# Research Resource Allocation and Comparative Advantage

*Jim Longmire and Donald Winkelmann*[1]

**Abstract:** Agricultural research managers are under increasing pressure to justify their decisions The empirical analysis of comparative advantage offers considerable potential to provide more precise information to research resource managers for their decisions. In this paper, the potential applications of domestic resource cost analysis to issues of research resource allocation are discussed. Three case studies undertaken by CIMMYT economists on issues of wheat research in Mexico, Ecuador, and Thailand are reviewed. The studies suggested ways by which the wheat research effort in the countries studied might be reoriented. The approach is particularly useful in countries where policy effects are large and in cases where potential new crops are being considered but also has many potential applications in agricultural research resource decisions.

## Introduction

Agricultural research has enormous potential for promoting economic development. Realization of that potential, among other things, rests on effective management of the resources available for such research. This paper concentrates on that part of nationally-supported agricultural research aimed at improved technologies and treats one approach to priority setting based on comparative advantage and a procedure for application of that approach, domestic resource cost analysis.

## Priorities, Research Resource Allocation, and Comparative Advantage

Publicly-supported agricultural research involves a process of juxtaposing the priorities of society with a sense of the attainable—a blending of the desirable with the possible. Conceptually simple, the operational problem of the research manager is dismayingly complex (Ruttan, 1983; and Scobie, 1984). The research manager strives to organize resources to provide the highest gains through the improved technologies that emerge from the application of those resources. Many types of information and criteria could be employed by research managers in their decision making, including the potential extent of adoption of the technology, the productivity gains implied by the technologies, food and nutritional needs when the research comes on stream, the probability of success of the research, and the benefits from the research relative to the investment involved. The weights used to measure gains are shaped by the priorities of the society.

While priorities and associated weights differ from place to place and time to time, they commonly rest on considerations of economic growth, food security, income redistribution, foreign exchange, and the environment (USDA, 1983; and Valdés and Siamwalla, 1984). Economic growth is usually seen as the point of departure, with each of the other factors modifying the weights implied by the first. For example, emphasis on food security might induce a higher weight to easily-stored staples than would emerge from only emphasizing economic growth. Also, income distribution goals could bring higher relative weights for crops typically grown by poorer farmers. Society's considerations immediately introduce a significant complication for the research manager because the trade-offs in the pursuit of particular goals are not always clear, because research (by definition) involves exploring the unknown, and because research takes time.

Information on the ability of different enterprises to contribute to national income (and therefore to economic growth) comes from the empirical analysis of comparative advantage, which provides a guide to the underlying competitiveness of different enterprises and how that competitiveness is affected by productivity changes. The analysis of comparative advantage can also provide information on the types of technologies to be pursued in particular regions (e.g., labour-intensive water-saving) or across regions (e.g., dryland research). Other information that is central to the analysis is the impact of policy interventions on incentives for farmers. Two concerns—valuing the technologies that are the product of research and identifying the characteristics a given technology should have—motivate the discussion that follows.

## Empirical Analysis of Comparative Advantage

Production decisions taken by farmers are based on expectations of prices, yields, and input requirements for particular enterprises, as well as other economic, biological, and social considerations. Explicitly or implicitly, farmers assess the profitability of different enterprises using

prices they face at the "farm gate." Rarely, however, does the profitability faced by individuals closely reflect the profitability to the nation. Subsidies, taxes, and exchange rates often significantly influence farmer prices. Empirical analysis of comparative advantage involves removing those policy effects and calculating national profitability of different enterprises.

Chenery (1961) developed the arguments underlying empirical analysis of comparative advantage. Any good (or service) that is tradeable (has the potential to be imported or exported) has an international price, its opportunity cost. The basic question in analysis of comparative advantage is whether or not a country can import the good for less than it can produce it domestically. If it costs less in terms of foreign exchange foregone to produce the good at home than to import it, then a comparative advantage exists in that good's production. To make such an assessment, one must strip bare the policy effects and compare enterprise budgets using world prices adjusted for transport costs. Domestic resource cost analysis further involves comparing the costs (in terms of foreign exchange) of domestic resources (those not tradeable) employed in alternative enterprises.

Empirical analysis of comparative advantage and policy incentives was advanced considerably in the 1970s, with leadership coming especially from work at the Food Research Institute of Stanford University (e.g., Pearson *et al.*, 1981) and the World Bank. Essentially, empirical analysis of comparative advantage involves the question: *Would* particular industries compete over the longer term against international markets, given the removal of all government assistance through taxes, subsidies, and exchange rates? Note that we emphasize "would" in that question, since removal of all government assistance and policy is not considered likely. Nevertheless, in taking longer term decisions on research resource allocation, knowing the ability of different industries to compete internationally is useful.

Analysis of comparative advantage is well suited to the case of economies with policies that are likely to be altered, as has been the case, for example, in some developing countries recently. The analysis can also be used to consider the impact of specific policies on competitiveness in instances where particular policies are likely to change.

Two key factors underlie whether or not a country has a comparative advantage in a particular activity: resource endowment and productivity. As economies grow, comparative advantages shift because the resource endowments (e.g., productive land, infrastructure, capital plant, and size of the workforce) of the country change. Comparative advantages also shift because technologies and other factors affecting the resource productivity change over time. Thus, the rates of investment in research and the research output will affect comparative advantage. Empirical analysis of comparative advantage can be used to show how productivity changes affect the competitiveness of different enterprises.

For the research manager, the analysis can provide information to assist in allocating resources between industries. A rule of thumb commonly used for allocating research resources between commodities is the share of each commodity to the size of the agricultural sector, subject to some minimum size of research effort on any particular commodity (Scobie, 1984). That rule of thumb is weakest in the case where policy distortions significantly affect market values and where potential exists for new crops or rapid changes within agriculture. Also, the rule is based on market values and takes no account of production costs, either to farmers or the nation. The analysis of comparative advantage can be particularly useful in overcoming those weaknesses, since it explicitly accounts for policies, prices, and costs and can be used to analyze potential enterprises.

Analysis of comparative advantage from the research manager's point of view can also be employed on specific questions of interest to biological researchers. Using sensitivity analysis of yields, for example, one can calculate the amount of productivity improvement needed to provide an enterprise with a comparative advantage in a particular region. For example, a research manager might be informed that commercial crop yields of wheat must be 25-30 percent higher to achieve a comparative advantage for wheat, but soyabean yields only 5-10 percent higher, under current levels of fertilizer and other inputs. The manager could then assess the probabilities of lifting yields through genetic research and redirect research activities towards those activities more likely to achieve competitiveness over the longer term through technological change.

The approach to analyzing comparative advantage offers a framework that brings into much sharper focus the trade-offs that research managers must consider. The approach can be used for many research resource allocation decisions, and the linking of policy effects and productivity to enterprise profitability offers plenty of scope for analyzing issues likely to concern the research manager.

## The Experience at CIMMYT

The potential value to research resource managers of empirical analyses of comparative advantage of alternative agricultural activities has encouraged us to undertake such studies at CIMMYT. Three such studies have been completed in the past two years and further studies are under way. A feature of the studies is their focus on particular regions, on crops of interest to CIMMYT (and competing or complementary activities), and on issues of importance to research resource managers. The methodologies employed in such studies are outlined in Byerlee (1983 and 1984).

The first study involved analyzing the comparative advantage of wheat grown under irrigation in the Sonora Region in northwestern Mexico with sophisticated large scale technology and under dryland conditions in the Tlaxcala Region on the eastern edges of the high valley of central Mexico with simpler small scale technology (Byerlee, 1983). The cost of domestic resources in wheat growing in the Tlaxcala Region was below that of barley and maize, the main competing crops. In the Sonora Region, a greater array of competing crops exists. Wheat was calculated to have a strong comparative advantage over competing crops, including cotton, especially when water supplies were limited. The domestic resource cost of wheat grown under dryland conditions was approximately the same as that of irrigated wheat, despite only little research having been done on dryland wheat. That result implies that a good case probably exists for stepping up dryland wheat research in Mexico. Since the comparison is for two regions within a country, the implications are probably consistent with other policy objectives.

The second study examined the comparative advantage of wheat growing in the Cayambe Region of Ecuador (Byerlee, 1984). Major competing enterprises include maize, potatoes, barley, and dairying. Dairying and potato growing were by far the most profitable enterprises to farmers, and wheat was the least profitable (Table 1). However, the analysis indicated that Ecuadorian policies, especially those concerning exchange rates (and hence subject to strong external pressures), discriminated strongly against wheat. When adjustments were made for those policy effects, wheat was calculated to be highly competitive with dairying. In that case, the analysis suggested that a case existed for increasing research on wheat, despite the fact that the wheat industry had declined considerably in Ecuador in the past decade.

The third study looked at the question of the comparative advantage of wheat growing in the Chiang Rai Province of northern Thailand (Harrington and Sudarat, 1984). Wheat is little grown in the area, in large part because disease severely restricts yields. The study considered wheat in two zones: the upland region on land not planted to rice and the lowland region in rotation with rice when no other crops were grown on land where supplies of water in the wheat-growing months were limited. The main findings were that on the upland, maize and mung beans were more competitive crops and major yield increases would be needed to make wheat competitive. In contrast, wheat phased into a lowland cropping system, where no other crops grew over the dry season, was quite competitive with only modest improvements in yields, providing that yield losses on rice were not seriously affected. The study suggested that yields needed to be some 40 percent higher in the upland than in the lowland cropping system for the upland wheat crop to become competitive. Thus, the study suggested the targeted domains for wheat research be reconsidered. That study is a good example of how sensitivity analysis can be employed on specific biological research questions.

With the experience gathered from studies undertaken to date, we intend to pursue further work at CIMMYT on the analysis of comparative advantage in specific regions in developing countries.

**Table 1—Farmer and National Returns to Land, Cayambe Region, Ecuador, 1983 (sucres/ha)**

| | Farmer | National |
|---|---|---|
| Wheat | 13,360 | 23,330 |
| Barley | 13,880 | 14,620 |
| Potatoes | 64,200 | 45,300 |
| Dairy (intensive) | 26,550 | 18,850 |
| Dairy (extensive) | 15,540 | 12,830 |

[Source: Byerlee (1984).]

The main benefit from such studies from the research manager's perspective is that they help sift through the impacts of policies on farmer incentives and assist in allocating resources between different commodities in particular regions. With a wider regional coverage, such studies would also assist research managers in the allocation of resources between regions.

Another major benefit that we see coming from such studies is additional and sometimes unique information on opportunities for agricultural research. Because the framework of analysis can guide thinking about the possible introduction of alternative enterprises over the longer term, the agricultural research manager is encouraged in that thinking. Sensitivity analysis can be conducted to derive the levels of commercial yield necessary for a given level of inputs to make particular crops competitive. Also, the research manager is exposed to the notion of trade-offs between enterprises and, therefore, between alternative research strategies.

A final benefit from such studies is in demonstrating to research managers the implications of changes in specific subsidies, taxes, and exchange rate policies on farmer incentives. A better understanding of those effects will assist the agricultural research manager to allocate resources to industries that are more likely to be internationally competitive over the longer term.

## Conclusion

Knowledge of comparative advantage through domestic resource cost analysis can enhance the precision of planning research resource allocations. As the approach reveals the separate influence of various policies on private and national gains, judgments about the likely permanence of given policies can be factored into projections about the future relative importance of given crops; e.g., the Ecuador study. Also, the approach can be extended to potential new crops, permitting more precision in describing yields needed to bring such crops into play, here adding to the precision of researcher estimates of the chances of reaching threshold levels; e.g., the Thailand study. Finally, where efforts on a given crop are being allocated among regions within a country, the approach is at its strongest as, in this case, only income distribution goals might cause significant departures from the application of straight comparative advantage (e.g., the Mexico comparison).

Two final points. The technique is not, however, a panacea, only an additional tool for the research manager. The technique has significant contributions outside of research resource allocation, especially in policy analysis.

## Note

[1]Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT).

## References


Byerlee, D.R., "Comparative Advantage and Policy Incentives in Wheat Production in Rainfed and Irrigated Areas of Mexico," CIMMYT Economics Program, El Batán, Mexico, June 1983.

Byerlee, D.R., "Comparative Advantage and Policy Incentives for Wheat Production in Ecuador," CIMMYT Economics Program Working Paper 05/84, El Batán, Mexico, Dec. 1984.

Chenery, H.B., "Comparative Advantage and Development Policy," *American Economic Review*, Vol. 51, No. 1, 1961, pp. 18-25.

Harrington, L.W. and Sudarat, S., "Wheat in Chiang Rai, Thailand: A Preliminary Look at Comparative Advantage," paper presented at the International Symposium on Wheat for More Tropical Environments, El Batán, Mexico, Sept. 24-28, 1984.

Pearson, S.R. *et al.*, *Rice in West Africa: Policy and Economics*, Stanford University Press, Stanford, 1981.

Ruttan, V., *Agricultural Research Policy*, University of Minnesota Press, Minneapolis, 1983.

Scobie, G.M., "Investment in Agricultural Research: Some Economic Principles," CIMMYT Economics Program Working Paper 03/84, El Batán, Mexico, Aug. 1984.

USDA, *Food Policies in Developing Countries*, Foreign Agricultural Economics Report No. 194, Economic Research Service, Washington, DC, Dec. 1983.

Valdés, A. and Siamwalla, A., "Foreign Trade Regime, Exchange Rate Policy, and the Structure of Incentives for Agriculture: Issues and Policies," International Food Policy Research Institute, Washington, 1984.