Setting Agricultural Research Priorities: Lessons from the CGIAR Study

Alex F. McCalla and James G. Ryan

The Consultative Group on International Agricultural Research (CGIAR) is a loose association of 40 donor agencies who provide about 250 million dollars annually to support international agricultural research on developing country problems in 18 institutes. The CGIAR is a relatively small actor on the global scene, representing less than 5% of agricultural research expenditures in developing countries and less than 2% of global public sector expenditure on agricultural research (Gryseels and Anderson). Therefore, it has always had to be selective in choosing the nature and focus of the research it supports. Priority setting and advice on resource allocation is provided by an independent Technical Advisory Committee (TAC). In this paper we provide a brief review of TAC's approaches to priority setting before focusing on their most recent exercise completed in 1992. This effort was by far the most comprehensive attempt to use quantitative analysis to identify priorities and link them to resource allocation. The approach described in TAC/CGIAR (1992) is best characterized as a modified congruence approach or scoring model, using a spreadsheet. The paper concludes with a critical appraisal of the strengths and weaknesses of the TAC approach relative to other approaches.

Alex F. McCalla is professor of Agricultural Economics, University of California, Davis, and Chair, Technical Advisory Committee (TAC), Consultative Group on International Agricultural Research (CGIAR). James G. Ryan is Director General, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India.

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Previous TAC Priority Analysis

The CGIAR was formed in 1971 to be a highly focused international research effort with the goal of expanding the production of food of importance to the poor in developing countries. The first two centers, inherited from joint Ford and Rockefeller Foundation efforts, focused on the three globally most important commodities—rice, wheat, and maize (corn). Two other centers focused on complex tropical farming systems in Africa and Latin America. TAC's early priority analysis (TAC 1973, 1976) addressed the question of what should be added to the CGIAR. Beyond globally important commodities that could be assessed using simple congruence analysis, based on the importance of the commodity, the CGIAR added considerations of (*i*) importance of the commodity to the very poor in less favored areas—millet, sorghum, cassava, yam, sweet potato, and potatoes; (*ii*) quality of diet, especially protein considerations, e.g., ground nuts, pulses, and livestock; and (*iii*) degree of research knowledge already available in the developed world. These other considerations involved broadening the original goal of "doubling the pile of rice in 20 years." Nevertheless, TAC continued to use global data on value of production and sources of critical nutrients. The analysis of priorities was qualitative, based heavily on TAC's judgment and was not directly linked to resource allocation. It was therefore very difficult to compare *ex post* results of research investments with *ex ante* qualitative research priorities.

By the early 1980s the CGIAR portfolio of centers was static at 13 and budget constraints became more binding. Therefore, the relative distribution of resources among activities and commodities became more critical than decisions about what new activities to undertake.

Donor members were also coming to the realization that economic access to food rather than availability of supply might be the most limiting constraint to improving nutrition. Further, concerns about long-run resource degradation and sustainability were beginning to emerge. The next TAC priority exercise (TAC/CGIAR 1987) attempted to include these broader considerations and proposed a relative distribution of resources among nine activities for the year 2010. The paper contained extensive discussions of research needs related to concerns about food supply, income distribution, resource management, and strengthening national research programs. It also laid out a substantial set of priority criteria but made no clear linkages between the criteria and the resulting recommendations. Regarding commodity priorities, TAC continued to compare the relative distribution of CGIAR resources with the relative values of production in the developing world. Again, recommended changes in priorities were primarily judgmental rather than being based on any quantitative approaches. At the conclusion of the discussion of priorities by the CGIAR in Ottawa in 1986, TAC was instructed to explore more quantitative and objective analysis when it prepared its next analysis for delivery in 1991–92. Further, in 1989 it was instructed to link the priority analysis to resource allocation. Thus the stage was set for the analysis discussed here.

The Approach Selected

Priority assessment is necessarily *ex ante*. It, like most economic analysis, attempts to relate a set of demands (needs) to potential supplies of useable research results. As such it requires a decision rule to allocate limited resources among unlimited and competing needs (demands). Most approaches to priority setting focus on the supply side of the equation by attempting to assess the potential impacts of alternative research investments on a specified objective function. If the objective function is simple—i.e., increasing production, increasing the value of production, or increasing economic surplus—such an approach is amenable to computing relative benefits, or rates of return. But suppose the objective function is complex and involves multiple trade offs. How should one proceed?

TAC's approach was to capture these multiple objectives by modifying a traditional measure of impact—changes in the value of production—to take into account concerns with equity, sustainability, and strengths of national partners in order to prioritize demand for research. The modified priority index so devised could then be used as a first approximation for the relative distribution of resources across activities, regions, ecologies, production sectors and commodities. At this point, supply-side considerations would be introduced to adjust the allocation to take into account probabilities of research results, useable technologies, local adaptation, adoption and ultimately impact. This demand-side approach can be contrasted with alternative approaches such as the ACIAR framework (Davis, Oram, and Ryan), which focus much more on the supply side and uses a simple efficiency oriented objective function of expected changes in economic welfare (surplus).

Comparing future priorities to current allocations could proceed in two ways. TAC could have used the background analysis on food needs and research challenges to evaluate current allocations and suggest needed changes; i.e., how should it modify what is. TAC rejected such an approach as too qualitative and judgmental. The alternative was to attempt a quantitative analysis of the desired future allocation of resources, comparing the outcome to current allocations to determine what changes were needed and whether they were feasible.

The approach adopted was to use a modified congruence approach using a spreadsheet analysis to force relative adjustments in priorities in one parameter to be done in the context of a zero-sum game. Simple congruence analysis would suggest allocating research resources in direct proportion to the relative value of production by region and/or commodity. The economic logic of the approach is sound—other things equal, the greatest returns to research should result from allocating resources to those commodities of highest value. Such an approach, however, has two basic limitations. First, it is clearly an economic efficiency criterion and may not adequately reflect concerns about income distribution, equity, externalities, and long-run resource degradation. Second, it assumes that the probability of research resulting in useable technology that can be adopted, adoption levels, and the size of the productivity gain is equal across all commodities. The TAC approach is simplistic compared to the ACIAR approach, which gives detailed attention to the probability of success related to the strengths of national programs as well as expected ceiling adoption levels. TAC's solution to the first problem was to use the spreadsheet to modify the value of production to take into account the more complex goals of the CGIAR and then use the modified priority indices as guides to resource allocation. For the second, probabilities of research impact were introduced only qualitatively at the end of the spreadsheet analysis.

The approach adopted by TAC began with a global assessment of food needs in the developing world for the year 2025. Critical variables were population growth, income growth, and urbanization. TAC accepted UN projections of the need to double food supplies by 2025. The next step was to redefine the CGIAR mission to reflect broadened concerns with sustainability and resource conservation, equity, income generation and employment, deforestation, and self-reliance instead of self-sufficiency. The next decision was whether to proceed using global aggregates (the approach used in earlier papers) or to disaggregate the analysis to use agroecological zones, regionally defined (ecoregions). Because of the increased concerns with sustainability TAC used FAO's agroecological zone classification to identify 21 ecoregions of importance in 4 geographic regions. Research issues in each ecoregion were then discussed in the context of potential CGIAR involvement. Because potentially all research needs are critical, TAC needed a way to rank the relative importance by type of research and research-related activities, agroecology, region, production sector—i.e., plants, animals, trees, and fish—and by commodity. This was necessary because ultimately TAC would need to make recommendations to the CGIAR as to how resources should be allocated to each center.

The analysis begins with value of production by commodity in each regional agroecology. TAC decided that to use only the value of production, as the baseline did not adequately account for issues of poverty and sustainability. Thus, for agriculture, a modified baseline with value of production, number of poor and useable land areas, equally weighted, was adopted, and indexed to equal 1000 for the world. In some cases the addition of these variables produced a composite value considerably different from value of production. In TAC's view the composite base represented a better beginning point for its analysis given the CGIAR's mission.

TAC considered additional parameters which could be used to modify the composite baseline to more directly account for particular concerns. Ultimately, 9 modifiers were selected for the agricultural analysis. These included equity variables such as extent of malnutrition and level of GDP per capita, and sustainability variables such as rate of deforestation and severity of soil degradation. The variability in the capacity of national programs was addressed by modifiers relating to numbers of scientists per country and the size of the country. Finally, a modifier was included to attempt to address the country's capacity to feed itself (self-reliance).

Several issues arise—what criteria should be used in selecting modifiers? How many should be used? How do we know we are not double or triple counting? What weights should be attached to each modifier? Should weights be equal or varied and what value should be used? Further, the spread or variability of the data used for a modifier gives that modifier different implicit weight. The greater the spread of values across ecoregions, the stronger the impact of the modifier. The model provides no objective way to answer these questions. In the end, TAC used its collective judgment.

Regarding weights, TAC conducted sensitivity analysis of the impact of alternative weightings and adopted a uniform weight not to exceed one-half (0.5). The rationale for uniform weights was the judgment that the data used already contained different implicit weights as noted above. Therefore, to apply a second differential explicit weight was unwarranted. The selection of a maximum weight of 0.5 reflected TAC's view that a greater weight would give undue emphasis to the modifiers relative to the baseline. To allow full disclosure to the readers, the results of the sensitivity analysis using weights of 0.25, 0.5, and 1 were displayed.

Following this analysis, TAC was able to produce modified priority values by ecoregion for each production sector—agriculture, forestry, and fisheries—and their included commodities. However, the analysis could not be used to produce relative priorities across five broad activity categories—(*i*) resource conservation and management, (*ii*) germplasm enhancement, (*iii*) production systems, (*iv*) socio-economic, public policy, and public management, and (*v*) institutional building. Relative priorities across these activity categories were determined qualitatively and then used in conjunction with model-generated, modified priority values by agroecology, regions, production sectors, and commodities to finally produce a set of priority recommendations for the CGIAR. In a subsequent analysis, using a financial spreadsheet, current center allocations were adjusted by the priority vectors on activities, regions, and commodities to produce target budgets for the centers for 1998, but this step must be the subject of another paper.

Advantages of the Spreadsheet Scoring Model

One of the attractive features of the approach chosen by TAC is its transparency to both scientists and decision makers. The concepts and variables chosen as proxies for the goals of the CGIAR are intuitively appealing. Additionally, the spreadsheet provides a valuable didactic device, especially in demonstrating the sensitivity of the resulting resource allocations to changes in the weights used for the baseline and modifying variables. Setting the spreadsheet up in a way that entailed a fixed total resource constraint ensured that TAC was made aware that they were dealing with a zero-sum game. Thus, when a weight was changed that resulted in an increased emphasis on a particular decision variable, such as the share of resources to a particular region, it came at the expense of a reduction in other regions. In this manner, TAC was able to explicitly link its priority assessments with the allocation of research resources across the system instead of implicitly, as in earlier exercises. This was a task given to TAC by the CGIAR, and the spreadsheet approach allowed this to be done in a credible and transparent way.

The TAC model allows multiple decision variables to be accommodated. It considers commodities, geographic and agroecological zones as the primary variables of interest in this respect. The desirable balance of research and research-related activities among these variables was of concern also, although TAC was not able to utilize the spreadsheet model to address this question. One requires a production function and/or a benefit-cost approach to be able to first transform what amount to inputs into outputs or goals, which could then form the basis for making choices on a common basis.

An attractive feature of the method was that the selection of baseline and modifier variables was kept separate from the process of establishing weights for them in the spreadsheet analysis. This is an important step in any approach to priority setting. Agreement on the variables which best represent the goals of research should be as objective a process as possible. The establishment of relative weights is essentially a more subjective exercise where decision makers use their collective value judgment. Keeping the two separate aids transparency and allows others to assign different weights. In a system with such a diverse array of stakeholders as the CGIAR, this is a valuable characteristic. Membership of TAC, the centers, the donor community, and the national agricultural research systems continually change, and the TAC analytical framework ensures that there will be available a procedure that remains in the system's corporate memory and provides the rationale for past decisions and scope to change them.

Lessons From the Spreadsheet Scoring Model

The attempt to use the approach to assess priorities and arrive at a pattern of consistent research resource allocations at a disaggregated level proved to be difficult. The resource-constrained spreadsheet turned out to resemble an unidentified system of equations where there were too many dimensions to be estimated (i.e., allocations to commodities, geographic regions, agroclimatic zones, research, and research-related activities) for the number of "exogenous" variables. The model could not be closed except by trial and error iterations. In the end, a consistent set of allocations resulted from a separate financial spreadsheet. TAC made a final judgmental review and marginally adjusted a minority of the center allocations from that derived in the spreadsheet.

In the future, TAC may want to consider not forcing a zero-sum game in priority setting. One alternative would be to use a set of priorities derived from an unconstrained spreadsheet scoring model of the conventional type, such as described in Cessay et al. for the Gambia, and use this to make adjustments to current resource allocations "at the margin." The latter is the preferred approach of Ryan and Davis, although employing an economic surplus approach rather than a scoring model. TAC purposely chose to adopt a "clean slate" approach to priority setting and, for this to work, it required the spreadsheet-scoring model to operate without explicit reference to current resource allocations. At the end, the recommended allocation was compared to current allocations. In the area of commodity research there was a high level of agreement.

The TAC model is input- or demand-driven, as explained earlier, and places primary emphasis on agroecological zones as the unit of analysis. Unlike the Davis, Oram, and Ryan approach, rates of substitution between the attainment of alternative goals with various research portfolios are not elicited with the TAC approach.

It had been intended to arrive at research resource allocations at the level of the agroecological zones, as well as according to commodities and activities. While the analytical process was indeed founded on agroecological zones, the fact that it was not possible to determine how the current research resources of the CGIAR were arrayed across the chosen agroecologies meant that broader geographic regions had to be used to realign the allocation process across this dimension. Additionally, the realization that research spillovers among agroecological zones are pervasive raises questions about the validity and relevance of using agroecologies or even larger geographic zones as a unit of account for the allocation of research resources. There is not a one-to-one relationship between financial input into a region and the flow of benefits. This again illustrates a limitation of the TAC input-driven framework. The Davis, Oram, and Ryan approach explicitly incorporates assumptions about the likely extent of research spillovers among agroecologies and offers guidance about the appropriate choice of agroecology to maximize the prospective benefit stream from research on each commodity.

Being demand-driven means the TAC framework is not capable of indicating milestones by which research outputs can be assessed *ex post*, as in supply-driven approaches such as Davis, Oram, and Ryan. With the latter, assumptions about research and adoption lags, cost savings and other factors can be tested against the actual performance of technologies in the field as part of the evaluation of research. Priorities can then be revised accordingly in the light of such experiences. The TAC model can only be used to monitor research inputs. The only indirect milestones available are changes in values of baseline and modifier values.

As is the case with most scoring models, it was found that the resulting resource allocations were extremely sensitive to changes in the weights selected. Furthermore, it is clear that assigning any weight is arbitrary. The results of its first runs using unitary weights showed that the implied resource allocations to the four basic geographic regions were substantially different to current system allocations. At that point, it was decided to conduct a sensitivity analysis and display the results. TAC, before proceeding with subsequent analysis, agreed, as noted above, that explicit weights should be uniform across modifiers and not exceed 0.5.

During the course of the exercise some other issues arose that remain to be addressed: (*a*) unlike other approaches such as benefit-cost analysis, the TAC approach ignores the time rate at which benefits accrue from alternative research portfolios, an important consideration in sustainability research; and (*b*) by using different baseline and modifying variables for the agriculture, forestry, and fisheries sectors, TAC could not use the model to determine the relative priority to be accorded to the three sectors.

Conclusion

The TAC approach succeeded in development of a transparent empirical framework for the assessment of agricultural research priorities in the CGIAR system. It provides a more intuitively appealing specification of goals than do simple models using value of production or, in particular, economic surplus, the meaning of which is obscure to all but economists. What it lacks is a supply-side to complement its demand-side orientation. One possibility would be to use a supply-side model such as Davis, Oram, and Ryan in a complementary fashion.

The chosen method was not set up to show donors to the CGIAR system the benefits that would flow from increased investments in it. It does, however, offer a mechanism to assist in the allocation of whatever resources donors put at the disposal of the CGIAR.

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