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TAC'S APPROACH TO CGIAR PRIORITY ASSESSMENT

(Agenda Item 5)

<u>Objectives of the Discussion</u>

This paper provides a discussion of TAC's approach to the evaluation of CGIAR priorities as a continuing activity, the monitoring of the implementation of agreed CGIAR priorities and strategies, and the assessment of the impact of research activities supported by the CGIAR.

TAC is invited to review the document and to provide comments so that the paper can be finalized and submitted to the CGIAR for discussion at ICW 1988.

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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1. Introduction

In its "Review of CGIAR Priorities and Future Strategies" TAC (1987 a) established priorities to guide the long-term strategic planning of the CGIAR System, the development of its programme structure, and the relative emphasis in resource allocation among commodity improvement programmes. These priorities must, at regular intervals, be reviewed and the evaluation of CGIAR priorities has become a continuing activity of TAC. The process of priority assessment incorporates not only priority setting, but also monitoring the implementation of agreed CGIAR priorities and strategies, and an appraisal of the impact of activities supported by the CGIAR (TAC, 1987 b).

In making recommendations on CGIAR priorities and strategies, TAC operates at two major levels. At the ex ante level, the Committee evaluates and sets CGIAR priorities for the allocation of resources across the System, to enable an appropriate balance among Centres, problem classes, commodities and regions. It also evaluates proposed new initiatives or activities as to their consistency with these priorities, and their recommended level of funding. At the ex post level, TAC monitors the implementation of agreed CGIAR priorities. TAC's discussions are guided by considerations related to the actually achieved and anticipated potential impact of Centre activities, emerging trends in world agriculture, and capacities of national research systems.

This paper reviews the approach TAC will take in CGIAR priority assessment as a continuing process. The mechanisms of this approach cannot be seen in isolation of the goal the CGIAR wants to achieve. The CGIAR goal and objectives are therefore outlined first, followed by a discussion of the needs for monitoring of the implementation of CGIAR priorities and impact assessment. The information needs for priority assessment are summarized. The paper then evaluates available quantitative methods for priority assessment. Finally, some recommendations are made concerning the use by TAC of quantitative methods for priority assessment. A tentative work programme until the end of 1989 is also discussed.

2. Goal, Objectives and Strategies of the CGIAR

An assessment of CGIAR priorities is to be undertaken within the framework of its goal. The CGIAR goal statement is comprehensive and covers the interests of both producers and consumers:

> "Through international agricultural research and related activities, to contribute to increasing sustainable food production in developing countries in such a way that the nutritional level and general economic well-being of low-income people are improved."

To achieve the general goal, the CGIAR works to a framework of eight objectives into which the activities of the Centres can be categorized. These objectives are:

(a) Managing and conserving natural resources (e.g. land, water and genetic resources) for sustainable agriculture;

(b) Increasing the productivity of essential food crops with a view to integrating them into improved production systems;

(c) Improving the productivity and ecological stability of livestock production systems;

(d) Achieving, through improvements in post-harvest technologies, the more complete utilization of agricultural products in both rural and urban areas;

(e) Promoting better human health and economic well-being through improved nutritional quality of foods, enhanced equity in access to foods, expanded economic opportunities and better management of overall family resources;

(f) Improving the policy environment to ensure the formulation of rational agricultural and food policies which favour increases in food production and commodity productivity;

(g) Strengthening national agricultural research capacities in developing countries to accelerate the indigenous generation, adaptation and utilization of enhanced technologies; and

(h) Integrating efforts both within and among Centres of the CGIAR System and, equally important, integrating the CGIAR System's activities with those of its various partners in the global system.

The goal and objectives are consistent with the policies of most developing countries with which the CGIAR works as a partner in the global agricultural research system. This global system is composed of national agricultural research programmes in developing countries, research institutes in more developed countries, and the CGIAR Centres. These are linked by networks and various means of communication exchange, and the impact of their efforts will be strongly influenced by agricultural policies and general economic development.

The partnership nature of the CGIAR limits its role to the development of intermediate technologies, which are tailored to local ecological and socio-economic conditions of farmers in developing countries by national institutes. Institutions in developed countries contribute to the improvement of agricultural technology in developing countries by conducting basic research, and by providing an educational system that helps to produce research scientists (Herdt, 1984).

The global system will have a joint impact on the central goal of the CGIAR, and the allocation of contributions of each of the partners is difficult, perhaps impossible, to estimate. CGIAR Centres will increasingly hand over responsibilities to national institutes, particularly in areas of applied research. In developing a strategy to develop priorities, the CGIAR, which accounts for only 5% of resources currently devoted to agricultural research for developing countries, should continuously focus on those areas where it has maximum comparative advantage, and in the allocation of resources strive for balance among countries with widely ranging research capacities, among opportunities and needs for research, and among regions. Research thrusts will contribute to several objectives simultaneously, and have an impact on several client groups, sometimes in opposite directions. As the CGIAR system gradually moves towards the strategic and basic areas of research, it may become increasingly difficult to satisfy specific national needs for institution building and research support services.

The eight objectives to achieve the central CGIAR goal can be best seen as a set of system-wide entities against which proposals for shifts in priorities are screened. TAC will judge the relative importance of each of these objectives to evaluate proposals and assess priorities.

3. Monitoring the Implementation of CGIAR Priorities and Impact Assessment

TAC proposes to produce an updated priority paper for CGIAR consideration every five years (TAC, 1987 b). The process of arriving at an updated paper in 1991 would proceed in different steps and consist of a gradual revision of the different chapters. In the evaluation of priorities, greater use would be made of quantitative models. As a first step a comprehensive bibliography was to be made of quantitative models that had been used, or proposed to evaluate priorities in resource allocation in agricultural research. The output of quantitative models would be used to augment TAC's collective judgement in the evaluation of resource allocation or proposed new initiatives.

There was also a perceived need for monitoring of the implementation of CGIAR priorities and strategies, both at the Centre and System-wide level. At the Centre level such monitoring could be undertaken using information provided by the Board of Trustees, Long Term and Strategic Plans, Internal program Reviews, Medium Term Plans, and External Program Reviews. At the System level, monitoring of priority implementation and impact measurement could be undertaken by consolidating information provided by Centres, and through periodic strategic analysis of commodities and activities, inter-Center workshops and special purpose System-wide reviews on specific issues.

Procedures are to be established to measure the impact of CGIAR activities. A differentiation is to be made between production impact and institutional impact, and between ex-ante and ex-post impact assessment. 1/

1/ The terms 'ex-ante' and 'ex-post' are used here in relation to technology adoption.

The distinction between production technology and research and development (R&D) technology, and their corresponding types of impact, production impact and institutional impact, has been discussed by Horton (1987).

Production technology was refered to as "all methods which farmers, market agents and consumers use to cultivate, harvest, store, process, handle, transport and prepare food crops and livestock for consumption. R&D technology was defined as "the organizational strategies and methods used by research and extension programmes in conducting their work". This distinction facilitates the codification of the comparative advantage of National Agricultural Research Systems (NARS) vis-a-vis the International Agricultural Research Centres (IARCs), and vice-versa.

Because of the heterogeneity in agricultural environments, farming systems and socioeconomic circumstances, as well as their institutional setting and proximity to the user, NARS have comparative advantages in generating production technologies whereas IARCs have comparative advantages in generating R&D technologies. Classifications of research activities in basic, strategic, applied and adaptive, or in component research and system research are perhaps less encompassing. They refer primarily to research activities and do not explicitly incorporate the institutional support and building role of the IARCs.

In this context, production impact can be defined as "the physical, social and economic effects of new cultivation and post-harvest methods on crop and livestock production, distribution and use, and on social welfare in general (including the effects on employment, nutrition and income distribution). Institutional impact refers to "the effects of new R&D technology on the capacity of research and extension programmes to generate and disseminate new production technology" (Horton, ibid).

This differentiation, however, does not facilitate the assessment of institutional impact in as much as such an enhanced capacity of NARS should be ultimately assessed by the value of its output; that is, by assessing the improved effectiveness of NARS in achieving production impact. It follows that institutional impact cannot be disassociated from production impact. As they interlink, both types of impacts need to be assessed as part of the same studies.

There are at least four groups of "clients" interested in the outputs of impact assessment. These are the donors, TAC as an advisory body to the CGIAR, the respective Centre, and the Centre's clients. Their information needs vary considerably in terms of detail and purpose, but essentially is the same information that could be grouped in three major types:

(i) on the potential (institutional and production) impact of proposed new activities or initiatives;

(ii) on the Centres' output (institutional impact), or forthcoming output (in the pipeline) and their potential (production) impact; and

(iii) on (production) impact achieved.

The first two types are necessarily ex ante in the sense that production impact has not yet occurred and hence its assessment must be based on subjective probabilistic scenarios (e.g. on adoption rate, ceiling and domain; on certain outcomes or market reactions; ...). The last type is ex post technology adoption and hence the assessment methodology does not involve probabilistic scenarios. It may still, however, require expert judgement or probabilistic estimates on other factors, such as stability of resistance to a pest or a pathogen, but there is less number of unknowns in the sense that the market to a large extent has already operated.

Granted that besides methodological and measurement problems, impact assessment takes time, human and financial resources, but as long as there is a need for the information it generates, its costs and benefits should be weighed against those of the more traditional, informal, intuitive approaches.

The information needs of the different groups of "clients" are illustrated in Table 1. Specific reference is made as to the purpose for which each group needs the information.

Donors need information on actual, forthcoming and potential accomplishments and impact, both as individual agencies and as members of the CGIAR. As individual agencies, donors must satisfy their constituencies that their funds are being meaningfully used and that future contributions would produce significant social benefits. They are also interested in learning about Centres' output leading to opportunities in which marginal investments (through special multilateral or bilateral projects) might have high potential social payoffs. As members of the CGIAR, donors need information on which to base their decisions, both regarding activities currently supported by the CGIAR as well as regarding new activities or initiatives.

TAC also needs information on actual and potential accomplishments and impact on which to base its recommendations to the CGIAR. Information on potential (institutional and production) impact of ongoing and proposed new initiatives is needed as an input into the review process of CGIAR priorities and strategies. Information on Centres' output, or forthcoming output, and their potential impact is needed to be able to monitor, mainly through the EPRs, the implementation of agreed priorities and strategies. It is also needed in order for TAC to be able to pass judgement on the potential impact of the Centres' research and cooperation activities proposed in the medium-term plans of the Centres. Information on production impact achieved is needed for learning about the ingredients for success or lessons from failures, and about activities required to extend adoption to similar environments elsewhere.

The Centres' Boards, management and staff are perhaps the most direct clients for the outputs of impact assessment. All three groups need information on actual and potential accomplishments and impact - albeit with different levels of detail, in order to perform their different steering, planning, monitoring and research functions. Scientists need it as key feedback for enhancing the relevance and effectiveness of their research and cooperation strategies. Management needs it to perform its specific functions, in particular for strategic planning and for project evaluation, selection and monitoring. Finally the Centres' Boards need information generated by the three types of impact studies for their policy, steering and monitoring functions, as well as for "accounting" to donors and clients.

The Centres' partners, the NARS, are the fourth group of "clients" directly interested in the outputs of impact assessment. This group includes agricultural policy makers, research, extension and development programme managers, and natural and social scientists engaged in R&D activities. Although their particular information needs vary with their specific roles, they are all interested in the results of assessments of production and institutional impact in their own country as well as in other countries.

Policy makers welcome information on production impact to satisfy their constituencies that their money is invested in activities with high social returns. They also need information on institutional impact as an indication that the institutions concerned are dynamic and searching for ways and means to become more effective and continuously improve their performance. In many instances, impact assessment may highlight policy constraints that impinge on impact, thus leading to eventual improvements on policy, programmes or regulations. Furthermore, policy makers welcome ex ante assessments of potential impact as a key input into their planning and resource allocation process.

Research and development programme managers can effectively utilize the various outputs of impact assessment in their specific planning and monitoring functions and in upstream extension (interface with policy makers, international agencies and donors). The keen interest shown by research managers on impact case studies, even if they refer to other countries, is evidence for their perceived value, particularly as they refer to policies and organizational strategies that lead to accelerating adoption and impact.

Finally, natural and social scientists in developing countries are both producers and clients of impact assessment. As researchers they are interested in alternative methodologies and in carrying out collaborative studies with biological and social scientists from the IARCs that have had experience in assessment research. They are also clients interested in the results of studies on outputs by the Centres and their potential impact, as they might affect their own research activities.

The question arises as to who should bear the responsibility for assessing impact and generating the information needed by the above mentioned four groups. In addressing this topic, the CGIAR Impact Study recommended that Centres develop mechanisms for monitoring their impact. TAC was in full agreement with this recommendation. TAC acknowledges that monitoring and evaluation of actual and potential impact of CGIAR supported activities, should be an internal function of each CGIAR Centre. It is TAC's contention that monitoring potential impact is appropriate and that it is reasonable to attempt to judge whether Centres are producing research results and technology components which could have significant impacts in the areas of intended use (TAC, 1987 b). This monitoring function, however, can be performed by the Boards and by

TAC (through EPRs, Long-Term and Strategic Plans, Medium-Term Plans, etc.) only if the information on potential impact is generated by the Centres . Centres have clear comparative advantages in generating most of such information.

The wealth of information accumulated by the Centres on their respective crops and on their production circumstances, on the performance of advanced lines and other technological components throughout the various agro-ecologies and farming systems vis-a-vis the existing production and socioeconomic constraints, and the Centres' partnership with NARS puts them in a position of clear comparative advantages to assess potential impact of ongoing and proposed new activities directly related to their respective mandates. Such assessments should be regarded as key and central components of their strategic plans.

Research assessing production and institutional impact is interdisciplinary in nature. Different disciplines need to interact to identify and disentangle the effects of the different biological, institutional, market and policy components. In the case of ex ante impact assessments the different disciplines need to interact to pass judgement on the probabilities of biological and socioeconomic outcomes. Because of their interdisciplinary orientation, the Centres' research programmes are in a good position to carry out such studies.

The two areas in which their comparative advantages are not as clear are with regard to new initiatives outside the Centres' mandates and with regard to production impact at the national level.

The need for formal assessment of the potential impact, vis-a-vis the CGIAR goal and objectives, of proposed new initiatives that currently fall outside the mandates of the Centres is a subject that should be addressed by TAC on a case by case basis, as part of its continuing evaluation of CGIAR priorities and strategies.

The assessment of production impact at the national level is a subject that, because of the sensitivities involved in attributing impact and because of cost effectiveness considerations, is better dealt with by either national scientists or through collaborative research and joint publications. Technologies are seldom made out of a single component, or even a package, generated and diffused exclusively by an international centre. In most cases, national research and extension programmes have made substantial and key contributions to the research and development processes. Often, the Centres have played more of a catalytic role, albeit critical, in putting together components developed by several institutions from many countries. Hence, as discussed previously, it is almost impossible to allocate individual contributions to the partners in the global agricultural research system. Yet, because of the potential sensitivities which might arise, it is particularly important that the production impact studies carried out by the Centres be done in close collaboration with the respective national programmes. This would better reflect the partnership nature of the operation.

TAC's continuing process of reviewing CGIAR priorities and strategies can be significantly enriched with the information generated by the Centres' studies on potential impact of proposed new activities and on Centres' actual and anticipated output. This information should normally be summarized in the Centres' strategic and medium-term plans, but it would be expected that the complete reports of the studies be made available to TAC.

It is important to note that these studies are the result of research which pull together the expert judgement of several people knowledgeable about the respective commodity, and that they are based on the best available data sets on production, utilization, institutional and policy settings. A good example of this type of study is provided by Herdt and Riely (1987) on international rice research priorities. In setting research priorities several Centres have conducted studies of various nature but have not always properly documented these. Appropriate documentation of these studies would allow TAC to enrich the broader picture on priorities and strategies with more detail and prospective information on the potential payoffs of investment in alternative research activities. This type of information will allow relating inputs required (activities and their costs) to specific outputs and their anticipated impact in relation to the CGIAR objectives.

The information compiled or generated by Centre impact studies would be, in general, of three types: (a) more disaggregated data or improved estimates on the respective commodities; (b) clear specification of production and market constraints and scope for research, applicability of results, and estimates of time and resources required to obtain them; and (c) estimates of potential impact in terms of production, productivity and socio-economic effects.

The studies would also provide a perspective on the relative importance of the different constraints by production region and systems, and experts' judgement on their researchability, and on the adoption time and domain of the technologies being or to be developed. They should address questions of yield stability and sustainability of production. As subjective and conditional as some of such information might be, it would not only represent the best informed judgement available but would also provide a concrete frame on which TAC can base its collective judgement and make recommendations regarding activities related to individual crops.

Finally, such studies would provide range estimates on potential impact of the technologies being or to be developed. As conditional and gross as these estimates might be, they are better than none. What is important, is to be able to anticipate the gross relative order of magnitude (range under various assumptions) and the direction of the impact in relation to the anticipated future costs of the various activities proposed. It is not that the Centres would be held accountable for achieving impact within the "estimated range" - in as much final impact depends on many circumstances far beyond their control. It is a matter of compiling and making explicit the best available information so decision on the allocation of public funds can be better made at all levels within the System.

The question arises as to whether ex ante impact assessment would represent an additional burden on the Centres. First, it seems to be less of a burden if the Centres conduct their own studies rather than somebody else does it for them "watching over their shoulders and arbitrating between them and their partners". Second, all Centres need to conduct some kind of *ex ante* assessment as part of their strategic planning processes. IFPRI has conducted several studies in which assessments of the potential socioeconomic impact of removing policy constraints were made. Some Centres (IRRI, CIAT, ...) have already conducted studies assessing the anticipated impact of their programs. Others (ICRISAT, ILCA, ...) have applied formal congruence models to determine their regional and/or commodity priorities in terms of specific socioeconomic goals. Most other Centres are, one way or another, adopting initiatives in similar directions. This phenomenon may be the result of the maturity of the Centres (including their social scientists), of their Boards, of the moral pressure brought about by the "CGIAR Impact Study", or by the funding stringency vis-a-vis the many research needs and opportunities brought about by the knowledge accumulated by the Centres and their partners, the NARS. Independent of the source of this phenomenon, the important point is that it is an ongoing process that could generate information valuable to TAC. TAC encourages this process and will use the information generated to complement other knowledge.

4. Information Needs for CGIAR Priority Assessment

Information needs for CGIAR priority assessment by TAC can be classified in three basic types: macro-economic and micro-economic data, data on CGIAR resource use and productivity, and data on resource use and productivity in NARS as well as in research institutes of developed countries. Much of this information is already generated through the Centres, NARS, System-wide reviews and EPRs.

These information needs are not linked to the use of quantitative models, although each analytical tool may have specific data requirements. Decision making always requires prior information, on which basis a judgement can be made.

Macro-economic data are needed to assess the global agricultural scenario, the importance of particular commodities relative to overall agricultural output and income, and the factors determining future food needs and supply. They should be available per country, as well as aggregated per region and per agro-ecological zone. Macro-economic information should incorporate data and trends on the following:

(a) Production and consumption variables:
- gross national product (GNP) and income;
- population figures;
- consumption of major staple foods, and food supply per capita (in terms of calories and protein);
- food aid
- volume and value of production of staple foods;
- yield, area and output per commodity;
- growth rates of income, GNP and population; and
- projected demand and supply.

(b) Trade variables:

- imports and exports per commodity on a volume and value basis;
- price and income elasticities;
- price and consumer subsidies;
- domestic and international border prices per commodity; and
- price indexes.

(c) Resource use and productivity:

- land use and productivity per commodity;
- seed, pesticides, fertilizer and irrigation inputs;
- use of machinery; draught animal power, and human labour inputs;
- livestock population and yield per species and breed.

Information on CGIAR resource use is needed to enable an appraisal of the past and current efforts by the CGIAR with respect to a particular commodity or discipline. The data necessary are, for each Centre, expenditures and manpower inputs per activity, commodity, discipline, region and country.

Information on expenditures and manpower inputs of national agricultural research organizations is necessary to enable the assessment of research efforts at the national level, so as to ensure complementarity with CGIAR efforts. In addition, TAC should be well aware of research efforts in developed countries and remain up to date with recent results obtained. An appraisal is also necessary of the level of basic vs. adaptive research both in CGIAR Centres and elsewhere.

As discussed in the previous chapter of this paper, a crucial information need for priority assessment relates to the evaluation of the impact (both ex post and ex ante) of CGIAR research. As the CGIAR Impact Study has demonstrated, this is no easy task. The output of the CGIAR Centres consists not only of improved germplasm or production techniques, but also of increased research capacity of NARS, strengthening of the organization and management of research, methodology and training.

At the ex post level measurements should be made of the numbers of farmers using the innovation, proportion of target area or population adopting, productivity increases obtained, effects on income and on the farming system. These are basically farm management data.

Estimates should also be made of the aggregate effects on production, consumption, human nutrition, income, income distribution, employment, yield stability and sustainability of the farming system. Most of these effects will work through local, regional, national and international markets. The marketing and processing mechanisms need to be understood, as well as distributional effects on producers, consumers and particular target groups. Major measurement problems arise from the fact that there may be a time lag of up to twenty years between the development of new technology and widespread farmer adoption.

The time lags involved in technology adoption further stress the need for ex ante impact assessment. The main difficulty here is to adequately estimate the probability of research success, and the ultimate effects on farm productivity. Good guesses can be provided on the type of technology that is likely to result from a given research effort, but the many pitfalls involved in the research process and the important role of serendipity (solving a problem through a chance discovery) cannot be foreseen.

At the international level, it is also important to have an appraisal of transferability of research results across agro-ecological zones or socio-economic groups. This will allow for the estimation of "spillover benefits" (Davis et al, 1987).

As noted earlier, improved germplasm and production technology are only part of the CGIAR output. The effects of institution building, strengthening research capacity, and policy research cannot easily be captured by quantitative variables and may have to be assessed in qualitative terms.

Data sources

For macro-economic variables the main data sources are FAO and the World Bank. The continent with the weakest data base is Africa, for which information on land use, livestock population and productivity, and prices is particularly weak or non-existant.

The FAO data bank is available through the AGROSTAT Information System. The food and agricultural commodity data base contains information on about 200 countries, 300 primary and 380 processed crop, livestock and fish products, and 200 forestry, fertilizer, pesticide and agriucltural machinery items, in addition to population and land use. It contains about 210,000 time series from 1961 onwards. Other statistical collections of FAO include land use, inputs and production (LUI), commodity balances for demand and supply, production and trade index numbers, demographic estimates, and supply utilization accounts. These data collections are used to produce a number of regular publications, such as the FAO Monthly Bulletin of Statistics, Production Yearbook, Trade Yearbook, Fertilizer Yearbook, and Food Balance Sheets. In preparing its "Agriculture: Towards 2000", FAO also developed the AT 2000 databank, containing projections of supply/utilization of agricultural commodities, crop and livestock production, land use, inputs and investment requirements on a country basis, between 1961 and 2000. These AT datafiles cover almost all developing countries, excluding China and a few smaller countries for which no data are available. FAO's databank also allows for stratification in agro-ecological zones, and identification of growing periods and land suitability for many regions.

FAO also maintains the Fisheries statistical data bases (FISHDAB), which presents time series of fish catches by country, species and fishing area, the International Fish Market Indicator System, Country Nutritional Requirements (RECTRY), and Agroclimatological Data (MANAGE). Each of the regional FAO bureaus maintains a number of data bases for their specific continent.

The World Bank has a databank of commodity prices and markets, containing time series from 1950 onwards, while UNCTAD has also a major collection of trade and commodity data. The World Bank also maintains a Socio-Economic Indicators Databank. The IMF has the Economic Information System (EIS), a major on-site compilation of financial, economic and trade statistics, national accounts and balance of payment data from most countries in the world. An overview of data sources in the international organizations of the United Nations system has recently been published by FAO (FAO, 1987 a).

Various CGIAR Centres have major data bases on the commodities of their particular mandate, such as CIMMYT (wheat and maize), IRRI (rice) and CIP (potatoes).

USAID, USDA and IFPRI both maintain comprehensive data banks on production, consumption and trade in developing countries. Both these institutes largely rely on FAO and World Bank as data sources, although they sometimes adjust these with information they have obtained themselves. IFPRI particularly has specific data sets for certain countries or regions on topics it has researched. This includes for example fertilizer consumption trends in sub-Saharan Africa. Farm management data will usually have to be compiled from individual reports published by Centres and NARS, and from the general research literature.

Data on CGIAR expenditures are available from the individual Centres and CGIAR Secretariat. Although aggregation per activity and discipline is not easy for historical records, it has become simpler since the application of the new resource allocation process.

Information on expenditure patterns and manpower inputs of NARS is patchy and, for many countries, simply not available. ISNAR has made a record of total research expenditures per country, but it is not disaggregated at the commodity, programme or discipline level. Manpower inputs are available for some individual developing countries, but only occasionally they are aggregated according to their education level (B.Sc., M.Sc., Ph.D.). It is difficult to estimate some manpower inputs, particularly those of expatriates when paid by their home government or by international organizations, or to compare education levels. Individual ISNAR reports on agricultural research systems of particular countries, also contain valuable data material.

Information on research activities in developed countries can usually be found through the national coordinating mechanism, or specialized information institutes, such as CAB International or ARS (Agricultural Research Service of USDA).

5. Quantitative Methods for Setting Priorities in Resource Allocation to Agricultural Research

For the evaluation of research priorities to become a continuing activity, TAC intends to make greater use of quantitative models to help guide its decisions on CGIAR resource allocation.

Although no model will ever be a substitute for TAC's collective judgement, formal models inject more objectivity and transparency into an intuitive and subjective exercise by forcing the user to clearly specify his objectives, and the set of assumptions that underlay the thinking process. The rationale for decision making becomes explicit. A quantitative framework which integrates subjective and objective information of both a biological and economic nature would also allow TAC to obtain a more comprehensive and balanced perspective of its strategic priority options, as it permits the ready assessment of the effects of alternative research investment strategies, shifts in goals and objectives, and changes in resource availability. It also allows for the incorporation of a larger number of variables in the considerations. This in turn permits an easier dialogue, by heightening the awareness of TAC Members and interested groups of the nature and the extent of the various trade-offs which are involved when setting research priorities.

Quantitative models are not intended to replace judgement, but to generate additional information that facilitates decision making. The techniques involved are merely thinking structures to "force methodical, meticulous consideration of all factors involved in resource allocation. Data plus analysis yield information. Information plus judgement yield decisions" (Cetron and Johnson, 1972).

5.1. An overview of available procedures

Over the past 20 years a considerable amount of literature has emerged dealing with systematic procedures to assist in the setting of research priorities. The literature relates to several disciplines, primarily economics, operations research and management. While most of the earlier efforts of research evaluation were *ex post*, i.e. assessing costs and benefits of past research, more recently the attention has focussed on *ex ante* models which evaluate research projects before they are conducted. There is a wide scope in the level of priority setting, ranging from the micro or project level, to the macro or programme level. TAC deals with the macro level, where the focus is on allocative problems across commodities or set of commodities, research activities and geographic regions. A good review of the scope and nature of the priority setting process in general is provided by Pardey (1987).

Quantitative methods used in studies on priority setting in agricultural research can be grouped in three basic types (Norton, 1987):

(a) establishment and weighting of multiple criteria for ranking commodities and research areas;

(b) use of benefit-cost analysis techniques to select commodities and research areas;

(c) application of mathematical programming and use of simulation models.

The use of each of these approaches in the literature is described below. A good overview of the methods is provided by Shumway (1977), Schuh and Tollini (1979), Norton and Davis (1981), Ruttan (1982), Anderson and Parton (1983), Norton and Pardey (1987) and Norton (1987).

The broader outlook on the field of agricultural research resource allocation can be found in Fishel (1971 a), Arndt, Dalrymple and Ruttan (1977), Martin (1981) and Ruttan (1982 and 1987).

5.2. Multiple criteria approaches

The establishment and weighting of multiple criteria for ranking priorities has probably been the most commonly applied formal priority setting procedure. The approach may include relatively simple rule-of-thumb methods, general congruence models and scoring techniques, sometimes used in combination.

Intuitive methods based on rules-of-thumb (such as the precedence approach which takes the previous year's funding as the basis for the current year's allocation) are simple and low cost, but have a low level of project scrutinizing. They indicate only how research resources might be allocated where a single criterion and objective is to be considered. They also have the disadvantage that research that reaches the limit of its productivity continues to be funded (Anderson and Parton, 1983).

Congruence models allow for more flexibility in the allocation process. The general principle of the technique is to allocate funds across research areas in proportion to a commodity's contribution to some criterion such as value of production, export earnings, contribution to nutrition, or share of physical output. For example, if the value of production of wheat is US$100 million, of maize US$50 million, and of sorghum US$25 million, then resources would need to be allocated in the ratio of 4:2:1. Ruttan (1982) refers to this approach as the parity model of research resource allocation. There are two assumptions implicit in the application of this model. First, that the opportunity for research to generate new knowledge to increase productivity is equal across commodities and research categories. Second, that the value of new knowledge produced by research is proportional to the value of output thereby ignoring the value added in processing, or the cost of inputs. A good discussion of congruence models is provided by Scobie (1984). Although the model lends itself easily to a first approximation of research priorities, a major drawback is that the approach is difficult to use for the evaluation of new research initiatives. In addition, Ruttan (1982) points out that the model is not as simple to apply as one may expect. In agriculture, the research resource allocation process involves a four-way allocation of resources: (i) among commodities; (ii) among resource categories; (iii) among steps or levels of the production and marketing system; and (iv) among disciplines. Congruence models can be applied to each of these dimensions singly, or in some combination but then their use becomes increasingly complex.

Binswanger and Ruttan (1978) have argued that factor scarcities have de facto influenced research priorities in the past, and that a successful research strategy should achieve cost minimization by economizing on the scarcest factor of production. In countries such as the United States or Brazil which had relatively abundant land resources and a strong demand for labour, the primary thrust was towards improvements in mechanical technology that would enhance labour productivity. In countries such as Japan or Denmark which had abundant labour resources, but scarcity of land, research focussed on increasing output per ha and intensification of livestock production (Ruttan, 1987). Resource allocation appraisals should therefore consider relative factor supplies in specifying research options.

McIntire (1985) used congruence analysis to determine and assess the allocation of research resources at ILCA. The approach taken is relatively simple but sound and logical. He analyzed the Centre's current resource allocation by agro-ecological zone, livestock species and geographical region, and discussed alternative approaches to determine percentage allocations. These included the incorporation of number of ruminant livestock units, factor analysis to define allocation criteria and the estimation of value of expected output. The analytical framework developed is a useful tool for an initial evaluation of resource use by comparing the actual with a congruent allocation.

Various studies have established multiple criteria for ranking priorities to enable the incorporation of a wide variety of factors that influence research selection. Previous work of the CGIAR falls in this category. Pineiro (1984) suggested a dominant criterion, the contribution that specific commodities make to nutrition, and a set of secondary criteria to modify the prime criterion. In a follow-up study, TAC (1987 a) established a principal goal, along with eight research objectives to achieve the goal and a comprehensive set of criteria that related to relevance, productivity and efficiency. However, weights used to aggregate were not explicitly provided, although numerical priorities were put on CGIAR commodity research (TAC, 1987 b).

Some studies have used scoring methods to specify a set of weights to aggregate across criteria and obtain a final ranking of research priorities. Key evaluators, such as research administrators or the research scientists themselves, are asked to express their evaluation of alternative research projects. These evaluations are based on the potential contribution of each research project to a prespecified goal, set of goals, or type of goals. The application of this method has been reviewed by Shumway (1977), Schuh and Tollini (1979), Norton and Davis (1981) and Anderson and Parton (1983). The four most significant applications of scoring models are by the USDA (Williamson, 1971), Iowa State University (Mahlstede, 1971), North Carolina Agricultural Experiment Station (Shumway and McCracken, 1975), and von Oppen and Ryan (1985). These models could perceivably merely pool ignorance and the exercise in quantification should not blind decision makers into thinking that the resulting aggregates are something other than subjective estimates (Toulmin, 1984). The usefulness of scoring models is best restricted to studies where there are a small number of independent attributes, and in comparing basic research projects with more applied ones (Anderson and Parton, 1983). Ruttan (1987) finds such models most useful in the scoring of projects against a single criterion. One by-product of a scoring model is that it clearly reveals data lacunae.

The use of weighted criteria in congruence models for priority setting at the national level is well illustrated in the procedures developed for the Dominican Republic, Ecuador and Uruguay (Norton, 1987). The model used weighted criteria to prioritize agricultural research by commodity and by major research area. Between 10 and 15 criteria were used to identify and select research priorities by commodity, and an additional 5 criteria to identify and select by research areas.

Venezian and Edwards (1987) followed a similar approach for regional priority setting in West Africa. The congruence model that was developed used weighted criteria for multiple goals, but was limited in its practical application because of the lack of readily available data. The authors also discuss the notion of comparative advantage of certain countries in producing particular goods. The main argument for the incorporation of this criterion in the setting of research priorities is the need for a country to earn foreign exchange, and to therefore place substantial emphasis on the net foreign exchange earning capacity of different enterprises. Comparative advantage of a country for a particular commodity can be measured by a ratio known as domestic resource cost (DRC). This parameter measures for each economic activity, the social cost, in terms of domestic resources (land, labour and capital), of generating one additional unit of foreign exchange either by exporting or by substituting imports. Expected commodity demand was incorporated in priority setting through a proxy variable, i.e. projected commodity prices. Other goals considered in this study were agricultural growth, human nutrition, food security, employment, self sufficiency and effectiveness of commodity research.

Weighted criteria models usually aim at fostering consistency between research priorities and development goals, and can be useful for a first approximation in priority setting. Their main drawback lies in the difficulty of assigning the weights and understanding the relations between them.

5.3. Benefit-cost models

Benefit-cost models treat research as an investment problem and make an estimate of the annual research expenditures over a specified length of time, and a probability distribution of benefits. A discount rate is then used to estimate net present value of projects. Benefit-cost ratios, internal rates of return, and net present values for alternative research activities are calculated. Projects are then ranked according to their expected payoff. A major advantage of the method is that it converts all variables into a single index, i.e. their monetary value. The use of benefit-cost models has been reviewed by Greig (1981) and Anderson and Parton (1983). These models have been used in different forms (Fishel, 1971; Ramalho de Castro and Schuh, 1977; Araji, Sim and Gardner, 1978; and Davis, Oram and Ryan, 1987). Most of them use the consumer-producer surplus concept originally developed by Schultz (1953) and Griliches (1958).

The approach analyses the effects of price changes induced by supply shifts generated by technical change, on consumer and producer welfare. It is narrowly focussed and has often sought to evaluate priorities solely on the basis of formal economic efficiency criteria (Pardey, 1987).

A further development was the MARRAIS model (Minnesota Agricultural Research Resource Allocation and Information System) (Fishel, 1971 b). This model allowed for the collection and computer processing of information that could be used either for the subjective evaluation of research activities or for the formal estimation of projected cost-benefit measures. The model involves three major steps: specification, estimation and analysis. Groups of experts provide estimates for many of the variables. The next step, selection of the research portfolio is not within the scope of MARRAIS itself, but is left to the decision maker. According to Ruttan (1982) MARRAIS is one of the most logically thought out and procedurally sophisticated research planning models available. Its high cost to users has however been an obstacle to its application. Schuh and Tollini (1977) note that there may be serious difficulties in applying it in an international context due to the large degree of variation to be found in the relevant variables and the difficult task estimators face.

de Castro and Schuh (1977) described a model focussing on growth and distributional effects of technical change along with direct and indirect effects of research. The model relies primarily on secondary data to project yield increases, adoption rates and probabilities of success.

Although the benefit-cost approach is extensive, systematic and consistent, its disadvantage is its high cost in terms of money and staff, and the difficulty in estimating with reasonable accuracy the costs and benefits of many research projects. In addition, until recently these studies have been restricted to national research assessment where only the prospective benefits to the individual country are considered.

A significant contribution in the use of quantitative methods for priority setting in international agricultural research was made by Herdt and Riely (1987). Using an elaborate scoring approach for obtaining expert judgements on the importance of various research problems in rice crop improvement, they suggest how research priorities may be derived and assess the resulting implications. The authors then identify those research areas and activities most suitable for a biotechnology approach. The method that was developed used both scoring and benefit-cost procedures and is a useful tool to assist in setting research priorities on a particular commodity, and could be applied at other international institutes.

Edwards and Freebairn (1981) were the first to formally introduce cross-country spillover effects of agricultural research in economic models. These effects can be of an economic or technological nature, and occur when research in a commodity, for which the researching country is a significant world trader, shifts world supply sufficiently to affect world prices. As a consequence, those countries which undertake agricultural research on commodities which are also produced in significant quantities elsewhere in similar agro-climatic zones, need to be cognizant of these spillover effects when appraising their domestic agricultural research policies (Pardey, 1987).

Recent work by Davis, Oram and Ryan (1987) has expanded this model. Their study uses a consumer-producer surplus approach to the assessment of commodity and regional priorities for international support of agricultural research in developing countries. An analytical framework was developed to assess the potential impact of research, and the likely spillover effects of commodity research to environments similar to those where research is being envisaged. Twelve major commodities were examined: rice, wheat, bananas/plantain, sugar, sweet potato, potato, pulses, groundnuts, sheep/goats, maize, coconuts and sorghum. Relatively homogeneous research domains were defined for each commodity using FAO agro-ecological zoning classification studies where available. The empirical analysis made use of both objective data (e.g. production, consumption, trade values, elasticities of supply and demand, prices and exchange rates) and subjective scientific judgments, and examined the implications of research which generates cost savings of 5% on each unit of production of each of the commodities examined.

The model used was a partial equilibrium trade model for agricultural research evaluation, originally developed by Edwards and Freebairn (1981, 1982 and 1984). The major extension is from a two-country to a multi-country model which leads to a comprehensive specification of spillover effects, the incorporation of differential capabilities of national research systems and likely differences in the ceiling levels of adoption of research results in different countries. The model assumes that research on an agricultural commodity, traded internationally, leads to a reduction of its cost of production, and generates effects on the economic welfare of producers and consumers in both exporting and importing countries. The authors have developed algebraic formulaes to estimate these effects. The model incorporates information on the impact of research, probability of success, rate of adoption of results, price factors, cost of research, growth in demand and supply, impact of government policies, and a research production function. The latter aspect describes the research output that could be expected from combining different levels of research inputs.

Time lags and the need for adaptive research were incorporated in the estimation of spillover effects. These were shown to be substantial.

The study was initially undertaken to assist the ACIAR to formulate its programmes. Three major ACIAR objectives were considered to be important: maximizing international benefits, spillover benefits and incremental benefits. Irrespective of the objective, the empirical results of the study indicated that the highest expected returns to research investment are in rice, more than twice that for the second and third ranked commodity, potato and wheat. Research on bananas/plantains, sweet potato, coconuts and groundnuts offer developing country producers and consumers a larger share of the expected economic benefits than any of the other eight commodities. However, the opportunity cost in terms of foregone economic benefits from research on rice would be substantial.

For commodities such as coconuts, sorghum, groundnuts, sheep and goats there would have to be much larger differences in the unit-cost-savings expected from research before the economic benefits would exceed those expected from research on the other commodities.

The contribution of spillover effects from regions where research is conducted to other regions with similar agro-ecologies and rural infrastructure were shown to be substantial. Between 65% and 82% of total international benefits from agricultural research on the 12 commodities evaluated were estimated to come from such spillovers. Policy makers in NARS no doubt ignore these in their decision making on resource allocation which is likely to result in under-investment and/or different patterns of investment by these countries. The authors argue that external agencies should explicitly consider these spillovers in appraising their continuing support to NARS.

The study of Davis, Oram and Ryan is innovative and has substantially refined the methodology of determining priorities for agricultural research. It is an important conceptual contribution and makes a useful appraisal of the effects of national versus international research. The study effectively links priority setting to the concepts of ACIAR goals and impact assessment. The model developed allows for a substantially better understanding of the nature of international agricultural research and highlights the importance of spillover effects.

The model has several weaknesses however which suggest a need for caution in the interpretation of the results and in its wider application. It is based on a partial equilibrium framework and the associated concepts of producer and consumer surplus. These are narrow, single objective economic concepts and a model of this nature would need a more general equilibrium framework that incorporates other economic and social factors. The ACIAR model also has substantial data needs, and these data are either not available or of lou quality in most of the developing countries, particularly in Africa. Some of the parameters, such as the anticipated benefits of research, are very difficult to measure and remain rough guesses. The inadequacy of the data base is a severe constraint to the application of the model beyond the Asia/Pacific region where most of ACIAR's activities are located, or Latin America.

The model has been applied to only 12 commodities although it is intended to extend the analysis at a later stage to incorporate 24 additional commodities. Much of the information used in the model is very subjective and the result of expert judgements. These include important elements such as probabilities of research success, rates of technology adoption, prices and elasticities. The model incorporates a large amount of simplifications, such as the generalized assumption of a cost-reducing impact of research of 5% for all commodities and regions, and the assumption of a uniform time lag between the introduction of research and adoption of its results by farmers.

Pardey (1987) suggests that a number of additional refinements to the ACIAR model may be necessary before it can be implemented. These include the incorporation of realistic population and income based demand shifting parameters, and spillover within rather than between national research systems; the explicit recognition of cross-commodity price effects; and the sharpening of the derivation of inter-regional, commodity-specific spillover effects.

Alston, Edwards and Freebairn (1987) have further refined the welfare surplus approach, by expanding the analysis to the evaluation of the effects of cost-reducing research under a range of government pricing policies through subsidies, taxes, quota's and deficiency payments. Their analysis shows the significant impact of government intervention on the size and distribution of benefits arising from agricultural research.

5.4. Mathematical programming and simulation models

Mathematical programming models to determine optimal allocation of research resources can be of two basic types: either more sophisticated versions of the scoring approach, or based on production functions. In general however, they rely on mathematical optimization to choose a research portfolio through maximizing a multiple goal objective function given the resource constraints of the research system (Norton, 1987).

The study of Russell (1977) is typical of the first type but he selected an optimal research portfolio rather than a simple ranking of research areas. His model is directed towards general use in appraising individual research projects in the U.K. It provides information on (i) the set of projects in the research programme, (ii) financing for each project, (iii) the marginal utility derived from investing in extra units of resources for the programme and each project, and (iv) the sensitivity of project selection to varying weights on goals. A similar model was developed by Cartwright (1971) to allocate resources optimally within an agricultural economics department. The advantages of such mathematical programming include sensitivity analysis applied to the weighting system, and extension to nonlinear weighting schemes (Anderson and Parton, 1983). The drawbacks are similar to those of scoring models, and an additional difficulty is the need to specify a preference function.

Production function models (Scobie, 1979; Davis, 1981; White and Havlicek, 1982; Barker and Herdt, 1985) focus on the relationship between agricultural productivity and research and typically involve a three- stage process. A model is constructed to represent the agricultural production sector, agricultural productivity is estimated as a function of research inputs, and the influence of varying these inputs on agricultural productivity and hence on production, farm incomes, etc. is observed. The production function technique is best for examining effects of research on the relative productivity and income shares of input categories (Anderson and Parton, 1983). The approach is often extended into an analysis of the production process using simulation models to study the effect of alternative technologies on output and income. The benefits from a research investment in various programme areas are then estimated. Pinstrup-Andersen and Franklin (1977) developed a detailed model of the small farm agricultural production system to represent the proposed structural relationships on the physical, technological and economic environment. The effect of uptake of new technologies on output and income were simulated and benefits from research identified. The model is logical but requires extensive amounts of data and estimation of many mathematical relationships.

Mathematical programming and simulation models depend on a subjective estimation of the relationship between research inputs and agricultural productivity. It is difficult to correlate historical research performance with future research payoff at a highly disaggregated level (Shumway, 1977). These models are also relatively complex and require large amounts of data.

de Wit, Van Keulen, Seligman and Spharim (1987) have applied interactive multiple goal programming techniques for analysis and planning of regional agricultural development. The method is illustrated with an example from a semi-arid zone in the Mediterranean Basin. The authors conclude that the method is a useful tool to assist in the selection of feasible development pathways within a wide range of technical and socio-economic scenarios, and in illustrating the margins for policy. The pathways illustrate the costs of emphasizing one goal in terms of the sacrifices of other goals. The quantification of the trade-off between multiple goals may then serve as a basis for compromise.

The use of interactive multiple goal programming could also be applied to the resource allocation process of the CGIAR. The method is based on linear programming and would allow for a mechanistic approach to assess trade-offs and the implication of goal or priority changes on resource allocation in the CGIAR. The data needed for such a model can be found in the medium term plans, programme and buget proposals and strategic plans of the Centres. Each Centre would be required to specify the areas in which they expect to have an impact, as well as the resource limits and constraints under which it operates.

The objective would be to maximize a set of CGIAR goals. The interactive approach requires that the desired solution is attained at the end of a series of interaction cycles. In the solution space, none of the goals could be improved without sacrificing another one, and a choice then has to be made on the basis of trade-offs. The production processes could be specified as "programmes" and "activities" within CGIAR Centres as defined by TAC under the new resource allocation process. Such a model could be of assistance during TAC discussions on CGIAR priorities.

5.5. Analytical tools and data needs

Each of the analytical tools discussed in previous sections of this paper has specific data requirements.

Some of the models are only "input" oriented, as their results give indications on the resources a particular programme, activity, commodity or discipline should receive. Other models are also "output" oriented, and estimate the likely benefits to be achieved from given inputs. Output models require an *ex ante* estimate of the impact of particular research activities and are therefore far more complex.

Weight criteria approaches are of two basic types: congruence models and scoring methods. Congruence models allocate resources in proportion to a commodity or discipline's contribution to one or more criteria. Scoring methods s~ecify a set of weights to aggregate across criteria to obtain a ranking of projects, based on their contribution to particular goals.

Congruence models are usually based on macro-economic indicators such as income, production, nutrition or employment. When longer term considerations are taken into account, these models usually also require projections of prices and demand. Scoring methods are based on information supplied by policy makers, administrators or experts.

Weight criteria models require a wide range of quantitative data, depending on the level of sophistication which is intended to be achieved. Although TAC used this approach to enable the incorporation of a wide set of criteria in priority setting, it did not provide weights used to aggregate across criteria.

Such weights could be provided through scoring methods. TAC members would then have to make a range of estimates on how each of the criteria would contribute to particular CGIAR objectives. Scoring methods rely largely on the individual's value judgement, which is in turn determined by experience, knowledge and intuition. Their usefulness largely depends on how effective a set of goals and objectives could be specified, and scores be aggregated.

Weight criteria approaches are usually "input" models, and do not put a direct link between resources allocated to a certain research programme and the productivity gains it is likely to achieve.

Benefit-cost procedures are "output" oriented but are very data demanding models. Research projects are ranked according to their expected payoff, and this estimate depends on a precise quantification of anticipated costs and benefits of the proposed activities. Among the necessary macro-economic data to operate such models are present and projected prices, elaboration of demand and supply, estimates of demand and supply shifts resulting from the research and implications on international trade. The approach also requires a careful assessment of the likely benefits of the proposed research, including both production and distributional aspects. The effects of government policies are also to be incorporated.

Many of these necessary data such as elasticities, prices, rate of technology adoption are usually not available in developing countries, and benefit-cost approaches would therefore have to depend largely on subjective and expert estimates.

Mathematical programming and simulation models are of two basic types: either based on production functions, or more sophisticated versions of the scoring approach.

Production function models on resesearch are very data demanding. They need data on the productivity gains resulting from research, and on the overall effects on the agricultural sector. Extensive amounts of macro-economic data, as well as on research impact are therefore required, as well as the estimation of many mathematical relationships.

The second type of mathematical models are more sophisticated scoring methods. These require a prior specification of a set of goals, and weights to select among these goals. Interactive goal programming falls within this category. This latter model is perhaps the least demanding model in terms of data needs. It would require a specification of CGIAR goals, an estimate how Centre activities and programmes contribute to these goals, and the expenditure and manpower inputs needed to execute Centre activities and programmes. The estimate how Centre programmes and activities contribute to CGIAR goals could be made by the TAC liaison scientist in collaboration with Centre management and the expenditures and manpower inputs required for various activities could be estimated from the medium-term budgets.

6. Implications for TAC's Approach to CGIAR Priority Assessment

A large number of quantitative models have been developed for the appraisal of resource allocation in agricultural research, particularly for national institutes. They have been useful tools to facilitate decision making, and have improved the understanding why and how these decisions were made (Ruttan, 1987). A schematic overview of the major evaluation techniques is presented in Table 2. A conclusion about the "best" model cannot be drawn, and as Anderson and Parton (1983) observe, judgement of which of the techniques is better than others is meaningful only given a detailed specification of the situation in which the technique is to be applied.

The application of quantitative models for priority setting by TAC will have to be a stage-wise and gradual process. TAC has a global mandate for developing countries, and no quantitative framework developed to date would adequately capture the complexities involved. The main shortcomings of the existing models are as follows:

(a) The modelling of two major considerations to CGIAR priority setting, research productivity (ex ante impact assessment) and efficiency (appropriateness for either national or international systems) indicators is still very unsatisfactory. There are as yet too many areas that cannot be quantified.

(b) The methodologies are largely beyond presently available data quality, especially in regard to Africa.

(c) The effects of government policies are not explicitly considered.

(d) All existing models have very strong elements of subjective judgement, and are highly simplified. Data errors far outweigh errors that are caused by imprecise quantitative procedures (Shumway, 1983). It is understood however, that all ex ante evaluation procedures are inherently subjective, and that objectivity is not equivalent to quantifiability (Shumway, 1981). No model will ever be a substitute for TAC's collective judgement.

TAC will remain up to date with methodological developments, and keep a watching brief on the approaches taken by other organizations that develop models to assist in priority setting. Various appraoches will be explored, including the use of weight criteria models, benefit-cost procedures, and interactive multiple goal programming.

These will augment the Committee's collective judgement in allocating resources across the CGIAR System.

The tentative programme of work until the end of 1989 is illustrated in Table 3. The approach requires for a comprehensive information and data base to be available to TAC. This data base is being developed at the TAC Secretariat. There is also a need for an update to the previous priority study on evolving trends in world agriculture and the factors determining future food needs. This update is undertaken in cooperation with FAO which has recently prepared a revised version of the "Agriculture: Towards 2000" study (FAO, 1987 b). TAC will use congruence models for review of different groups of commodities within the framework of priority assessment. An interactive multiple goal programming model will be developed to assist in discussions on priorities in resource allocation. TAC will also remain informed about the progress and results obtained by ACIAR, which is currently refining and validating its model.

Discussions on CGIAR priority assessment will take place during every TAC meeting, but a preliminary evaluation of CGIAR priorities is scheduled for TAC 50 in October 1989. During this meeting, a major review will also be made of CGIAR strategies within the framework of the global agricultural scenario. At that time an evaluation will also be made of the approach to priority assessment taken, and the usefulness of different analytical tools used in the process.

TAC will also monitor selected trends (e.g. dairy imports in sub-Saharan Africa) and assess their implications, and remain informed of macro-economic developments across the world. It encourages the Centres to undertake ex post impact assessment studies, preferably in collaboration with its partners, the NARS. TAC also encourages the Centres to undertake ex ante impact studies as an integral part of their strategic planning efforts. Both types of impact studies will substantially strengthen TAC's deliberations and facilitate the process of continuous priority assessment.

Table 1. Information Needs from Different Types of Impact Assessment Studies by Client Group

Type of Study	Client Group			
	Donors	TAC	Centers	NARS
Assessment of potential impact of proposed new activities (*ex-ante*)	Convincing constituencies that future contributions would have high social returns. CGIAR decision making.	Review of CGIAR priorities and strategies and balance of collective effort.	Strategic planning. Consultation with NARS.	Assisting Centres in focusing on national priorities. Methodologies for their own priority setting.
Assessment of Centre's outputs and their potential impact (including in pipeline) (*ex-ante*)	Rationale for continuing funding. Identifying special project and bilateral program opportunities.	Monitoring implementation of agreed priorities and strategies through EPRs. Recommending 5-years P&B to CG.	Monitoring strategic plan. Identifying constraints to adoption. Adjusting cooperation strategies.	Own strategic planning. Convincing constituencies of potential payoffs of applied and adaptive res. Identifying institutional and policy constraints.
Assessment of production impact achieved (*ex-post*)	Accounting to constituencies and maintaining their enthusiasm for continuing funding.	Learning from successes and failures.	Accounting to donors and clients. Illustrating to other NARS potential impact.	Accounting to constituencies. Centres & donors. Fund raising. Learning from third country experiences. Methodologies for own impact assessment.

TABLE 2. COMPARISON AMONG MAJOR AGRICULTURAL RESEARCH PRIORITY SETTING METHODS

	PRIORITY SETTING METHOD			
CHARACTERISTIC	WEIGHTED CRITERIA	EXPECTED ECON. SURPLUS	MATH PROGRAM.	SIMULATION
OPERATIONAL CONSIDERATIONS				
1. Relative Cost in Researcher's time	medium	medium	medium	high
2. Relative Cost in Priority Setting Analyst's time	medium	medium	high	high
3. Relative cost in Administrator's time	medium	medium	medium	medium
4. Relative overall data requirement	medium	medium	medium	variable
5. Relative ease of comprehension by decisionmaker	high	medium	low	low
6. Ease of incorporating subjective information	high	high	high	high
7. Ease of incorporating non-quantitative information	high	low	low	medium
GOAL RELATED ISSUES				
8. Requires explicit elicitation of goals	yes	usually	yes	usually
9. Can determine distributional affects on consumers and producers at various income levels	no	yes	no	yes
10. Can handle uncertainty	yes	yes	yes	yes
11. Can consider tradeoff among multiple goals	yes	sometimes	yes	yes
CRITERIA RELATED ISSUES				
12. Can consider private sector research incentives	yes	difficult	difficult	yes
13. Can consider economic policy and trade effects	yes	yes	yes	yes
EVALUATION RELATED ISSUES				
14. Can be used to set priorities for research at the aggregate level	no	yes	no	yes
15. Can be used to set research priorities at the commodity level	yes	yes	yes	yes
16. Can be used to set priorities for non-production or non-commodity oriented research	yes	difficult	yes	yes
17. Can be used to set priorities for basic research	yes	difficult	no	sometimes
18. Can evaluate secondary impacts of research on employment, environment, nutrition	yes	sometimes	sometimes	yes
19. Usually estimates a rate of return to research	no	yes	no	sometimes
20. Can quantify geographic spillover effects	no	yes	no	yes
21. Can consider the lags involved in research and adoption	yes	yes	yes	yes
22. Facilitiates priority setting when the number of commodities is large	yes	difficult	difficult	difficult

Source: Norton and Pardey (1987)

Table 3. Tentative Work Programme for CGIAR Priority Assessment During 1988/89

	1988									1989											
	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Development Data Base & Commodity Indicators																					
- Cereals	----	----	*				*														
- Root & Tubers					----	----	*														
- Food Legumes							----	----				*									
- Livestock							----	----				*									
- Policy & Genetic Resources									----	----	----				*						
Global Agricultural Indicators		----	----	----	----		*									----	----	----	*		
Congruence Model	----	----	*	----	----	----	*	----	----	----	----	*	----	----	*						
Interactive Model							----	----	----	----	----	*	----	----	*						
ACIAR Model															*						
Preliminary Assessment CGIAR Priorities																----	----	----	*	- -	- -
Review of CGIAR Strategies																----	----	----	*	- -	- -

N.B.: ----- = period of work
* = discussion by TAC

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