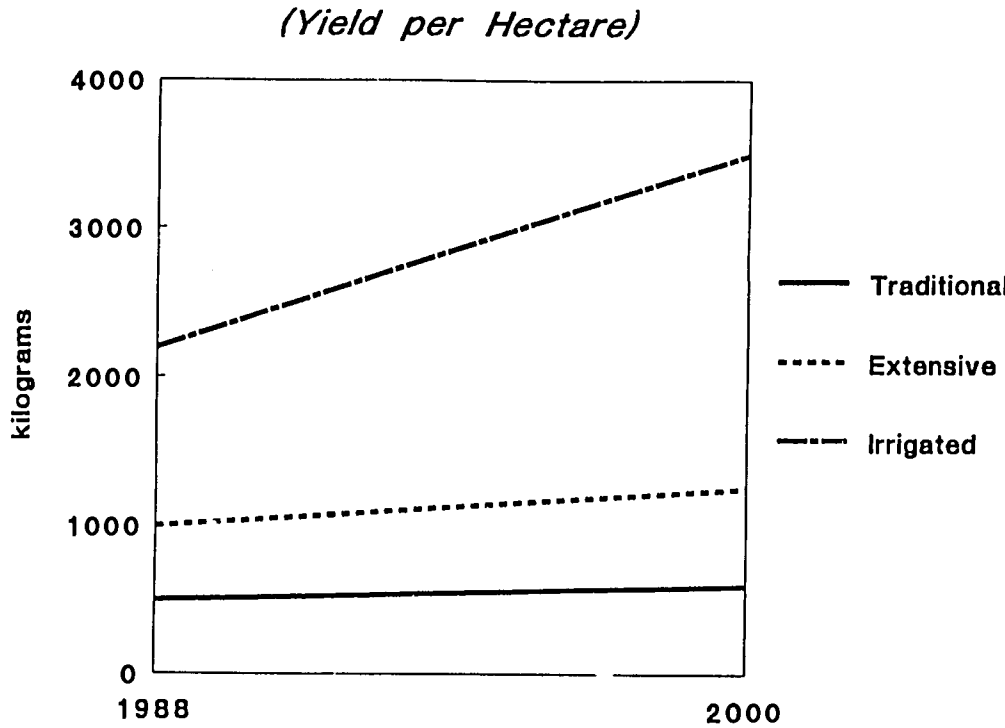


FIGURE 1b

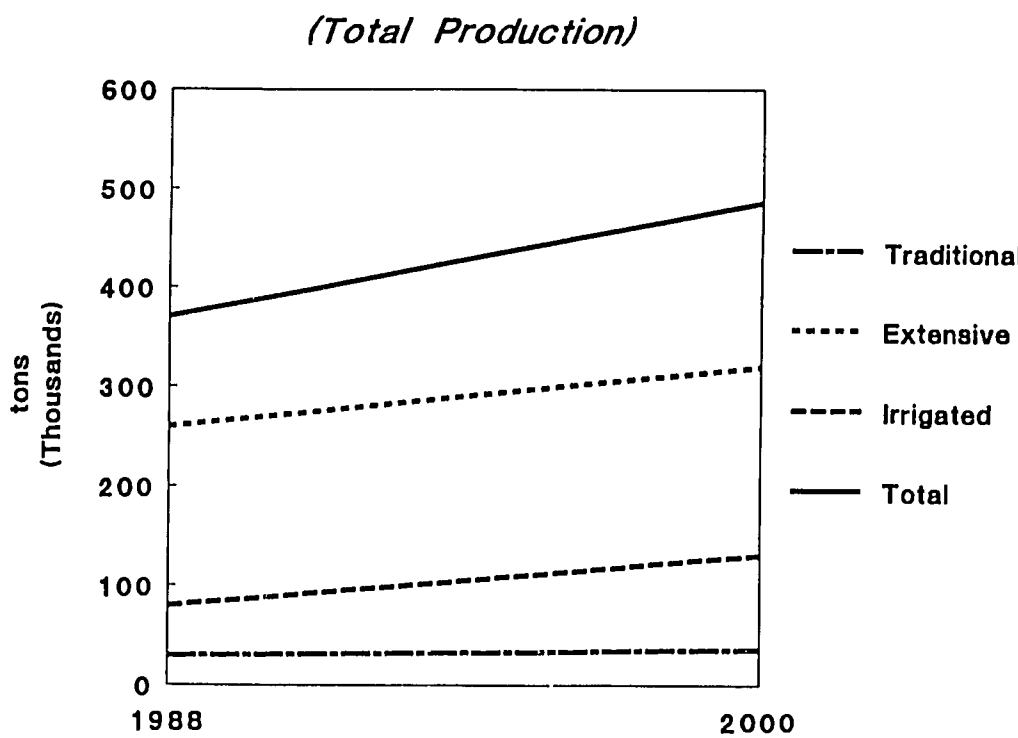


FIGURE 2a: PRESENT PRODUCTION AND OBJECTIVES

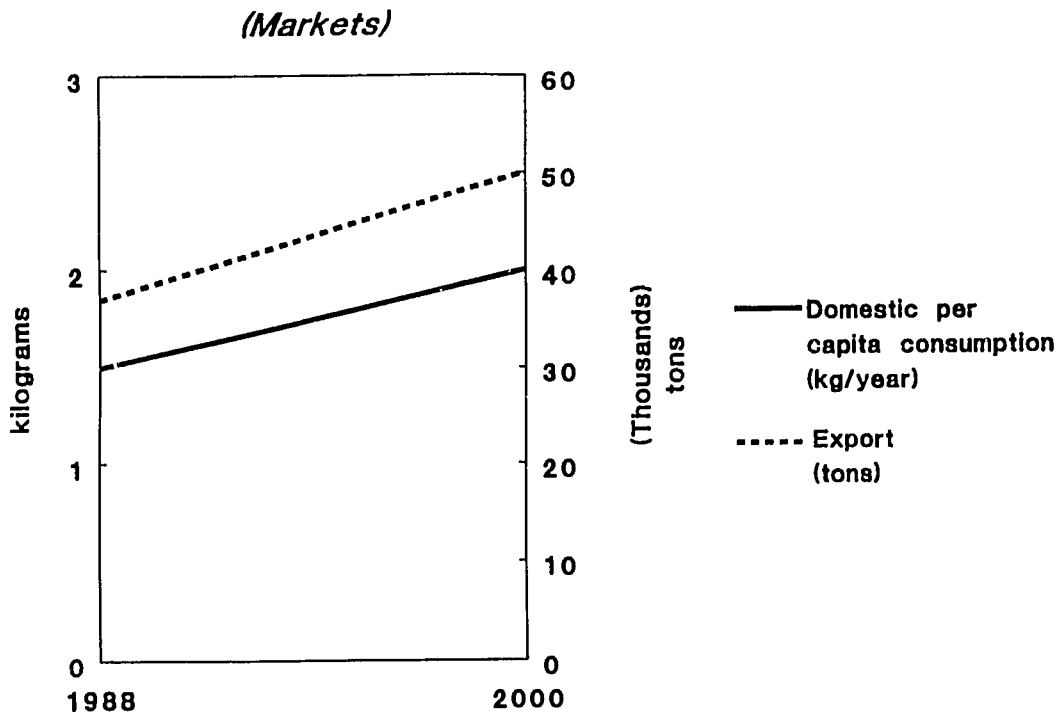
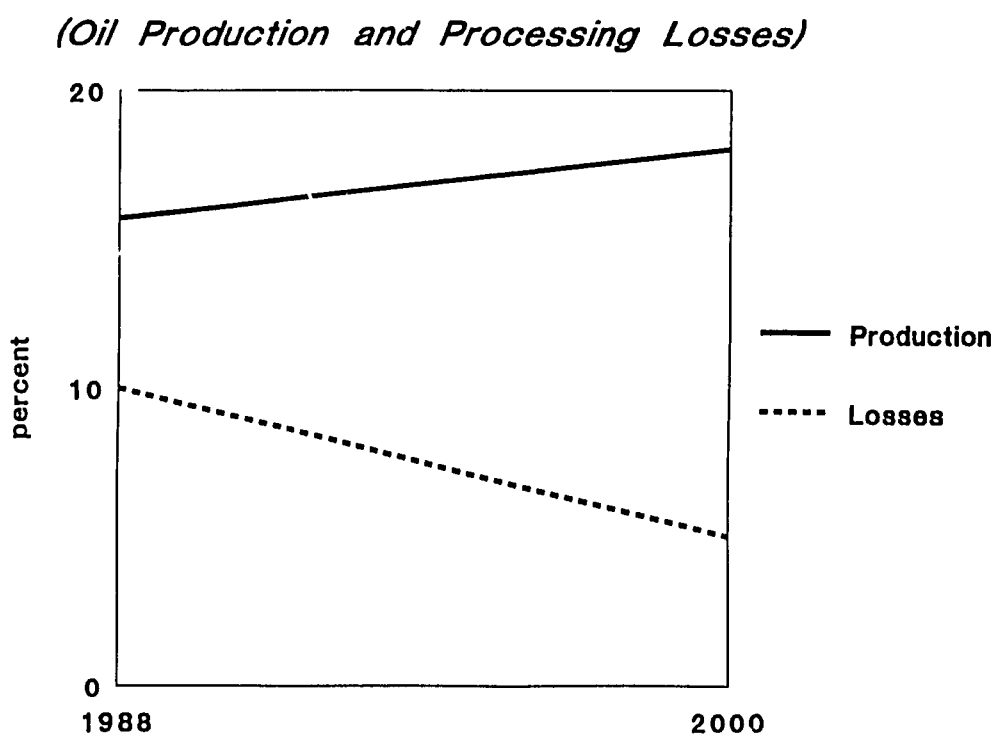


FIGURE 2b



2. increase per capita olive oil consumption from 1.5 to 2.0 kg and per capita table olives from 1.7 to 1.8 kg;

3. increase export of table olives from 37,000 to 50,000 t;

4. reduce losses from 10 to 5% of total production;

5. increase oil-extracting ratio from 15.7% to 18%.

This information is used as input for the later steps. In particular, at the end of Step 2, the development objectives are evaluated against the identified constraints. Box 1 shows the assessment of the development objectives of the olive sector, given the constraints.

In Step 4, the same information is used to calculate the value of the production increase to which research is expected to contribute. This is, in turn, one of the criteria for priority setting (Step 7).

After completing this review, the next step is to identify the constraints that stand in the way of achieving the development objectives and the productivity potential of each of the systems.

4.2 Step 2: Analysis of Constraints to Production Increase

Constraints to agricultural productivity increase can be found in production, marketing, processing and/or handling; they can be either technical or socioeconomic and institutional.[19]

Socioeconomic and institutional constraints can be found in the following areas:

- fiscal and monetary policies (in particular exchange rates);
- price policies (producer prices, input subsidies, consumer prices);
- import-export policies;
- land tenure;
- input distribution network and credit policies;
- extension services;
- marketing;
- processing and food industry.

Technical constraints can be grouped under production constraints and post-harvest constraints.

[19] A constraint is understood to be an impediment to taking full advantage of an opportunity.

BOX 1:EVALUATION OF DEVELOPMENT OBJECTIVES FOR THE OLIVE SECTOR

1. The production target for olive oil is a 3.1% annual increase until the year 2000, one third more than the annual increase over the last twenty years. Such an increase is feasible only with improved productivity resulting from the adoption of new technologies.

2. Relatively low producer prices limit the adoption of new technologies. Consumer demand for olive oil is price elastic: consumers begin switching to other edible oils when the price of olive oil is more than twice the price of other oils. Hence, the relative price of olive oil is unlikely to increase substantially.

3. Olive prices are also depressed by government policies that favor competing oils, namely grain oils. The import of those oils is subsidized and domestic grain oil production is encouraged by government input and marketing policies. These programs tend to reduce oil grain prices, putting downward pressure on olive oil prices.

   Policy makers should be aware that these policies have a negative influence on the development of the olive sector.

4. Farmers are not likely to increase their use of costly input without being assured of higher producer prices. Since producer prices are unlikely to increase, research should aim to develop technologies that reduce cost per unit of output.

5. The adoption of new technologies may also be hindered by a number of social and institutional factors, in particular the land tenure system, as land, water rights and trees, do not necessarily belong to the same individual.

6. The profitability of the sector could be greatly enhanced through improved storage, improved processing, packaging, classification, and the like. However, private entrepreneurs need to invest in order to fully exploit these potentials. This is unlikely to occur until more favorable socio-economic and institutional conditions are created, by promoting producers and processors organization and by readjusting government policies as per paragraph 4 above.

7. The adoption of new technologies which stimulates production could result in a fall in producer prices if demand is not sustained. Policy makers forecast an increase in domestic demand from 296,000 to 412,000t based upon population growth and an assumed per capita consumption increase from 1.5 to 2 kg/year. This increase is unlikely without an increase in per capita income or a decrease in consumer prices. Given the restriction in domestic demand, external outlets should be explored in parallel to the domestic market in order to secure the demand, for example, through exports of table olives and high quality olive oil.

   The program committee decided to bring these considerations to the attention of the policy makers at the level of the Ministry of Agriculture.

Production constraints include:

- genetic problems -- low productivity of clones and varieties; low tolerance or resistance to pathogenic agents; low performance in non-optimal conditions such as poor soils and low rainfall; poor adaption of these clones and varieties to different agroecological conditions;
- uncontrolled pest and disease infestation;
- agronomic problems -- inadequate cultural practices including poor sowing and poor soil and water management practices; non-optimum calendar of operations; inadequate techniques for soil cultivation and fertilization; low performance of existing production systems;
- poor harvesting techniques.

Post-harvest constraints include:

- transportation and marketing;
- losses through storage and processing;
- low value-added and poor quality of products.

Production constraints may vary from one agroecological zone to another, so it is necessary to analyze them by production system and/or by agroecological zone.

A "tree" design of constraints is used to analyze the constraints (see section 6). Starting with a central, general problem characterizing a commodity or a production system, one traces down through a cause-effect analysis all the factors that come to bear on that central problem. Each round of the analysis gets at more specific factors. Box 2 and Figures 3 and 4 give an example of part of the tree of constraints that was designed for the Olive Program in Morocco.

As presented in Figures 3 and 4, the tree of constraints may appear somewhat simplistic in its form. One should keep in mind that the tree of constraints is a brainstorming tool: a box must capture an idea using a few words. However, each of these boxes may have prompted a lively discussion, which is reflected in the write-up.

Designing a tree of constraints presents many advantages. It systematically takes a farmer's perspective into account, and important ideas are less likely to be left out. In addition, the intellectual discipline imposed by the systematic search for all the causes of a constraint reduces the chances of singling out one scientific area of expertise during the analysis. However, a tree of constraints is only effective if the analysis is carried out in a multidisciplinary context, which should exist in a properly constituted Program Steering Committee. (See section 6.)

This tool highlights the limiting effects of socioeconomic and institutional factors when they are the cause of a technical constraint. In such cases, a technical solution alone is

Figure 3: Part of Tree of Constraints for the Olive Sector (Morocco)

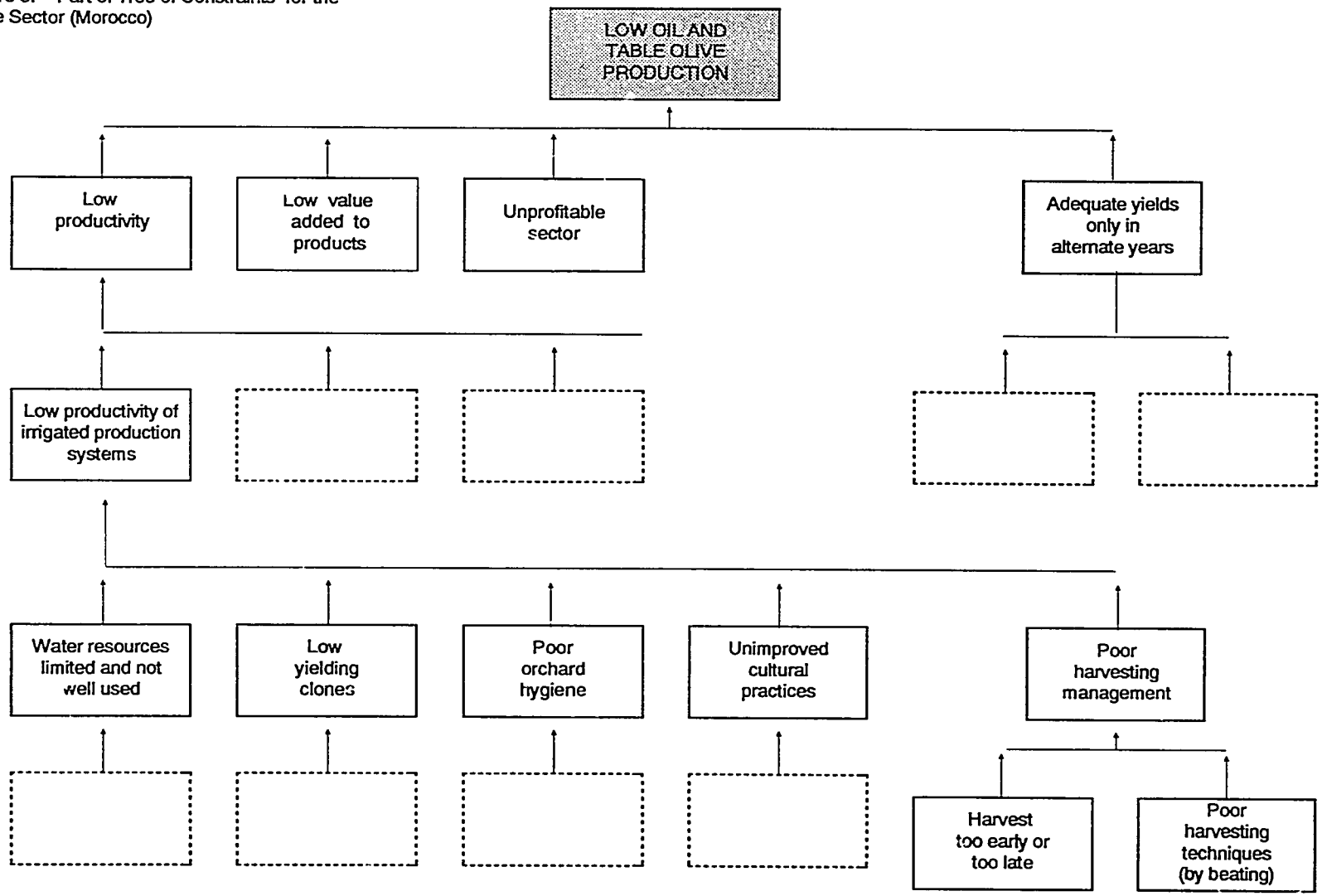
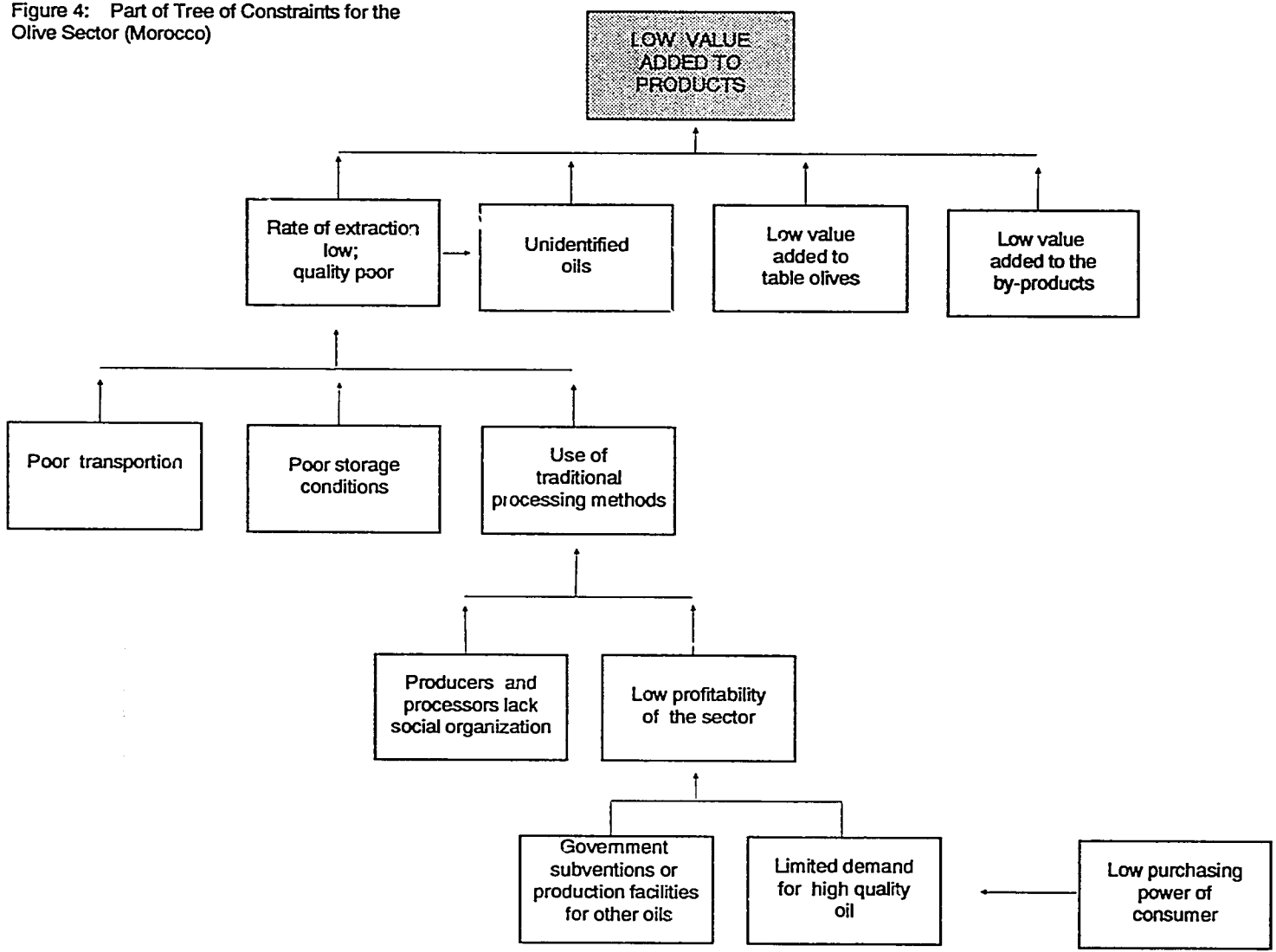


Figure 4: Part of Tree of Constraints for the Olive Sector (Morocco)



unlikely to solve the problem. In the illustration of the Olive Program (Box 2), the poor quality and low processing ratio for olive oil are partly due to prevailing, traditional processing techniques. This appears to be a technical problem. However, further analysis shows that the lack of investment in modern equipment is due to:

1. Lack of organization of the producers and transformers.

2. Low purchasing power of Moroccan consumers which limits demand for high-quality oil.

3. Government policies that favor competing oils. These policies, aimed at subsidizing grain oil imports or promoting local grain oil production through a well organized input supply and marketing system, put a downward pressure on consumer oil prices including olive oil prices.

This is an example where, in the absence of systematic analysis, one may have promoted a technical solution; i.e. developing improved or new processing technologies characterized by a better oil yield and higher oil quality. However, the tree of constraints shows that efficient organization of oil processors is necessary if they are to invest in new technologies. It also demonstrates that government policies towards the grain oil sector will have to be adjusted. Generating a new technology without additional policy measures will not solve the problem.

Such information will be used in two ways.

1. Socioeconomic constraints may be a major obstacle for adoption. They will have to be taken into account when deciding which technologies should be developed as priorities. Step 7 of the method presents a priority-setting procedure with one of the criteria being the estimated adoption rate of new technologies.

2. Researchers should advise decisionmakers that the socioeconomic and institutional environment may hinder the adoption of research results.

4.3 Step 3: Review of Current Knowledge and Achievements

After analyzing the constraints, the next step is to review the existing research results for each constraint. The review should follow two avenues -- domestic research and external research, whether international, regional, or from another country with similar agroecological conditions.

4.3.1 Domestic research

The review should evaluate any research already undertaken to tackle the constraints of each production system, and the research results. The following questions need to be answered:

BOX 2: ANALYSIS OF CONSTRAINTS ON THE OLIVE SECTOR IN MOROCCO

The central problem of the olive sector is the insufficient level of production of olive oil and table olives, both from a quantitative and qualitative point of view. Four causes were identified (see Figure 3 and 4):

1. low productivity in each of the three production systems (irrigated, extensive and traditional);
2. low value added to the products;
3. inefficient marketing/processing/exporting situation that makes the sector as a whole unprofitable;
4. problem of alternate production years.

At the next level, the low productivity in the irrigated system was traced to:

1. non- optimal use of water;
2. unproductive existing varieties;
3. plantations infested by pests and diseases;
4. unimproved cultivation practices;
5. unimproved harvesting techniques.

If one traces one of the causes down to the third level, for example, "unimproved harvesting techniques", two causes are identified:

1. the technique used, "beating" (gaulage), which depreciates the quality of the fruits and adversely affects future production;
2. optimal harvesting dates are not known.

The Program Committee stopped the search for more causal factors as they felt they had collected sufficient detail for this "branch of the tree".

Another example from the same "tree of constraints": starting again from "low production of table olives and oil (quantity and quality)", due in part to the problem of "low value added to the products". This is due among other things to the fact that (see Figure 4):

1. the processing ratio is insufficient and the oil is of poor quality (acidic);
2. different kinds of oils are not identified;
3. the value added to table olives is low;
4. by-products are presently not used.

The first (processing ratio) in turn, is due to:

1. poor transport and storage conditions;
2. traditional processing techniques.

The reasons for the techniques remaining traditional are:

1. lack of organization of the processors and producers;
2. limited demand for high quality oil due to the low purchasing power of Moroccan consumers.

- Which research results are ready for dissemination and can be transferred to extension?

- Which research results need to be further tested and validated on-farm and should be incorporated in the technical specifications to be used by on-farm researchers?

- Which are promising on-going research activities scheduled for completion?

- Which are promising on-going research activities that do not have sufficient resources to attain meaningful results?

- Which are research activities with very low probability of success?

- Which are the areas suffering from insufficient or no research activities?

This analysis makes it possible to identify the problems already solved, and those that need further research. Further research is needed if only partial results have been obtained or if the results obtained so far need to be tested and validated on-farm or in other agroecological zones of the country.

The analysis also draws attention to unproductive research activities which should be evaluated to decide whether they should be continued or interrupted. Finally, it identifies areas lacking research.

4.3.2 External research

The purpose here is certainly not to carry out an exhaustive overview of the research done in the area. Rather, it is to identify technologies generated by other national or international institutions that could be adapted to the agroecology of the country, especially in the areas where domestic research has not been very active so far.

If such technologies are identified from the review, then the research strategy for the particular theme can be quite different. Testing and adaptive research could substitute for longer and more costly applied research or even strategic research.

This review is also a way to communicate new information. It enables members of the Program Steering Committee to update their knowledge on the sector, and to hear about breakthroughs in disciplines other than their own.

4.4 Step 4: Determination of Research Objectives

For each identified constraint, research opportunities are identified by agroecological zone and/or by production system. This leads to the design of another tree, this time a "tree of objectives".

The tree of objectives is a translation of the tree of constraints. The cause/effect relations become linkages, highlighting all the specific objectives that have to be achieved before the conditions are met to reach the overall objective. Figure 5 is the tree of objectives that corresponds to the tree of constraints in Figure 3.

The translation of the tree of constraints into a tree of objectives is not as mechanical as it may appear. Each objective reflects a research opportunity.

A research opportunity does not necessarily arise from turning a constraint upside down. Capitalizing on the knowledge of its members, the Program Steering Committee identifies research opportunities corresponding to particular constraints. It evaluates their scientific feasibility and merit for development purposes.

Some constraints cannot be researched, while others have already been solved. If they have been solved in-country, then no research objective is needed, only a development objective. For example, one of the constraints of the olive sector is that farmers do not practice "rejuvenation". This technique is now well known, but its adoption is difficult as it means foregoing revenues for several years because of land and tree tenure. It is therefore no longer a research problem, but a development problem.

Sometimes, a solution has been found in-station, but no on-farm testing has taken place. For example, improved olive varieties exist but they have not been adopted, partly due to lack of on-farm testing and demonstration. This type of constraint suggests a specific research objective and strategy.

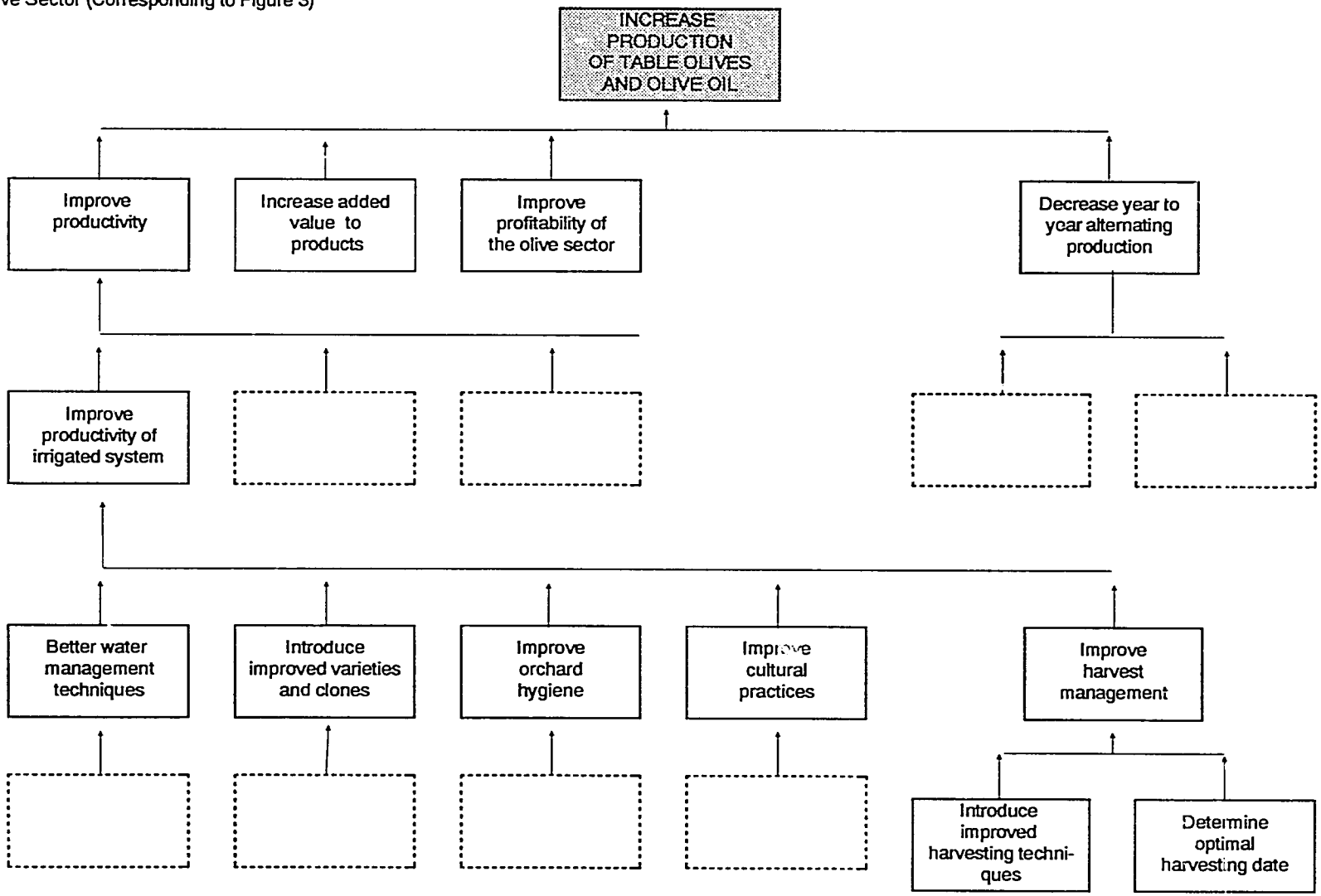
Finally, if a solution has been found outside the country, there is yet another research objective and strategy. For example, improved harvesting techniques for olives, using nets, have been developed in other countries. Research will limit itself to testing and adapting these.

In some cases, the limiting effect of socioeconomic constraints is such that there is no research opportunity. In Morocco, this occurred with the pastoral system of the Forage Program. Some identified constraints, although they were technical, were not researchable because of overwhelming social constraints. For example, it was found that one cause of low productivity of pastures was the disappearance of highly nutritious perennial grasses due to overgrazing. Technical solutions that were discussed by the Program Steering Committee centered on range management techniques, with some kind of enclosure practices. However, such techniques, which have been unsuccessfully tried in the past, are not appropriate in a situation where land is communal property while livestock is privately owned. Some political measures are needed before a technical solution can be introduced with any chance of success.

4.5 Step 5: Identification of Research Areas

A program and its corresponding subprograms (where applicable) consist of smaller units, referred to as research areas, themes, or projects. (Terminology varies from

Figure 5: Part of Tree of Objectives for the Olive Sector (Corresponding to Figure 3)



country to country.[20]) Whatever the terminology, we are referring to the next level of disaggregation under the program or the subprogram.

The areas of research emerge from an analysis of the tree of objectives. Each objective can be looked at as an overall objective of a research area or as the objective of an activity within a research area. There is really no right or wrong answer here, but some principles need to be kept in mind when making this decision.

1. A coherent grouping of activities with time limits should correspond to each area of research. The expected results, when combined, will provide a solution to a problem (or exploit an opportunity) in the agricultural sector. These activities form a coherent grouping in the sense that all are required to achieve the overall objective of the area of research.

2. The concept of a research area as an aggregation of activities designed to solve a problem of the agricultural sector corresponds to the reality farmers face. Farmers' problems are rarely one-dimensional, so a solution is likely to warrant a multidisciplinary approach. The research area provides a natural forum for scientists to interact around a common goal.

Returning to the example of the tree of objectives of Figure 5, the research objective "to develop appropriate harvesting techniques" has two sub-objectives:

a. to determine the appropriate harvesting date;

b. to test and adapt appropriate harvesting tools and equipment.

Here one can identify either a single area of research with two activities, or two distinct areas. The Committee decided it made little sense to identify two areas because both have some of the same effects: lower fruit quality and lower future production through inappropriate harvesting techniques. Both research results are needed to solve the problem.

When it comes to priority setting, it is more realistic and simpler to evaluate one area (taking into account all the activities aimed at improving harvest) than to try and distinguish between two areas. The latter method would run the risk of one of them not being considered for implementation.

The objectives should be as specific and quantified as possible, and should highlight the importance of the technology to be generated. The specific and quantified objectives of the area of research "harvesting techniques" are given as an example in Box 3. Quantified objectives form the basis for the evaluation upon completion of the research activities.

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20 In some countries, such as the Philippines, the programs are made up of research areas; a research area has projects, themselves made up of activities. In others, for example Burundi, the programs are made up of research themes, projects, and operations. In Morocco, programs are made up of projects, operations, and activities within operations. We have adopted the term "area" here. Once an "area" is selected for study, then researchers will design "projects" that correspond to these "areas of research". There is probably no terminology that is entirely satisfying. What is important to keep in mind is that a program is made up smaller units, whatever they are called.

Specific research activities must correspond to these detailed objectives. The committee must have an idea of the research activities in each area, including long-term activities, in order to determine researcher time and specialities needed (see below, section 4.6).

But the design of the project(s) corresponding to the areas of research is not done at the level of long-term program formulation. Project design is left to the researchers responsible for the project(s). In particular, they must determine a research strategy, since different research strategies may be feasible to achieve a particular research objective.

Socioeconomic and institutional constraints either can constitute an area of research or can be studied as an activity within a larger area of research. Even if no specific research activities are warranted, they still need to be considered when setting priorities among research areas, as these factors may hinder technology adoption (See section 3.7).

4.6 Step 6: Program Costs and Human Resource Gap Analysis

4.6.1 Program Costs

An estimate of program costs may be based on the number of scientists needed. First, the share of a research-year per calendar year required to carry out each activity in a research area is determined. The duration of the activity is also determined. The aggregate of research-years across different areas gives the total research-years needed per calendar year for the program. Given the duration required by each area of research, the total number of research-years to complete the program is known.[21]

Then, norms for operating funds and for support staff per scientist can be used to calculate the level of annual funding necessary to carry out all the activities.[22] Of course, this excludes any special equipment that may be required. That has to be identified separately. The total costs of scientists' time, support staff, operating expenses (calculated using a norm per scientist), plus any special equipment, will give a fairly accurate idea of the long-term program cost.

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21 A full time researcher is not equivalent to one research-year as time is spent on other duties, such as management, teaching, liaison with extension services, etc. In Morocco, it is estimated that a full-time researcher spends about 70% of his/her time on research.

22 A norm can be determined by evaluating the current funding situation of various projects and programs in-country which may receive different levels of funding and staffing. Such a comparison can help determine an appropriate and sustainable level of funding per scientist. Also, different kinds of research activities have different operating costs: for example, the per scientist cost of livestock research or on-farm research will be higher than the cost of on-station agronomic research, but less than the cost of biotechnology.

BOX 3: OBJECTIVE AND OPERATIONS

Area of Research: Improved Harvesting Techniques.

Objective

To develop appropriate and cost-effective harvesting techniques. These would include determining an optimal harvesting date and optimal harvesting tools and equipment, taking into account tree stature and orchard topography. The techniques should lead to an improvement of fruit quality (measured by a 5% increase of the share of table olives of total production in the irrigated and extensive production systems) and a 10% increase in future production. A 10% increase in future production due to better harvesting techniques is a plausible "guess mate".

Activities

1. Determining an optimal harvesting date in the Haouz region.
2. Determining an optimal harvesting date in the Sais region.
3. Confirming the results of experiments in manual harvesting with nets in various regions.
4. Adapting mechanical harvesting to Moroccan agroecological conditions.

4.6.2 Analysis of the human resources needed to carry out the program

The number of research-years for the whole program is determined as described above. It is based on the percentage of a research-year needed for each activity. This percentage should be the minimum required to produce results. Research-years are identified for each discipline and, if possible, for each level of expertise. The location of each area of research (which experimental station or laboratory) is also identified.

Aggregated for the entire program, this information gives the total number of researchers needed if all areas of research are taken on, and the mix of disciplines and the level of qualifications needed by location.

The research area mentioned above, "Harvesting Techniques", requires 0.2 of a research-year of an agronomist and 0.1 of a research-year of a socioeconomist, for a duration of four years. Therefore it costs 1.2 research-years. It will be located at the Regional Center of Marrakech.

4.6.3 Analysis of existing human resources

The objective is to determine the number, discipline, and qualification of existing researchers, the percentage of their time presently spent on the program, and their location.

This analysis concerns all human resources in the country, related to the program. This nationwide analysis should be done even if the program under consideration is not national but institutional. Taking into account the human resources available in other institutions (universities, ministries, parastatals, and the private sector, if applicable) will result in the design of a research program whose activities complement those of other national institutions.

4.6.4 Gap analysis

People are the most important resource of a research system, as well as the most limiting. Training staff takes time and redeployment is never easy, so research institutes often have difficulty responding to change.

The comparison between existing and desirable resources highlights the human resources gap, in terms of number of researchers, disciplines, and level of training for each location where research activities should be taking place.[23]

Figure 6 and Table 3 in the Annex, show the result of the gap analysis for the Olive Program, by disciplines, as it relates to the Marrakech Regional Center. For example,

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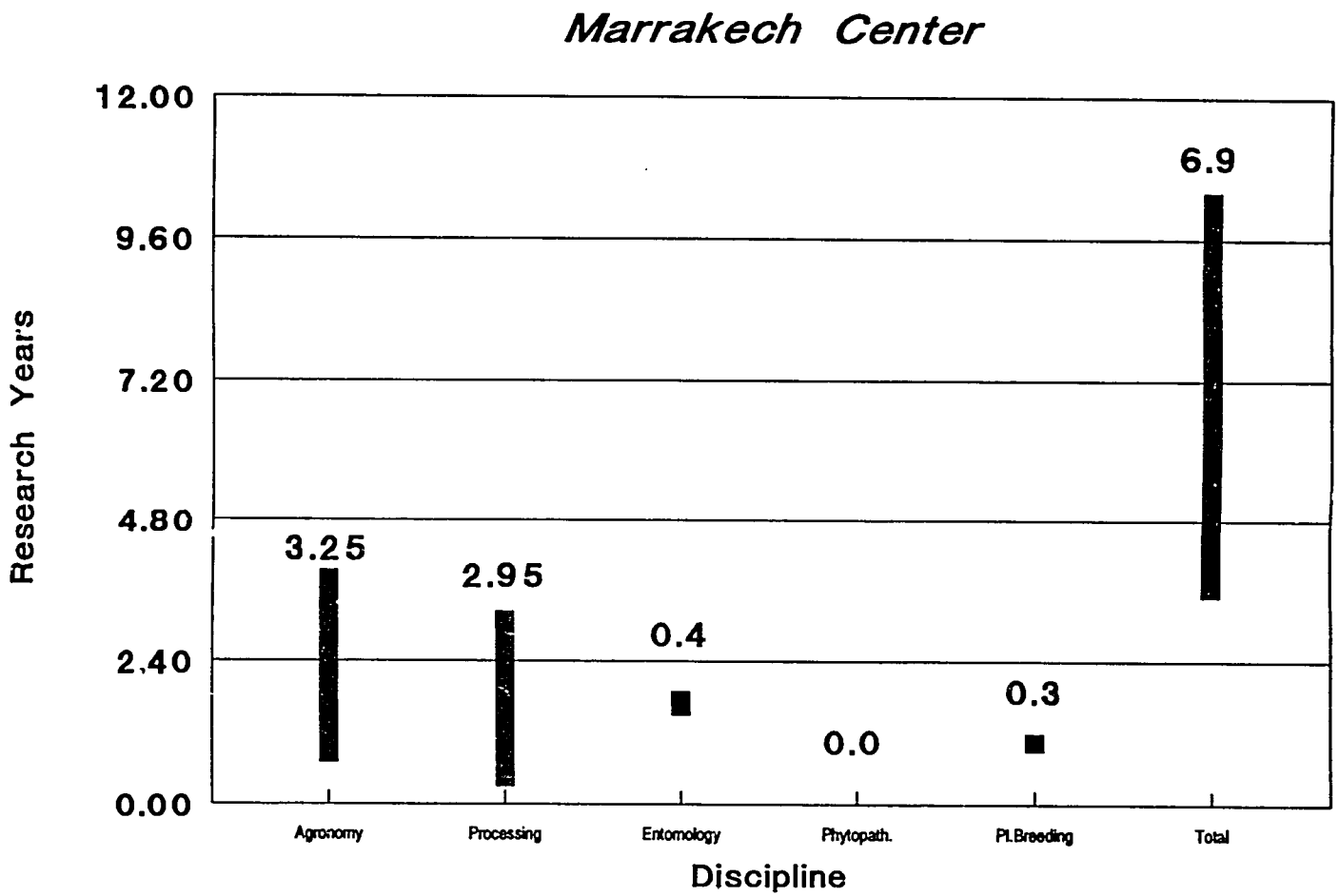
[23] Once priorities have been set, this information constitutes the basis for the design of a human and physical resource development plan.

FIGURE 6: RESEARCH YEAR GAP



four research-years of agronomy would be needed in Marrakech, but at the present only 0.7 is available. Therefore, there is a 3.3 research-year gap in agronomy in Marrakech. If all the research areas identified were taken on, the program would need an additional 14.7 research-years. But the Olive Program is unlikely to get more than seven additional researchers, which represents approximately five research-years. Therefore, not every area can be considered for implementation.

In Morocco, policymakers had indicated the number of additional scientists that would be made available to the programs. In other countries, policymakers might not be able to do this. (They may be waiting for information from committee members about essential activities and required resources, before they can finalize resource allocation.)

In either case, priority setting becomes necessary. In the first case, the human resources available for the program are likely to limit the number of research areas that can be taken on. Even if all projects are potentially beneficial, a choice has to be made according to their contribution to national development objectives.

Priority setting is also necessary in the second case, where policymakers are awaiting an indication of priorities among all desirable research activities, to determine the level of resources to be allocated to the program.

4.7 Step 7: Priority Setting Procedure

A number of priority setting procedures are available.[24] The one outlined below is based on the criteria outlined in section 3.4.1.

Whether one procedure is more appropriate than another depends, first of all, on whether it is used for priority setting at the policy or the program level. Secondly, some priority-setting procedures demand more data, are more time consuming, and require a higher level of skill than others. Therefore, choosing one priority-setting procedure over another depends on the country's particular circumstances.

The procedure presented here was inspired by the scoring model developed by George Norton at a number of priority-setting exercises in the Dominican Republic, Ecuador, Uruguay, The Gambia, and Bangladesh.[25] Norton's model was developed to set priorities among programs. Here it is adapted to set priorities within programs.

As outlined in section 3.4, priority setting within programs is different from priority setting among programs. To recap, at the policy level, criteria to measure the contribution of research to the three objectives (efficiency, distribution and security) are formally integrated into the priority-setting model. At the program level, the most

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24 Contant and Bottomley (1988). Most of the existing ones are best used at the policy level to set priorities between programs, with the exception of the cost/benefit method proposed by Contant and Bottomley, which can be used to set priorities within programs.

25 Pardey and Norton, forthcoming; Ceesay et al., 1989; Norton 1987.

important objective is the efficiency objective. The distribution and security objectives do not enter into the formal calculation because these issues have been settled at the policy level.

The ranking of research areas proposed here is based strictly on the efficiency index. This does not mean the national objectives for security and distribution should be ignored by the Program Steering Committee. They must be discussed in detail and taken into account when determining research objectives and types of technologies to be developed.

The criteria for efficiency have been presented in section 3.4 and are included in the procedure proposed here.[26] They are:

- importance of the problem;
- rate of technology adoption;
- probability of research success;
- effect of technology on the environment;
- research costs.

Evaluating the importance of the problem is not always easy as data on the affected areas and yield losses caused by the problem are not always available. Or, data on the productivity increase or per-unit cost reduction that can be expected as a result of adopting a particular technology are often not available. In some cases, data on affected areas may be available, but the yield loss caused by the particular problem may not be.

In such a situation, evaluating the benefit to be gained from alleviating the problem can be done in two steps:

a. Calculate the value of total potential production increase (corresponding to yield improvements) or of inputs saved (corresponding to per-unit cost reduction) for the commodity for the agroecological zone. Such data are gathered and reviewed under Step 1.

b. Estimate the importance of alleviating a particular constraint for achieving the total potential production increase. This estimate is a composite of the estimate of area affected and potential yield increase.

The way to combine the criteria is given by the following calculation:

$$\text{Area Score} = \frac{V \times P1 \times P2 \times P3 \times A}{C}$$

where:

[26] Except for the criteria related to the use of the scarcest production factor. The members of the Program Committees we worked with did not feel confident that they understood this criteria well enough to rate each area of research against it.

V = Net value of the potential production increase for the commodity in the agroecological zone under consideration, expressed in monetary units;

P1 = Importance of the technology to achieve this potential (in %);

P2 = Adoption rate of the technology (in % of the total area under the commodity);

P3 = Probability of research success (in %);

A = Adjustment, to take into account negative or positive environmental effects;[27]

C = Research costs.

In most cases, it is impossible to calculate the net value of the production increase as future production costs associated with the technologies to be developed can rarely be estimated. Sometimes even present production costs are unknown, except for a few well-studied crops, most often cash crops, for which data are regularly collected and analyzed.

In such a case, the gross value of increased production can be used instead, but with caution. It must be kept in mind that not being able to take into account production costs will bias the scores towards irrigated over rainfed production for a given commodity. However, production costs can be taken into account to a certain extent through the adoption rate, as the cost of implementing a technology will affect its rate of adoption.

A scale has to be chosen at the beginning of the priority-setting exercise for P1, P2 and P3. No more than three or four levels should be allowed, since attempting to achieve greater precision is meaningless.[28] The tree of constraints (Step 2) provides valuable information for assessing potential adoption rates. It highlights the relationship between technical and socioeconomic constraints.

After the scale was agreed upon, the values for P1, P2, P3, and A for each research area were obtained either by consensus, by delphi technique, or by a rating from each participant. Large discrepancies were discussed and an average was calculated.

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27 0.9 : the technology may have negative effects on the environment;
1 : the technology is neutral;
1.1 : the technology is expected to have positive effects.
If the criteria for the use of the scarcest production factor had been included, it would have been treated as an adjustment:
0.9: for a technology that will use the scarcest production factor more than in the present situation;
1 : for a neutral technology vis a vis this criteria;
1.1: for a technology that saves on the scarcest production factor.

28 For the Moroccan Olive program, it was agreed that if a technology is expected to be "well" adopted, then it will be adopted on 75% of the area; 25% if it is poorly adopted, and 50% if it is average. Similar choices have to be made for the levels of probability of research success and the importance of the constraint. 75%, 50% and 25% corresponded to a high, medium and low chance of success of research activities respectively, while .7, .5., and .2 corresponded to the relative importance of the constraint.

For research costs, as discussed under Step 6 of the method, a good proxy is the number of research-years needed to obtain results in the area. Therefore, the research-area score corresponds to an annual gross benefit per research-year at the peak of adopting the technology.

A simple computer program has been designed to calculate the score of each area and rank them according to this score. Table 1 and Figure 7 show the scores and ranking for the Olive Program of Morocco using the above formula.[29] Given that only five additional research-years will be available, and taking into account the amount of scientist time needed for each area, only the first 19 areas of research (out of 36) can be considered for implementation.

The values of potential production increase and research costs have already been determined in Steps 4 and 6. So there is minimal added work needed to set priorities. It involves evaluating research areas by importance of the constraint, technology adoption, probability of research success, and effect on the environment. It takes about a day of work for the participants to rate all the areas of their program.

This procedure allows everybody to participate as it does not require any special skills. Everybody can master the concepts used and do the calculations. Above all, the final score of a research area is easy to understand and transparent because the criteria used are kept explicit throughout the ranking.

4.8 Non-Commodity Program Formulation

It may prove easier to begin program formulation with commodity programs. The basic elements for the non-commodity programs will begin emerging from the analysis already done for the commodity programs. The Moroccan NARS, for example, has 14 programs -- 12 commodity and two system-based -- for specific agroecological zones, the arid and semi-arid zone and the Saharan oasis. The design of the Aridoculture program, in particular, was made much easier by first analyzing the constraints under the commodity programs for the major commodities of concern. (In the arid zone, these are cereals, forages and small livestock.)

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[29] Here is an example of how a score is calculated using the procedure outlined above: the area of research "methods to control dacus" in the irrigated system ranks first and its score is obtained through the above formula, where
V = 100 000 000 Dirhams (Gross value of potential increased production in the irrigated system).
P1 = .5 : (The constraint is of average importance.)
P2 = .75 : (The adotion rate of the technology is likely to be high.)
P3 = .75 : (The probability of research success is high.)
A = 1 : (The technology is neutral vis-à-vis the environment.)
C = 1.6 : (.4 of a research-year during 4 years.)

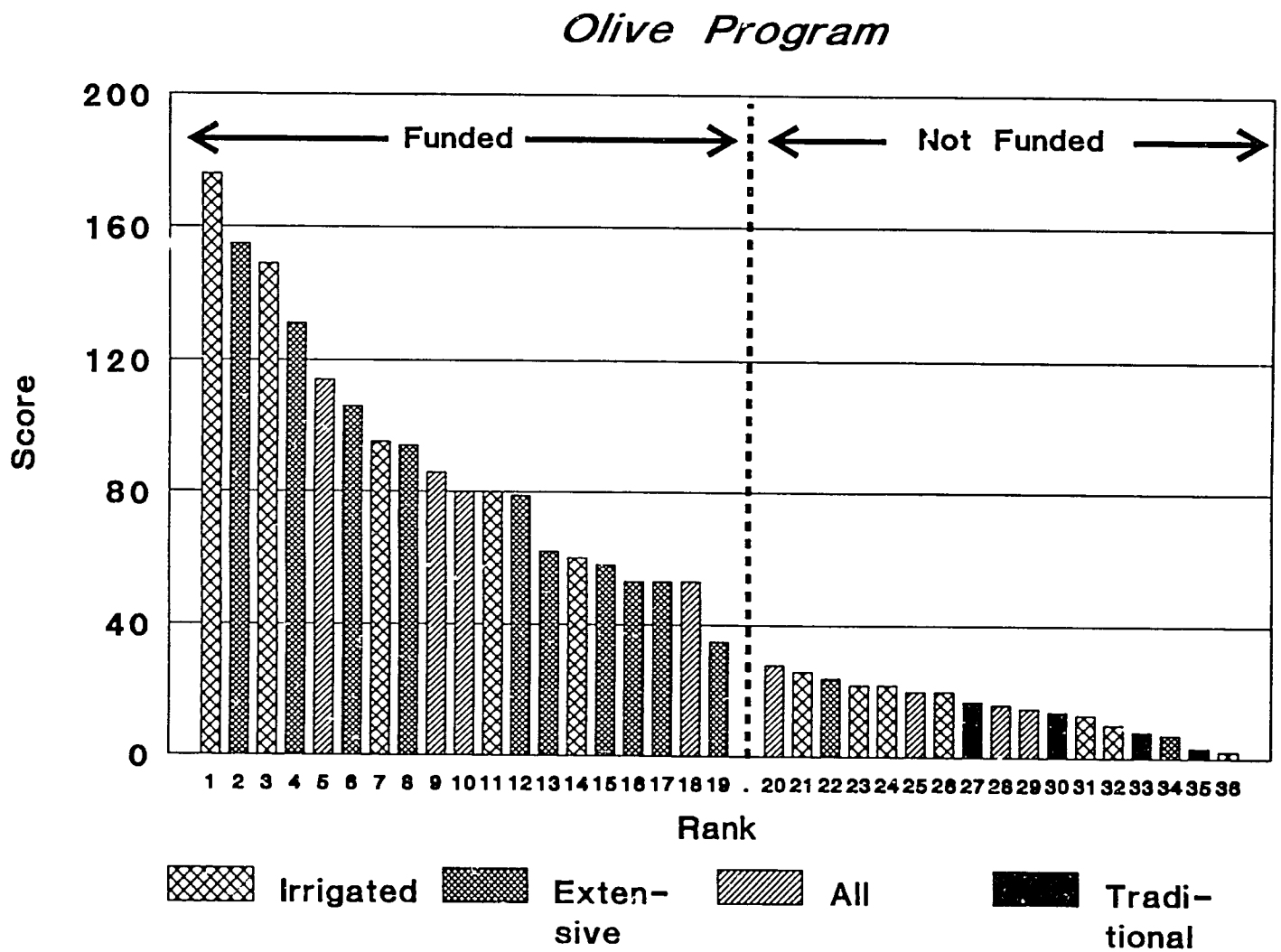
Score = 17,600,000

TABLE 1: PRIORITIES AMONG RESEARCH AREAS OLIVE PROGRAM

RANK	AREA OF RESEARCH	SYSTEM	SCORE
1	Methods to control "dacus"	Irrigated	176
2	Optimal tree spacing	Extensive	155
3	Methods to control "teigne"	Irrigated	149
4	Methods to control "teigne"	Extensive	131
5	Harvesting techniques	All	114
6	Soil cultivation techniques	Extensive	106
7	Methods to control "psylle"	Irrigated	95
8	Methods to control "dacus"	Extensive	94
9	Propagation techniques	All	86
10	Extraction technology	All	80
11	Nitrogen nutrition	Irrigated	80
12	Nitrogen nutrition	Extensive	79
13	Methods to control "psylle"	Extensive	62
14	Irrigation technology	Irrigated	60
15	Intercropping systems	Extensive	58
16	Clonal selection	Extensive	53
17	Selection of adapted varieties	Extensive	53
18	Fruiting in alternate years	All	53
19	Integrated pest management	Extensive	35
20	*Technologies for preserving olives*	*All*	*28*
21	*Integrated pest management*	*Irrigated*	*26*
22	*Root-stocks*	*Extensive*	*24*
23	*Selection of adapted varieties*	*Irrigated*	*22*
24	*Clonal selection*	*Irrigated*	*22*
25	*Olive sector profitability*	*All*	*20*
26	*Soil cultivation techniques*	*Irrigated*	*20*
27	*Methods to control "psylle"*	*Traditional*	*17*
28	*Oil quality standardization*	*All*	*16*
29	*Utilization of by-products*	*All*	*15*
30	*Methods to control "teigne"*	*Traditional*	*14*
31	*Intercropping systems*	*Irrigated*	*13*
32	*P.K. nutrition*	*Irrigated*	*10*
33	*Methods to control "dacus"*	*Traditional*	*8*
34	*P.K. nutrition*	*Extensive*	*7*
35	*Soil cultivation techniques*	*Traditional*	*3*
36	*Root-stocks*	*Irrigated*	*2*

Italics indicate those areas of research for which there are no resources available for implementation.

FIGURE 7: PRIORITIES AMONG RESEARCH AREAS



But a system's program is more than a collection of research areas related to the commodities in the zone. It specifically addresses the constraints emerging from the interaction among the agricultural activities in the system. In the Aridoculture program, five subsystems were identified, all of them having small ruminants and a crop rotation of one of the following groups: 1) wheat/cereal; 2) wheat/fallow; 3) wheat/legumes or maize; 4) barley/fallow; 5) natural pasture.

In the wheat/legumes subsystem, one of the constraints identified was the negative effect that the low frequency of leguminous crops in the rotation had on wheat productivity. This is a typical example of a system constraint rather than a commodity constraint.

5. PROGRAM PLANNING PROCESS

The method was designed specifically to be used by Program Steering Committees in the design of long-term programs.[30] The term "Program Steering Committee" is used as a generic term for an organizational device whose function is planning, monitoring, and evaluating a program. In what follows, we will:

a. review the function and membership of a Program Steering Committee;

b. analyze the rationale for directly involving such a Committee in program formulation rather than leaving the responsibility to a planning unit; and,

c. indicate how to use the method.

5.1 The Functions and Membership of the Program Steering Committee

As mentioned earlier, program planning presupposes the scientific organization of research into programs, by commodities, themes, production factors, or systems. Each program is monitored by a Program Steering Committee presided over by a program leader or coordinator.

A Program Steering Committee is an institute-level organizational device. It is different from a Research Policy Committee at the interministerial level, whose function is to prepare policy guidelines for the whole national agricultural research system. It also differs from a technical group at the station level, which can assist a team of researchers to prepare details of a research project proposal or an annual work program and budget.

However, a Program Steering Committee's work is not carried out in isolation from the work of the Research Policy Committee. It takes its guidelines from the Policy Committee and provides that committee with technical information about program content.

A Program Steering Committee provides a forum where researchers and their clients can interact. The clients of agricultural research are those groups that will directly use the research results: the producers in all sectors; the ministries concerned with agricultural planning and development; other researchers; and extension personnel. In addition, there are groups that will not use the research results directly, but will be concerned with

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30 Program Steering Committees can be found under a host of different names: Program Commission, Commodity Panel or Team (Philippines), Comité par Programme (Burundi), Comité Sectoriel (Morocco), etc. One has to be careful, though: sometimes these words are used for a different organizational device altogether. In Cameroon, for example, le Comité de Programme is a subcommittee of the Board of Governors of the Institute. For a discussion of the function, membership and structure of Program Steering Committees, see in particular Dagg and Hayworth (1988) and Arnon (1989: 387-391).

the adoption of research results, such as enterprises involved in the export or processing of agricultural products.

The functions of a Program Steering Committee are to:

a. identify the needs of the clients (vis-à-vis the commodity or the production system) and translate these into research objectives;

b. determine priorities within the program and allocate resources accordingly, within the framework provided by policy guidelines;

c. review the long-term program document based on (a) and (b);

d. review research proposals formulated by researchers in accordance with the long-term program;

e. monitor and evaluate research results at various intervals: annually, as part of the programming cycle; short-term (approximately three years); and medium-term, as part of the preparation of an Action Plan;

f. review the research results that are ready for dissemination;

g. provide a communication channel for all parties concerned with the program: research institutions, universities, ministries, development agencies, farmers, and the private sector, if applicable.

In order to perform these functions, the members should represent the various groups in the agricultural sector that have a stake in the activities and in the expected results of a research program. These are (Figure 8):

1. research institutions and universities and any other institution, including those in the private sector, that have research activities in the same area;

2. extension services;

3. parastatals and/or private sector companies (dealing with agricultural inputs, marketing of output and export);

4. ministries dealing with agriculture;

5. producer groups, including processing industries, whenever possible.[31]

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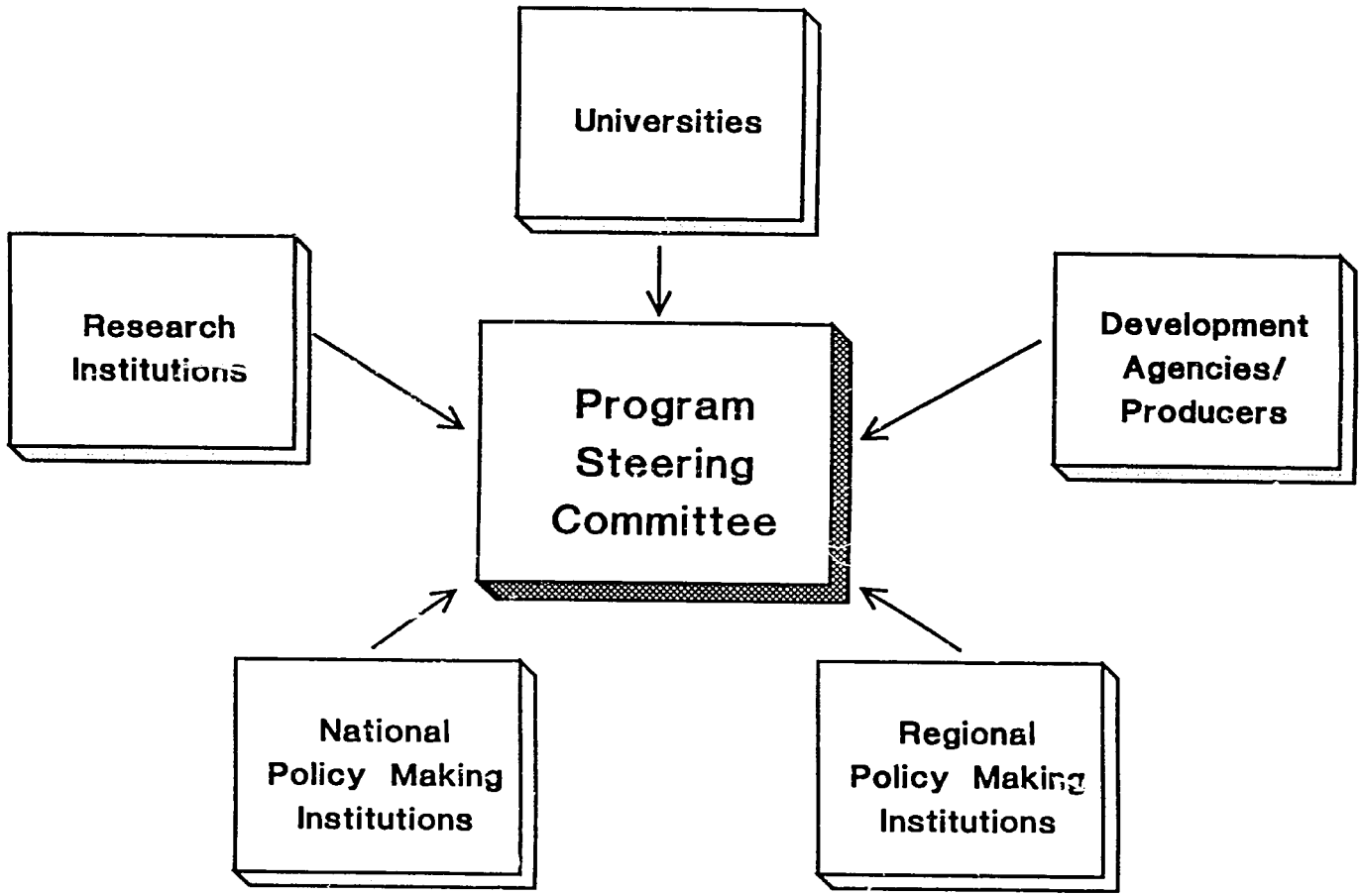
[31] Including producer representatives on Program Committees may not always be easy, except when representative farmers organizations exist. There are relatively few developing countries with such organizations. Where they do exist, they tend to be large-scale producers, or export growers, who do not represent the wide spectrum of farmers. In addition, having farmers on the Program Steering Committees may be a token representation, as social and cultural barriers between farmers and the rest of the members are likely to hinder their participation. However, farmers' representation is by no means the only way to ensure that farmers' concern find their way into program formulation. Farmers' concerns can be brought in by on-farm researchers, extension-agents, PVO's agents (Private Voluntary Organization), etc.

FIGURE 8: COMPOSITION OF A PROGRAM STEERING COMMITTEE



The leadership of the Program Steering Committee is best vested in a research institution (e.g., INRA in Morocco). The representatives of the research institutions and universities are senior researchers or research managers. The ministries, extension services, and parastatals should be represented at the directorate level.

For the purpose of program planning, the participants should be a careful mix from national and regional levels. It is also essential for the committee to be multidisciplinary and include rural sociologists and agricultural economists. Social scientists provide much needed insights into the socioeconomic constraints that farmers face. In addition, agricultural economists are needed to translate the information discussed during program planning workshops into an analysis directed at the policymakers, such as the one presented in Box 2 for the olive sector. It may happen that neither the program nor the research institute has any social scientists. In such cases, an economist from the ministries dealing with rural development and a sociologist from a technology transfer agency should be co-opted.

It should be noted that a Program Steering Committee does not belong to the organizational structure of a research institution (i.e., to its hierarchy). It has an advisory role to the organizations carrying out research for the content of the programs.

5.2 Program Committee or Planning Unit?

The method is intended for use by the type of committee described above, rather than by a Planning Division or Unit. Obviously, if Program Steering Committees do not exist and if it is not feasible to establish them, the present method can be used by planning units. Whether the task is performed by the former or the latter, the end product is the same -a planning document. But without the involvement of scientists and other stakeholders in its design, many of the method's advantages will be missed, as we shall see below. This by no means implies that a Planning Unit does not have an important role to play (see section 6).

To strengthen program planning, better links are needed between research objectives and economic and agricultural development objectives, on one hand, and the needs and adoption capabilities of research users, on the other. Technically speaking, the Planning Unit staff can do this by consulting the clients of the program on constraints that should be addressed. With this information, plus the national development objectives, the planning unit can determine research objectives and priorities.

However, it is preferable for a Program Steering Committee to be in charge, where all the parties with a stake in the program -- whether researchers or research users -- take part in analyzing the constraints and determining research objectives and priorities. The process is participatory rather than consultative, ensuring as thorough and systematic account as possible of all aspects of the problems. It also provides a forum for research to improve its responsiveness to development needs.

Other major advantages of direct participation by all concerned parties, rather than just consulting them, are that:

a. it enables them to build the commitment necessary for program implementation at a latter stage;

b. it provides a structured framework for two-way communication between groups and institutions that do not communicate easily.

Nonetheless, relying on a Program Steering Committee is not without problems. Its output will reflect the knowledge and competence of its members. A poorly qualified Program Steering Committee will produce a poor analysis, no matter how useful its planning tools.

Also, if the method is to provide optimum results it requires a multidisciplinary approach and opinions reflecting a wide range of interests. Both are hard to come by. Social scientists, for example, are poorly represented in the field of agriculture.

The greatest difficulty, though, is to get non-researchers to devote a few days to a workshop on program planning.

Their presence is important. To involve ministry and development agency representatives in formulating program activities and setting priorities helps build political support for implementing and financing programs. In addition, ministries and other agencies involved in agricultural development planning and implementation can grow acquainted with the socioeconomic and institutional conditions needed for a favorable environment for technology adoption.

Such a panel as the Program Steering Committee, representing a wide range of interests, can provide a solid assessment of the development objectives. This can greatly contribute to agricultural development planning and policy-making.[32]

This aspect of linking researchers with policymakers is sometimes overlooked. Winning political support for research funding often attracts all the attention. But research can provide more than technology towards the development of agriculture. It can and should provide valuable input to the design of agricultural policies. For this to happen, linkages between researchers and policymakers must function effectively. Program planning through a program Program Steering Committee is an opportunity for fostering such linkages.

Involvement of scientists in the committee is crucial. Scientists have a vested interest in their subject matter, with years of commitment and professional recognition at stake. In science, top-down directives, particularly those dealing with reallocation of scientists'

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[32] This aspect did not escape the Moroccan Minister of Agriculture who, on becoming aware of the content of the exercise and the stakes involved, recommended a staff member from his Division of Planning and Economic Affairs to participate in all future program planning workshops.

efforts, will not be implemented without serious distortion unless scientists have been involved in the decision-making process.

In evaluating program planning workshops held in Morocco that used the present method and process, scientists appreciated the fact that program activities were not dictated by INRA's management, but rather were the result of the Program Steering Committee's analysis -- their analysis -- applying a systematic and logical method and coming to a consensus on research priorities.

Setting research activities in the overall framework of the national objectives, together with non-researchers, shows the researcher his/her social role: his work has a value, no matter how small, that contributes to the achievement of overall national objectives. Again, in their evaluation of the planning method and process in Morocco, the scientists were quite sensitive to this aspect of the process.

Finally, this process of program planning provides a framework for conceptualizing research activities in a team and system perspective. Again in Morocco, researchers highly valued the exercise in that it enabled them to see their work in relation to that of other scientists.

5.3 Role of the Planning Unit

The planning unit manages the process and acts as the technical secretariat for the Program Steering Committee. This involves:

1. Preparing the workshops and meetings of all the Program Steering Committees.

2. Collaborating with the program leaders, collecting and processing the information to be analyzed or used by the Program Steering Committees.

3. Assisting the program leaders in writing the program document.

4. Ensuring coherence and consistency among programs.

5. Assembling all the long-term program documents as the basis for a long-term resources development plan.

6. A GUIDE TO THE USE OF THE METHOD

The different steps of the method are dealt with during Program Steering Committee workshops, prepared by the program leader and staff from a planning unit, if one exists.

Two workshops, both of three days' duration, are necessary. The period in between the meetings is used for write-up and consultation.

6.1 The First Workshop

The objective of the first workshop is to review the sector of concern in the program, analyze the constraints, review research results, and determine research objectives (Steps 1 to 4 of the method). The workshop needs to be carefully prepared beforehand by collecting and processing information for review of the sector, development objectives (Step 1) and the state-of-the-art research (Step 3). Personnel involved in the preparation of baseline documents or presentations to the Program Steering Committee are:

- the Program leader;
- staff from the planning unit of the research institute(s) (if any);
- staff from the planning unit of the Ministries dealing with agriculture who are members of the Program Steering Committee;
- other senior scientists from the Program Steering Committee, in particular to provide the state-of-the-art research in the area concerned.

During the first workshop the members of the Committee:

- review the situation of the sector based on presentations prepared as described above;
- analyze the constraints using the tree of constraints as a tool for group analysis;
- review the state-of-the-art research, again on the basis of presentations;
- determine research objectives using the tree of objectives as a tool.[33]

If the members of the Program Steering Committee lack expertise in a particular area, then the temporary addition of an outside expert should be considered. An outside person may bring with him/her new ideas or new ways of thinking or attacking problems. This is important as the design of long-term programs should give Program Steering Committee members an opportunity to think strategically about critical issues facing the area of concern of the program.

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[33] This method is followed in particular by GTZ to run ZOPP workshops (ZOPP = Goal Oriented Project Planning).

6.2 Use of Visualization Techniques

Managing group discussions, especially when it comes to analyzing constraints, may be quite difficult. Visualization techniques can prove very useful for focusing discussions and ensuring rapid progress. In this technique, everybody writes his/her ideas on cardboard. The discussion leader then assembles the ideas by theme on a display board. Each idea is discussed and retained as is, adjusted, or discarded.

Visual aids have proven particularly useful in conducting program planning workshops in Morocco and Mali. They helped to:

- focus the discussion and prevent circular arguments;
- ensure all important ideas were considered;
- give each member an equal chance to participate in the discussion;
- obtain a consensus without certain individuals dominating the debate.

6.3 Activities between the Two Workshops

The analysis produced by this first workshop is the basis for the write-up of the first four sections of the long-term program document. The write-up is organized and coordinated by the Program leader, with the help of the planning unit. This first part of the document is circulated among members of the Committee as well as outside players for more comment.
Between the two workshops, scientists meet to:

- identify research areas and the corresponding activities on the basis of the research objectives;
- determine the human resources needed per research area and expected duration.

An inventory of all scientists in the country working on the topic, with the percentage of their time devoted to it, is prepared.

6.4 The Second Workshop

The second workshop brings back all the members of the Program Steering Committee, in order to:

- review and comment on the first part of the program document (up to step 4);
- review the research areas identified by the scientists;
- set priorities.

The final step is to determine the number of research areas, in order of priority, that can be considered for implementation. If the allocation of human resources to the program has already been established, then the areas of research, along with their human

resources, can be ranked in priority order. Priorities determine which research areas will be included for implementation.

If, as is often the case, the resources still have not been allocated among programs, then the planning unit aggregates the documents from all the long-term programs. Each program document gives the priorities among research areas, together with their number of research-years. Based on these priorities and on other socioeconomic data, policymakers will allocate resources among the programs. Once the level of resources is known, each Program Steering Committee can determine the research areas to be considered in their program.

These program documents also serve as the basis for preparing a human and physical resources development plan at the institute level.

7. SUMMARY AND CONCLUSIONS

The purpose of this paper was to present a program planning method and a procedure for setting priorities within programs.

It is recommended that a Program Steering Committee rather than a planning unit use the method. The rationale is that some of the key elements of the method, such as the analysis of constraints, determination of research objectives, and priority setting, are best done through direct participation rather than through consultation. Direct participation builds commitment to the results and to decisions on a program's priority activities. Such commitment is important to guarantee later implementation. The scoring process proposed for priority setting also requires full participation.

The method was designed to address some common deficiencies frequently found in research programs. It aims to improve the link between research objectives and agricultural development objectives, and to improve the relevance of research programs to the needs and adoption capabilities of farmers. It involves a review of current research activities, priority setting, and a gap analysis of human resources.

The iterative process between the various levels of planning and priority setting should be emphasized. The method presupposes that the main programs (commodities and research areas) have already been defined at the policy level and that resources have already been broadly allocated between programs.

However, the program's scope can vary depending on the number of objectives and type of research strategy. The appropriate scope to be given to a program cannot be completely determined until a global view of the whole national research portfolio is obtained through a similar analysis for all programs. At this stage, given the overall resource availability and the priorities between programs set at the policy level, it is possible to determine the appropriate level of resources to allocate to each program.

In this way, designing programs and determining their appropriate scope provides the necessary input for adjusting the allocation of resources <u>among</u> programs at the policy level.

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ANNEX

TABLE 1: MAIN CHARACTERISTICS OF OLIVE PRODUCTION SYSTEMS

SYSTEM	AREA		DENSITY	YIELD		PRODUCTION	
	in Ha	in %	Trees/Ha	Kg/Tree	Kg/Ha	Tons of Olives	% Total Prod.
Traditional	60,000	16.8	100	5	500	30,000	7.9
Extensive	260,000	72.8	100	10	1,000	260,000	68.4
Irrigated	37,000	10.4	145	15	2,250	80,000	23.7
TOTAL	357,000	100.0		--	--	370,000	100.0

TABLE 2: SYNTHESIS OF THE PRESENT SITUATION AND OBJECTIVES

	PARAMETERS	SITUATION 1988		OBJECTIVES HORIZON 2000	
1.	**Population**	25 million inhabitants		32 million inhabitants	
2.	**Consumption Oil/Person**				
	- Olive	1.5 kg		2.0 kg	
	- Other	10.0 kg		10.0 kg	
3.	**Oil Demand Covered by:**	287,500 t		384,000 t	
	- Imports	207,500 t	(71%)	160,000 t	(42%)
	- Grain Oil Production	43,000 t	(15%)	160,000 t	(42%)
	- Olive Oil Production	40,000 t	(14%)	64,000 t	(16%)
4.	**Production**				
	a) Traditional:				
	Yield/ha	500 kg		600 kg	
	Production	30,000 t		36,000 t	
	b) Extensive:				
	Yield/ha	1,000 kg		1,250 kg	
	Production	260,000 t		320,000 t	
	c) Irrigated:				
	Yield/ha	2,200 kg		3,500 kg	
	Production	80,000 t		130,000 t	
5.	**Destination**				
	a) Table Olives:				
	Consumption 1.7kg/per	42,000 t	1.8 kg/p	57,000 t	
	Exports	37,000 t		50,000 t	
	Total:	**79,000 t**		**107,000 t**	
	b) Oil Production:				
	Olive Oil Prod. 15.7%	40,000 t	at 18%	64,000 t	
	Losses	37,000 t	(10%)	24,000 t	(5%)
	NET PRODUCTION	333,000 t		462,000 t	

TABLE 3: SCIENTIST NEEDS BY CENTER AND SPECIALITY
(in Research Years)

SPECIALITY	CENTER	NEEDS	AVAILABLE1	GAP
Agronomy	Marrakech	3.95	.70	3.25
	Meknès	2.65	0.30	2.35
	Total	6.60	1.00	5.60
Processing	Marrakech	3.25	0.30	2.95
	Meknès	1.50	0.00	1.50
	Total	4.75	0.30	4.45
Entomology	Marrakech	1.90	1.50	0.40
	Meknès	2.30	0.00	2.30
	Total	4.20	1.50	2.70
Phytopathology	Marrakech	0.10	0.10	0.00
	Meknès	0.10	0.10	0.00
	Total	0.20	0.20	0.00
Plant Breeding	Marrakech	1.20	0.90	0.30
	Meknès	1.10	0.45	0.65
	Total	2.30	1.35	0.95
Economics	Meknès	1.00	0.00	1.00
TOTAL	Marrakech	10.40	3.50	6.90
	Meknès	8.65	0.85	7.80
GENERAL TOTAL		19.05	4.35	14.70

(1) Available nationwide