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EX ANTE ASSESSMENT OF CONSUMPTION AND NUTRITION EFFECTS OF AGRICULTURAL RESEARCH

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Current and expected future malnutrition has been used extensively in support of investment in research on food production. However, expected nutritional effects do not usually play a significant role in establishing priorities within such research and designing the desired technology. Expected impact on total food or nutrient supply has been used as a proxy for relative nutritional impact of alternative lines of research. However, the relative change in supply is a poor indicator of relative nutritional impact.

There are three principle reasons for this. First, the proportion of the total supply change which affects nutrient-deficient groups varies among research projects. Secondly, the adjustment in the consumption of foods, other than those for which supply is changed, may be of considerable importance in determining the final nutritional implications and, thirdly, the nutritional status is affected by the magnitudes and distribution of incomes generated by the particular research output. While the magnitude of incomes generated is likely to be related to the magnitude of the supply change, its distribution need not be.

The nutritional effect of a given line of research depends on the resulting change in nutrient consumption by deficient groups. But the resulting change in nutrient consumption by deficient groups is determined by a number of factors, of which change in total food supply is but one. Thus, efforts to incorporate nutritional goals into agricultural research planning must look beyond expected supply effects.

Decisionmakers in agricultural research who wish to incorporate nutritional goals into research planning are severely constrained by the lack of supporting research on this topic. The purposes of this paper are to explore how nutritional goals or an acceptable proxy for such goals may be considered and to suggest supporting research of high priority. The first part of the paper outlines the issues and relationships to be considered. An approach for dealing with nutritional effects of agricultural research and technological change is suggested next and the paper finalized with an outline of urgent research needs.

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Issues and Relationships

Nutritional considerations may be incorporated into agricultural research planning either by orienting the research itself toward the achievement of nutritional goals or by identifying associated measures to facilitate the achievement of these goals or correct or compensate for undesired nutritional effects of research. Such measures may consist of projects or policy measures of various kinds. Whether nutritional considerations are best dealt with through research and technology design or through complementary measures depends on the particular set of circumstances. In either case, however, it is essential to pay explicit attention to nutritional effects of research if the achievement of nutritional goals is of high priority. Modifications in technology design or introduction of complementary measures may have significant nutritional effects without causing unacceptable changes in the achievement of other goals. Which tradeoffs related to the achievement of conflicting goals are acceptable is, of course, a political question. But to deal effectively with this question, the tradeoffs must be explicitly considered. Merely assuming that increasing food production will result in improved nutrition or that increasing production of non-food cash crops will have no adverse nutritional effects is to avoid the issue. Positive nutritional effects may be greatly enhanced and negative effects avoided if nutritional issues are considered along with other issues in research planning.

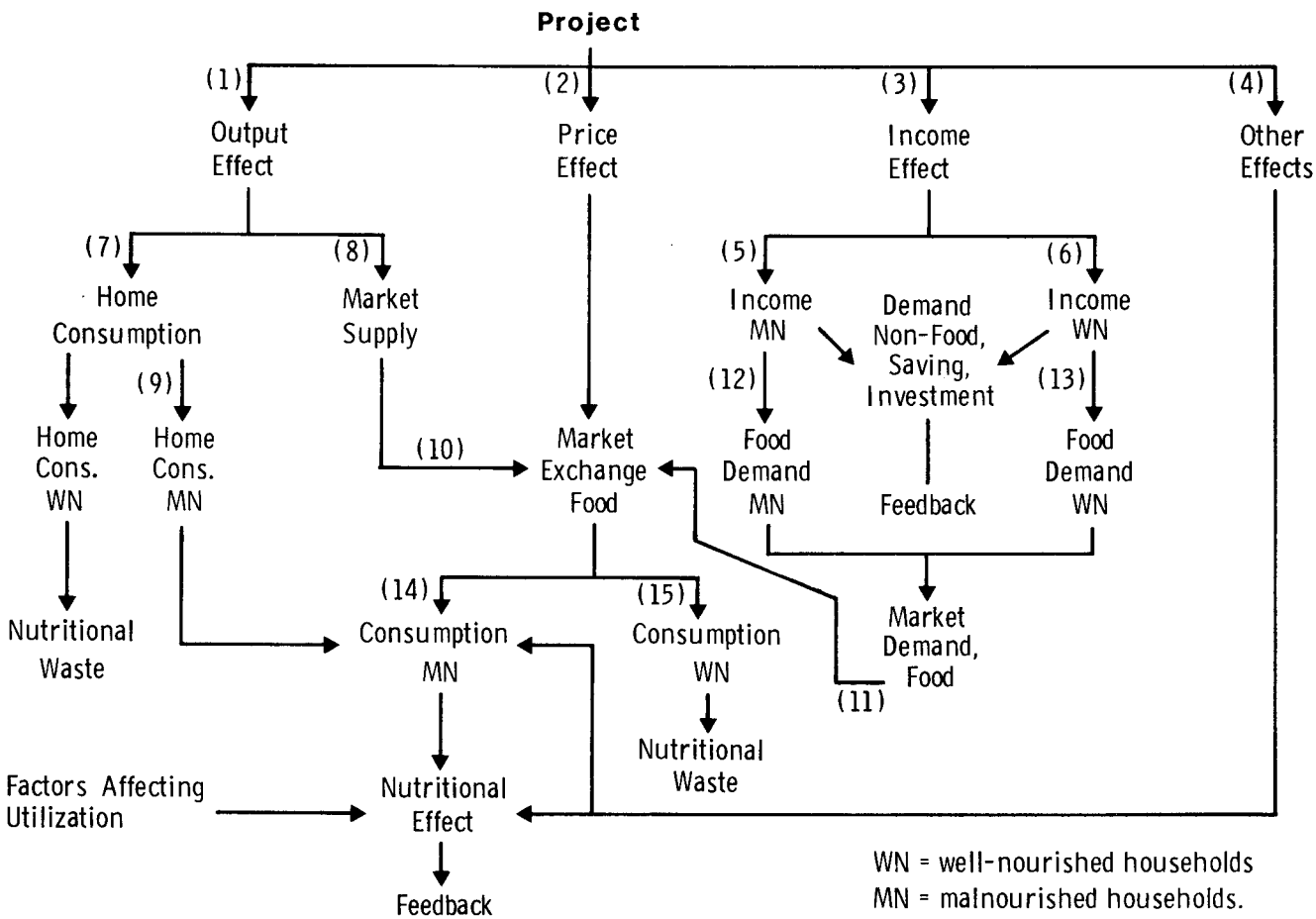
A conceptual framework for the estimation of nutritional effects of agricultural research and technology is shown in Figure 1. Its purpose is to show the most important linkages between a research project and the nutritional status as well as the key parameters for which data should be sought and analysis performed. Probability of success in research, and the associated research costs and time requirements are not shown. A given research output provides the point of departure.

Agricultural production research may influence nutrition through changes in food output, food prices, and incomes. The output effect may be direct, e.g., expanded production or change in the nutritional composition of a commodity towards which the research is aimed, or it may be indirect, e.g., commodity substitution or output effects of input oriented research. The output effect on nutrition may be positive, neutral, or negative. Changes in output are reflected in either home consumption, market supply, or both. Changes in home consumption may or may not affect households with malnourished members. Changes in market supply may, in turn, influence prices and consumption by malnourished and well nourished households. The key question from a nutritional point of view is not how the aggregate output of nutrients is affected but the change in the consumption by malnourished households.

If the change in market supply is sufficiently small not to have any impact on prices or prices are otherwise kept constant, then the nutritional effect of output changes per se is limited to a possible change in home consumption by malnourished households. Consumption by malnourished households obtaining their food through the market exchange will not be affected. This will be the case whether nutrient output is expanded or reduced.

Agricultural research and associated public policies may affect food prices directly, or indirectly through changes in output or incomes. Whether direct or indirect, the price effects

Figure 1. Illustration of Linkages Between Project and Nutritional Effect.



may be important for the distribution of food and real income among groups, e.g., malnourished and well-nourished, and should be considered in research planning. In the case of most agricultural research, any price effects are likely to be indirect. However, existing or suggested policy measures of various kinds, e.g., price support and foreign trade policies, may, of course, have significant direct price effects. Such effects should be considered in research planning. Agricultural research may have a very significant nutritional impact through changes in incomes of malnourished groups. Low-income farmers, agricultural workers, workers in rural service, and input supply sectors are some of the most obvious potential beneficiaries. Changes in incomes by these groups affect their demand for food which, in turn, alters their competitive position in the market and, as a result, their food consumption. Furthermore, changes in incomes by producers may alter their home consumption.

Income changes among well-nourished groups is also likely to influence food demand, the competitive market position of the various consumer groups and, thus, consumption of well- and malnourished groups. Increasing incomes among well-nourished groups may bid up food prices and reduce consumption among malnourished groups. If prices are kept constant and the market supply is adjusted to avoid market shortages, income changes among well-nourished households will not influence nutrition.

Agricultural research may influence consumption and nutrition in ways other than those mentioned above. In particular, some research may alter the intrahousehold distribution of incomes and household budget control. Furthermore, the demand for time by the various household members may be changed. These and related issues may have significant nutritional implications. Factors influencing the extent to which consumption changes among malnourished households will result in nutritional changes, e.g., health, intrafamily food distribution, and nutrient balance in the diet are, of course, of major importance.

Only the first-round effects have been discussed. This should not be interpreted to mean that agricultural research is expected to have no sustained nutritional effects or that nutritional changes have no impact on future economic growth and equity. On the contrary. By focusing agricultural research and technological change on nutritional and other basic needs as an integral part of economic growth, improvements in human resources and a more equal access to the benefits of growth are facilitated. Furthermore, investments and savings resulting from technological change in agriculture and associated factor and consumption linkages may facilitate significant future nutritional changes. However, in order to keep the analysis within reasonable limits, only the first-round effects are explicitly considered.

Key Parameters

Figure I illustrates the key relationships and parameters. The relationships were discussed above. Key parameters may be divided into two groups: (1) project-specific, and (2) non-project-specific parameters. Project-specific parameters refer to the output, price, income, and other effects illustrated in Figure I by (1), (2), (3), (4), (5), and (6). Overall direct output and income effects should be considered in research planning irrespective of whether nutrition is an issue or not. However, the effects need to be disaggregated on malnourished and well-nourished groups to be useful for purposes of nutritional assessment. Indirect output effects, e.g., commodity substitution, should be considered in research where they could be expected to have significant nutritional effects. Effects on the seasonal food availability--an issue of considerable importance for nutrition in many cases--should be considered. The impact of research on non-food agricultural commodities on food supply and food prices is also an important issue.

Direct price effects are uncommon and effects on intrahousehold income distribution, budget control, and time allocation may be excessively difficult to estimate. Thus, to incorporate nutritional considerations, output and income effects would ideally be estimated by group, e.g., malnourished farm households, malnourished landless labor, etc. Furthermore, in cases where they appear to be important, attempts should be made to estimate project effects on intrahousehold variables mentioned above.

Other project specific parameters refer to the distribution of the output effect between home consumption and market supply (7), (8), and the resulting change in home consumption by malnourished farm households (9).

Once the market supply for a given commodity has been affected, its impact on market prices is not likely to depend on the particular research project. The same is the case for changes in a particular household's or group's market demand for a particular commodity due to income changes. Thus, parameters needed to estimate the indirect price effects on supply and demand changes (10) and (11), are nonproject specific. Similarly, the relationship between the demand for individual food commodities and incomes of a particular household, i.e., the change in demand caused by a change in incomes, is not a function of the particular project. But the parameters for this relationship may differ

from one household or group to another. Thus, parameters must be estimated for each of the groups of interest. Since, as mentioned above, income changes among well-nourished groups may incluence consumption by malnourished households, the analysis must include both well- and malnourished groups (12) and (13).

The relationship between commodity demand and incomes may depend on the intrahousehold distribution of incomes and budget control. Thus, if a project shifts income or budget control from one household member to another, the above relationships and parameters may change. In other words, if greater household budget control is gained by a certain household member, a larger or smaller proportion of incomes or income changes may be spent on food. This implies that the parameters explaining income-food demand relationships must be re-estimated. In such cases, reliance on existing non-project-specific parameters may cause large errors. Projects affecting the role of women in low-income rural households are of particular interest in this respect.

On the basis of estimates of changes in the market prices for foods and changes in the relative competitive position of the various consumer groups, the distribution of the market supply between malnourished and well-nourished groups may be estimated (14) and (15).

It has been assumed but not explicitly stated throughout the above discussion that malnourished households were identified and grouped. This, of course, is not necessarily so. Therefore, the most critical non-project-specific information is that needed to identify households with malnourished members and group these households according to the type of nutritional problem (what and who) and primary causes. These are the groups for which the above disaggregated analyses must be carried out.

The discussion presented in this section on key relationships and parameters may be briefly summarized as follows: Efforts to estimate ex ante the nutritional consequences of agricultural research projects should ideally seek answers to the following questions:

1.) What are the nutritional problems; who is short of what and why? The information needed to answer this question is not project specific. Rather, it should be considered as essential background information for all development activities and public policy. Thus, the cost of obtaining and updating such information should not be charged to an individual agricultural research project.
2.) How does the project affect the output of each individual food commodity? Both direct and substitution effects should be considered. For example, how would a non-food-oriented project affect food production through area substitution? Are there complementary measures that are expected to influence food availability?
3.) What proportions of output increases or decreases are expected to be reflected in home consumption by malnourished households and what proportions are expected to be added to or subtracted from market supply?
4.) Is the project expected to change the seasonal food availabilty?
5.) Are expected changes in market supply likely to have an effect on commodity prices? If the answer is affirmative, attemps shuold be made to quantify the the effect. How would such price changes affect future food production and home consumption by malnourished farm households? Such analysis would rely on estimates of the appropriate elasticities by group. These are discussed below.
6.) Is the project likely to have a direct price effect? If the answer is affirmative, attempts should be made to quantify the effect.
7.) How are incomes and costs of the project expected to be distributed among the groups of interest, i.e., identified functional classes of malnourished households (low-income farmers, landless labor, etc.) and well-nourished as a single group?
8.) What are the income and price elasticities for each of the principal food commodities within each of these groups? These estimates are not project specific and should be considered as essential background information. How are the income changes expected to affect the demand for the various food commodities and home consumption?
10.) What is the net effect of changes in supply and demand on commodity prices?
11.) What is the net effect of changes in incomes, prices, and home consumption on food consumption by malnourished households?
12.) Does the project alter existing intrahousehold distribution of incomes, budget control, and food? If the answer is affirmative, efforts should be made to judge how this might affect the income-consumption relationships, the consumption patterns, and the nutritional effects of changing household consumption. Until additional research has been done, only qualitative judgments can be made on this topic.
13.) Is the project expected to affect any of the factors that determine the extent to which changes in consumption by malnourished households will affect nutrition,

e.g., health and time constraints?

14.) Are there any obviously important second-round nutritional effects that should be considered?

Some of the information needed to answer the above questions is nonproject specific, i.e., it need not be obtained for each project. Thus, an effective functional classification of the population, estimates of income, supply and demand elasticities, and descriptions of the market structure are examples of things that--once obtained and periodically updated--may serve for any research and development project, provided an effective disaggregation is performed. In fact, whether the focus is on project specific or non-project-specific parameters, the primary difference between the information needed for assessment of impact on efficiency goals and that needed to assess nutritional effects is the level of disaggregation. As a rule, average estimates for the population as a whole are of little value for the assessment of nutritional consequences.

Obtaining solid quantitative estimates on all the relationships discussed in this section is likely to be excessively resource and time demanding. Surely, beyond a certain point, such efforts would present diminishing returns and attempts to obtain quantitative perfection could result in very low or negative marginal net returns. Thus, short cuts that would provide effective guidelines without requiring excessive amounts of resources and time must be sought.

A Suggested Assessment Approach

Ideally, ex ante assessment would show how selected nutrition indicators such as mortality of selected groups, work capacity, or anthropometric measures would be affected by the project under consideration. However, cost and time considerations, together with unavoidable uncertainties associated with the results of any ex ante assessment approach would undoubtedly point in the direction of an approach considerably less "perfect," yet providing effective--although possibly rough--estimates of nutritional effects of agricultural research projects.

The assessment approach suggested below is a compromise between cost and time considerations and "degree of perfection." It is recommended that further research and testing be undertaken to explore the feasibility of the approach for routine project assessment. The approach attempts to estimate how a given project would affect consumption by households with malnourished members, ignoring intrafamily food distribution.1/ Project impact on intrahousehold distribution of income and budget control, time allocation of individual household members, and seasonal variations in food availability is also ignored in this approach.

Both output and income effects are considered. The approach assesses the nutritional effects in terms of total change in calorie consumption by malnourished households caused by the project.2/ The approach requires quantitative estimates of project impact on the supply and home consumption of each of the food commodities affected and the resulting price changes. It also requires quantitative estimates of project impact on incomes by functional group and the resulting change in consumption. The approach is briefly outlined below.

Development and empirical testing of a model to estimate the output effect on calorie consumption by various income groups is reported elsewhere (Pinstrup-Andersen, Londono, and Hoover, 1976). Basically, the model estimates (1) how an increase in the supply of each of a number of food commodities is distributed among income strata, (2) the corresponding adjustments in the consumption of all foods, and (3) the resulting impact on calorie and protein consumption by income stratum. A model to estimate the income effect has also been developed and empirically tested (Pinstrup-Andersen and Caicedo, 1978). This model estimates how calorie and protein consumption by various income strata is affected by changes in stratum incomes.

Thus, on the basis of expected impact of a project on commodity supply, home consumption, and incomes by the various groups of interest, the models may be combined to provide an estimate of the total change in calorie and protein consumption by malnourished households. Together with estimates of project costs, such a measure may provide useful guidelines for project design, if improved nutrition is a major goal. Using sensitivity analysis for alternative project elements and designs, the cost-effectiveness of such alternatives may be estimated at the margin, e.g., the cost (in terms of project benefits foregone or resource costs) of improving the calorie intake by target households by a certain amount.

Thus, the primary utility of the approach for project design relates to the choice among alternative projects or project designs. Suppose that a given project modification results in an expected reduction in net economic benefits from the project of x dollars while expected calorie consumption among households with calorie-deficient members increases by y calories. The cost of expanding the calorie consumption by one calorie is then x/y. This ratio may be compared to the least expensive alternative way to expand calorie consumption. One decision rule might then be to accept the project modification only if the expansion in the calorie consumption cannot be obtained at lower cost by some alternative means. Using this approach as a guideline for (1) choice among projects, (2) project

design, and (3) modifications of on-going projects assures that efforts to achieve nutritional goals through agricultural research projects do not ignore more cost-effective alternatives for reaching these goals.

While elements of the approach presented above have been developed and empirically tested, the approach has not been tested in its totality. Therefore, it is important that testing and adaptation of the approach be performed before it is introduced into routine project assessment. Such testing and adaptation is currently being planned by IFPRI and the World Bank.

Needs for Additional Research

There is an urgent need for the development and testing of assessment approaches such as that mentioned above, which could be applied within reasonable resource and time constraints. While this in itself would be a major research undertaking, additional research is needed to facilitate ex ante assessment of consumption and nutrition effects of agricultural research and other development efforts. In particular, additional research and testing are needed on three topics:

1.) Development and testing of workable methods to estimate or approximate price elasticities of demand by food commodity and functional group. Price elasticity estimates by income stratum or functional group are critical to the kind of assessment suggested here. Yet, disaggregated time series data are very scarce and currently used methods for estimating price elasticities from cross-sectional data are not acceptable when applied at the individual commodity level. Innovative work in this area combined with procedures for collection of the appropriate time series data might have a high payoff.

2.) Research to improve our understanding of the consumption and production decisions made by semisubsistence rural households with particular emphasis on: (a) the interaction between the two, (b) the effect of changes in intrahousehold distribution of income control and time allocation on food consumption by individual household members, (c) the effect of production and price risks and seasonal variation in food availability on consumption and nutrition, and (d) ex post evaluation of the consumption and nutrition effects of technological change within the semisubsistence rural household. Current knowledge on these issues is grossly deficient for ex ante assessment of the consumption and nutrition effects of alternative research and technology for small farm agriculture. Thus, until additional information is obtained, expected consumption and nutrition effects cannot play a major role in the design of such research and technology. Fortunately, a considerable amount of research is underway on some of these issues, particularly the question of time allocation.

3.) Ex post evaluation of the consumption and nutrition effects of technological change in selected areas and for selected commodities. Findings from ex post evaluations are likely to be useful for the preparation of ex ante assessment. Furthermore, such findings would provide guidelines for the design of research and technology to be pursued, even in the absence of formal ex ante assessment. They may also assist in the design of public policies and strategies for institutional change. In particular, the findings would be useful for the design of public policy measures aimed at facilitating desirable consumption/nutrition effects and correcting or compensating for undesirable ones.

Notes

1/If the necessary data are available, consumption by malnourished members of the household may be substituted for household consumption. This would clearly improve the approach but also increase costs.

2/The effect on the consumption of other nutrients, e.g., protein, may also be estimated.

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