Nutritional Adaptations of Linear Programming for Planning Rural Development

Peter H. Calkins

Linear programming can help plan rural development if the income-maximization and least-cost diet models are integrated within the resource and management limitations of small-scale representative farms. Seven modifications adapt linear programming to subsistence households. Caveats in this context include risk, level of nutritional awareness, production scale, and result sensitivity. Through six model formulations for a representative Nepalese farm, linear programming identifies the most nutritious and profitable production patterns; trade-offs between nutrition and income; and the costs of constraints relating to levels of credit, market availability, and human capital development.

Key words: linear programming, Nepal, nutrition, rural development, subsistence farms.

The decade of the 1970s focused increasingly on holistic solutions to rural deprivation. The shibboleths of the day called for "integration," "appropriateness," and attention to the nutritional and income needs of those passed by in the biochemical revolution in crop production of the 1960s. With regard to human nutrition, linear programming has proven successful in planning least-cost menus for hospitals in developed nations (Balintfy, Stimson and Stimson, Hall). But the institutional setting of the hospital or school in a developed country is far different from the homestead of a subsistence farmer.

The farm family in a developing country must be both an efficient producer and an efficient consumer of food. If we assume the objective is to maximize the value of production subject to meeting minimal dietary requirements, a linear programming framework can be applied at the local, household level. The linear program must combine the least-cost diet model with the income maximization model and build in the resource and management limitations of small-scale farms in representative agroclimates.

Previous studies have furthered such research methodology (Mudahar, Singh, Smith, Andrews and Moore). In this paper, I first summarize specific modifications for applying linear programming to small-scale farms in subsistence economies, while pointing out the limitations of linear programming as a tool in this context. Then, I use several linear programming formulations to test the feasibility of, and measure the trade-offs between, income and nutritional objectives. Finally, I illustrate the use of linear programming to identify more nutritious, higher-income production patterns for a representative farm in the hill region of Nepal.

Modifications of Linear Programming for Application to Subsistence Farms

The nonmarket orientation of subsistence farms means that they face unique limitations in the acquisition and use of technology and the factors of production and that they cannot depend upon the market to supply their food needs. The type of linear programming model used to optimize production on a farm in a developed, capitalistic economy must be re-

Peter H. Calkins is an assistant professor, Department of Economics, Iowa State University.

The author is grateful to Michael Boehlje, Iowa State University, Victor E. Smith, Michigan State University, and two anonymous reviewers for reviewing an early draft of this paper, and to Daniel Sisler and Richard Boisvert, Cornell University, for their suggestions in formulating the conceptual framework.

structured so that realistic and beneficial farm plans may be extended to subsistence farms. Seven modifications were developed in a study of four representative farms in Nepal (Calkins), which would apply to most subsistence contexts.

First, in addition to production, feeding, milling, selling, and input purchase activities, activities that portray processing, storage, purchase and consumption of fresh or preserved foodstuffs must be included (table 1). These permit the family to retain foods for home consumption and to spread their intake of nutrients over the year. An appropriate loss in nutrients should be included to reflect the effects of cooking, drying, or fermentation. Whenever a commodity can be either sold or consumed by the household, the model must contain both selling and consumption activities so that the solution will determine the optimal quantities to be devoted to each use. Radishes and paddy rice in table 1 are examples.

Second, nutritional constraints representing the aggregate family demand for each nutrient in each season (e.g., monsoon protein, winter niacin) should be included in the rows of the matrix at greater than or equal to minimum levels. The example in this paper includes nine types of nutrient constraints in each of three seasons, yielding twenty-seven matrix rows in all. Required levels may be taken from the recommended daily intakes for various sex and age groups (FAO). For example, the average daily requirements for a prime-age, adult male were 2,625 calories, 48 milligrams (mg.) protein, 450 mg. calcium, 18 mg. iron, 1,500 mg. carotene, 9 mg. thiamine, 1.35 mg. riboflavin, 14.7 mg. niacin, and 30 mg. ascorbic acid. For protein requirements in particular, the weight of each family member should be multiplied by the factors implicit in the FAO computations for "seemingly well-nourished" individuals. In this paper, no attempt will be made to take account of the quality of protein consumed, though this may be included through nonlinear formulations (Smith). Aykroyd is a good source of information about caloric requirements: for major age-sex groups over the age of fifteen, he gives basic metabolic and energy expenditure totals for different types of work. Labor records must then be consulted to determine the percentage of sedentary, moderate (e.g., cooking, walking, and harvesting grain), and heavy (e.g., carrying loads, woodchopping, and plowing) work performed by each sex-age group. Adjustments for different basic metabolic needs due to temperature changes should also be reflected in the figures for seasonal caloric requirements.

Third, constraints may have to be added to reflect the tastes and preferences of the local population. Sweet potatoes may be a rich source of β-carotene, but if the family refuses to eat any more than ten kilograms per month of this food, a less than or equal to constraint should be included. Similarly, there are physiological barriers to eating too much of a given foodstuff; it would be unrealistic to hope that a

Table 1. Partial Linear Programming Matrix Adapted for Human Nutrition on Farms in Developing Countries

	Grow Paddy	Grow Radish	Raise Cows	Hire Labor	Mill Paddy	Eat Rice	Sell Paddy	Ferment Greens	Eat Radish	Eat Garlic	Graze	Row Type
Income over consumption	−	−	−	−	−		+					N
Land	+	+										L
Labor	+	+	+	−	+		+	+			−	L
Manure	+	+	−									L
Paddy	−				+		+					L
Rice					−	+						L
Paddy straw	−		+									L
Radish		−							+			L
Radish greens		−						+				L
Calories						+		+	+	+		G
Ascorbic acid								+	+	+		G
Paddy area	+											G
Max. garlic consumption										+		L
Herd size			+									E
Grazing transfer			−								+	L

Note: "+" indicates a positive matrix element coefficient; "−" indicates a negative matrix element coefficient; blank indicates no entry.

family could depend upon garlic as its major source of protein, for example. Thus, the "optimal" solutions for meeting the consumption demands most efficiently will not necessarily provide acceptable diets for the family. These "structural and variety requirements" are noted by Balintfy.

Fourth, the maximand must be changed from the simple "net farm income" of the standard linear program to "net farm income over consumption." Because of the changes listed above, the maximand now reflects not just the gross value of produce less the cost of purchased inputs and operating capital, but also the retention of part or all of the produce for home consumption and/or the purchase of food from the market to meet nutritional requirements.

Fifth, special attention should be given to computing the supply and productivity of labor, the most abundant resource on most subsistence farms. Careful observation of common tasks performed by each member of the family yields a coefficient of comparative productivity, which should be multiplied by the total number of hours per day that person has available for agronomic and livestock production. Where livestock grazing is a significant activity on the farm, a grazing externality activity should also be included to reflect the labor saved by herding more animals. As each animal is added, average labor requirements per head in the farm plan are reduced by an appropriate amount in the months in which the animals are herded.

Sixth, because of the malnourishment or even death which may attend crop failure, land allocation constraints should be included in some formulations to reflect the traditional allocation of land to broad classes of crops, like grains and legumes, which has allowed the farmer's forebears to survive in the area. Land purchase or rental activities should be included only after careful consideration of local conditions.

Finally, traditional production techniques should be adhered to, at least in the initial formulation of the model. The use of chemical fertilizers, pesticides, and other improved technology may not be suitable to the subsistence farmer's resources, risk-bearing ability, or level of management.

Alternative Formulations

In developing a farm model for use in generating income and nutritional policy recommendations for a wide number of farms, the linear program should be systematically modified to determine the sensitivity of the optimal solution to different policy measures and goals of the farm operator. For instance, the prices included in the maximand row, and the type or level of constraint as indicated in the right-hand sides may be varied, as well as the type and number of activities included in the matrix. The following six formulations were used by the writer (Calkins):

(*a*) the simple short run (allowing for adjustments that can be made within two cropping seasons) with no nutritional constraints;

(*b*) the short run with nutritional constraints and unlimited use of the market to meet consumption demands, i.e., the family may purchase food from the market place and sell surplus production;

(*c*) the short run with nutritional constraints and marketing limited by a ceiling on capital borrowing—this formulation both highlights the trade-off between income and nutrition and induces home labor to be more productive, as there are limited funds to hire outside labor;

(*d*) the short run with nutritional constraints and no food buying—this formulation shows the trade-off between income and nutrition when all food consumed on the farm must also be produced there;

(*e*) the short run with nutritional constraints plus the assumption that 75% of acreage must be planted to cereal and leguminous crops—this formulation reflects the opportunity cost, if any, of traditional cropping patterns; and

(*f*) the long run, a period ten years hence, including projected price relationships and allowing for changes in levels of livestock and fruit tree production—this gives an idea of the ways in which the production of given commodities may become or remain profitable or nutritious over time, and why.

One caveat with regard to the use of linear programming is its inability to treat risk. By assuming perfect knowledge of market prices and yields—with no account of how each varies separately over time, or how they work together to produce variable total revenues—linear programming tends to predict optimal combinations which may in fact be risky. The best way to overcome this problem is to reformulate the model as a quadratic program with the variance in returns as the objective function to be minimized and a target income as a parameterized constraint. Unfortunately, in developing countries adequate time-series data are not available, while cross-sectional variances would ignore interannual price patterns. The 75% acreage constraint to grain and legumes, whose yields are fairly stable, is an alternative (if mechanistic) way of reflecting risk aversion.

A second caveat regards the assumption that subsistence families are aware of and wish to optimize their nutritional statuses. Linear programming can only suggest what optimal changes in the diet might be. Therefore, the optimal results must be attended by nutritional extension programs before they can be fully realized.

A third caveat regards expanding acreages to activities currently engaged in on a small scale. Not only does the traditional problem of linearity distort the programming of biological systems; there is also the heroic assumption that measurements of planted area, inputs, and output from, say, three tomato plants are sufficiently accurate to reflect production conditions on a per hectare basis.

A fourth caveat is that programming results may be sensitive to slight variations in resource levels, prices used, and the choice of maximum or minimum consumption levels and area constraints. Two approaches may be taken to improve result applicability. The first is to make sure that the farm selected is as representative as possible of its group for policy purposes. The farm in this paper is one of four chosen on the basis of a survey of 600 households to represent discrete microclimates and resource levels. Case studies were used rather than synthetic composite farms because of the dangers inherent in averaging resource availabilities and other structural parameters. The second approach is to perform sensitivity analysis to determine the range over which the results are applicable to a given farm.

The six institutional formulations to be presented do allow policy analysts to identify barriers that prevent households from taking advantage of crop and livestock production combinations which could increase nutritional adequacy and improve income. Given the caveats noted, such an identification of barriers may be of greater prescriptive usefulness than specific behavioral recommendations to individual farm operators.

Programming Formulations

In this section of the paper, I will illustrate the use of linear programming to identify more nutritious, higher-income production patterns for a representative farm in the hill region of Nepal.

A Sample Farm from the Nepalese Hills

To exemplify each of the six formulations, let us consider Masino Tamang (assumed name), whose homestead lies at 1,992 meters in a temperate-zone village in Nepal (Calkins, pp. 124–74). Masino has a total of 0.1526 hectares of irrigated lowland, 0.2910 hectares of unirrigated upland, and the following brood animals: 1 cow, 2 milk buffaloes, 4 ewes, and 2 hens. He is 62 years old and lives with his 52-year-old wife, his two daughters of 13 and 11 years, and his son of 5 years.

The current nutrient balance for the family in the early and monsoon seasons is fairly good, with a 40% riboflavin shortfall the only deficiency in the former and 8% calcium and 14% riboflavin deficiencies in the latter. In the winter season of two months, five of nine nutritional elements are deficient: riboflavin (by 58%), β-carotene (48%), ascorbic acid (12%), niacin (11%), and calories (4%). Riboflavin deficiency, present in all three seasons, can result in dry skin, inflamed corneas, and general debility. Only this deficiency is serious, because β-carotene, which is consumed in excess in the other two seasons, can be stored in the body's fat for much longer than two months.

Current production patterns. The following are the percentages of available land grown to each commodity for each type of land in each season (early, monsoon, winter) under Masino's current cropping patterns:

	(%)
Early Lowland (14 Nov.–14 June)	
Wheat	8.3
Fallow	91.7
Monsoon Lowland (15 June-14 Nov.)	
Paddy	100
Early Upland (15 Feb.–14 Aug.)	
Maize	68.9
Potato	1.5
Soybeans	0.7
Green beans	0.9
Pumpkin	0.2
Yams	0.2
Chayote	0.4
Bitter gourd	0.4
Green amaranthus	0.5
Red amaranthus	0.5
Chili	0.1

Early Upland continued	(%)
Mustard	4.4
Taro	8.7
Permanent crops	12.6
Monsoon Upland (15 Aug.–14 Dec.)	
Millet	17.6
Monsoon potato	8.7
Soybean	0.7
Pumpkin	0.2
Yams	0.2
Radish	32.4
Rape	0.4
Chayote	0.4
Bitter gourd	0.4
Chili	0.1
Mustard	17.6
Taro	8.7
Permanent crops	12.6
Winter Upland (15 Dec.–14 Feb.)	
Chayote	0.4
Chili	0.1
Mustard	4.4
Rape	0.4
Taro	8.7
Permanent crops	12.6
Fallow	73.4
Permanent Crops	
Mango	2.6
Peach	8.7
Bamboo	1.3
Net Income	
Rupees (Rs.)	3,580

Net income represents the total market value, before consumption, of all livestock and agronomic production for the year, less the costs of hiring labor and bullocks. The main double-cropping patterns are wheat followed by paddy in the lowland and monsoon millet transplanted into a standing early maize crop in the upland, with various horticultural crops occupying upland for from one to three consecutive seasons. Paddy and wheat are traditionally the only crops grown in the lowland, because it is a full hour's walk to many lowland fields from Masino's homestead.

Formulation One: The Simple Short Run

The simple short-run formulation stipulates that (*a*) permanent crop acreages and livestock levels are fixed, (*b*) food buying and selling activities are allowed, (*c*) there are no changes in technology, (*d*) there is no limit to capital borrowing, and (*e*) Masino Tamang only wishes to maximize the sale value of his product after production costs have been deducted. The following optimal land-use pattern emerges from linear programming:

Early Lowland	(%)
Wheat	100
Monsoon Lowland	
Paddy	100
Early Upland	
Potato	88.7
Permanent Crops	11.3
Monsoon Upland	
Rape	88.7
Permanent Crops	11.3
Winter Upland	
Rape	88.7
Permanent Crops	11.3
Net Income	
Rupees (Rs.)	14,926

One hundred percent of available irrigated land should be devoted to the wheat-paddy rotation. On unirrigated upland, on the other hand, potato and rape greens should be grown at the maximum permissible level. As upland constitutes about two-thirds of all land on the farm, this result shows a significant shift from grain to horticultural predominance to maximize income.

Formulation Two: The Short-run Optimal Solution with Nutritional Constraints and Unlimited Borrowing

We now expand the matrix to include nutrient constraints, which are varied from 0% to 150% of suggested FAO levels to measure the impact on cropping patterns, hiring, selling, feeding, consumption practices, and the level of income. The unbroken line in figure 1 shows that income over consumption declines from Rs. (Rupees) 14,925 to Rs. 11,253, reflecting up to a Rs. 3,672 "grocery bill" for adding 150% of the family's requirements over the eat-nothing, simple short-run, optimal formulation.[1]

At the 100% level of nutritional adequacy, a Rs. 2,375 grocery bill is used to buy 972 kilograms (kg.) of soybeans, 218 kg. of radish, 35 kg. of yams, 153 kg. of pumpkins, 53 kg. of mustard greens, and 1.8 baskets of peaches to meet nine nutritional requirements in three seasons. Optimal cropping patterns, labor and

---

[1] The lines in figure 1 for formulations two and three resemble curves only because they connect program values from individual linear programming formulations. They are not to suggest that nonlinear programming was used.

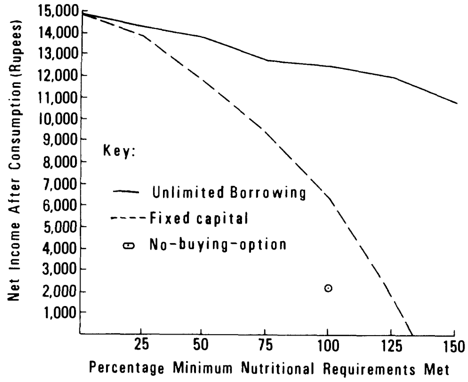

Figure 1. The trade-off between income and nutrition under unlimited borrowing, fixed capital, and no-buying-option formulations

bullock hiring, and livestock feeding activities do not change from those in formulation one. The only products previously sold but now retained are winter milk and early season peaches. This suggests that these are the cheapest sources of riboflavin and β-carotene, respectively, for these two seasons.

Formulation Three: The Short-run Optimal Solution with Nutritional Constraints and Fixed Capital

The cash with which Masino buys supplemental food for his family is limited. Formulation three parameterizes nutritional requirements subject to the constraint that Masino may borrow no more capital than 771 rupees needed in the simple income-maximizing solution. With each 25% increment in nutritional requirements, farm activities are forced in the direction of more nutritious but perhaps less profitable crops. The broken line in figure 1 represents this trade-off.

By the 100% level, the following pattern becomes optimal:

Early Lowland	(%)
Wheat	100
Monsoon Lowland	
Paddy	100
Early Upland	
Maize	38.8
Potato	49.9
Permanent crops	11.3
Monsoon Upland	
Millet	38.8
Radish	3.7
Rape	46.3
Permanent crops	11.3
Winter Upland	
Rape	46.3
Permanent crops	11.3
Fallow	32.7
Net Income Over Consumption	
Rs.	6,300

The most striking change that has occurred over formulation two is that early potato and monsoon rape production has been drastically reduced in favor of the maize-millet rotation. This shift reflects the fact that calories in all seasons (in addition to riboflavin) are nutritionally binding. Radish is also important enough to displace some of the rape on monsoon upland. This change occurs both because of the lack of capital to buy radishes and because with every hectare of radishes come a corresponding amount of nutrient-rich radish greens.

As to the trade-off between consumption and sales, paddy is earmarked for home use in the monsoon and winter, while millet, maize, and potatoes are grown to satisfy early season energy needs. All meat and fruit are now reserved for farm consumption. In addition, milk sales virtually disappear because of niacin and riboflavin needs, while millet supplies the necessary calcium in the early season. The only food which continues to be bought is soybeans, demonstrating what a valuable source of nutrients this grain legume is.

The restriction on capital not only means that farm output must be more nutritious, it also causes a shift from hired labor to labor-saving crops which can be grown by home labor. Seasonal redundancy of family labor is reduced.

Formulations one and two have demonstrated that the linear program can sort out the least-cost source of nutrients even when there is no effect upon the optimal production and input-hiring pattern, while formulation three has shown the ability of the model to develop production and consumption recommendations simultaneously.

Formulation Four: The Short-run Optimal Solution with Nutritional Constraints and No Food Buying

To reveal the trade-off between higher nutritional demands and on-farm production in its most extreme form, we may develop a forced self-sufficiency formulation, whereby Masino must meet 100% of his family's nutritional requirements with no market purchase.[2] The following land-use pattern becomes optimal:

Early Lowland	(%)
Wheat	100
Monsoon Lowland	
Paddy	100
Early Upland	
Maize	53.4
Potato	35.3
Permanent crops	11.3
Monsoon Upland	
Millet	53.4
Radish	4.8
Rape	30.5
Permanent crops	11.3
Winter Upland	
Rape	30.5
Permanent crops	11.3
Fallow	58.2
Net Income over Consumption	
Rs.	2,092

This cropping pattern (and diet), represented by a circled point in figure 1, is much closer to traditional ones because of the predominant maize-millet rotation. The drawback is that income over consumption plummets from Rs. 12,479 to Rs. 2,092, indicating a strong trade-off between levels of income and nutrition if everything consumed on the farm must also be grown there.

As might be expected from current dietary deficiencies, the shadow prices under formulation four are highest for riboflavin in the early (Rs. 263 per mg.), monsoon (Rs. 66), and winter (Rs. 33) seasons, followed by monsoon and winter niacin (Rs. 1.1 and .06, respectively). Early monsoon and winter calories have shadow prices of Rs. .90, .60, and .30, respectively. That the above constraints are binding implies that cropping patterns in the no-buying-option formulation have had to be rearranged in favor of home-grown crops rich in these nutrients. Specifically, area grown to low-return maize and millet has been increased to relax the caloric and niacin constraints, while area grown to radish roots and greens has been increased to relax the riboflavin and niacin constraints.

[2] This stipulation means that one may generalize the results to all farmers of the temperate zone without fear of causing supply and demand distortions. One must, of course, assume that selling prices for produce remain at their present farmgate level and that such produce will be purchased from the farmer by middlemen for sale elsewhere.

Formulation Five: The Short-run Optimal Solution with Nutrition and Cropping Pattern Constraints

Formulation five posits that in meeting 100% of his nutritional demand with buying options and unlimited capital borrowing, Masino must follow the general practice of hill farmers: to devote about 75% of his upland to grain and legume crops. The following land-use system becomes optimal:

Early Lowland	(%)
Wheat	100
Monsoon Lowland	
Paddy	100
Early Upland	
Maize	68.9
Soybean	6.1
Potato	13.7
Permanent crops	11.3
Monsoon Upland	
Millet	68.9
Soybean	6.1
Rape	13.7
Permanent crops	11.3
Winter Upland	
Rape	13.7
Permanent crops	11.3
Fallow	75.0
Net Income over Consumption	
Rs.	2,370

There is a large opportunity cost associated with forcing maize-millet and soybean into the cropping pattern in accordance with traditional land use. This may be measured in terms of the difference in income over consumption (Rs. 10,109) between formulations two (Rs. 12,479) and five (Rs. 2,370) at the 100% level of nutrition.

Formulation Six: The Long Run

The final formulation allows livestock numbers and permanent crop areas to vary and employs projected input and output prices for the ensuing ten years. The solution for Masino's farm indicates that milk cow specialization within livestock, grain specialization on irrigated lowland, vegetable specialization on irrigated upland, and no fruit trees constitute the optimal use of land and other resources on temperate zone farms like Masino's in the longer term.

Sensitivity analysis of the prices of output and purchased inputs shows production patterns to be stable. However, varying purchased food prices induced great variation in optimal diet. These results suggest a possible policy of controlling relative prices to consumers in the marketplace.

Conclusion

The application of linear programming to a subsistence Nepalese farm has shown that large gains in income accrue from growing increased areas to potatoes, radishes, and rape on upland fields, depending upon the availability of capital and the flexibility of traditional cropping preferences. The cheapest sources of a full range of nutrients are also horticultural, including soybeans, radish, yam, pumpkin, mustard greens, and peaches. Only if the buying power of such commodities is reduced does maize-millet production for home consumption come into the optimal solution or products from the fixed activities, milk, meat, and fruit production figure in on-farm consumption.

Through different model formulations, linear programming can identify clearly the most nutritious and profitable production patterns. Moreover, formulations three through six reflect different types of institutional constraints involving, respectively, credit, market development, extension and education to alter traditional beliefs and strengthen human capital, and long-run price policies. These and other possible formulations permit the policy analyst to infer the direction of change in optimal patterns under various policy choices.

Microlevel studies of linear programming cannot solve nutritional and income problems in a vacuum, however, and must be supported by a commitment of research and extension resources. In Nepal, for example, horticultural crops are much more subject to price variability and marketing losses than grain crops. Government policies to improve marketing mechanisms and foster producer cooperatives would reduce the riskiness of horticultural production, which is now the main barrier that prevents farmers from realizing the benefits of growing these crops. Research should be geared to improving varieties of, and reducing pests in, those commodities with the greatest potential for increasing the nutrition and income levels of the rural population.

[Received July 1980; revision accepted November 1980.]

References

Andrews, Margaret S., and John R. Moore. *An Integrated Production-Consumption Farm Model for the Dominican Republic*. University of Maryland Agr. Exp. Sta. Contribution No. 5209, 1976.

Aykroyd, W. R. *The Nutritive Value of Indian Foods and the Planning of Satisfactory Diets*. New Delhi: Indian Council of Medical Research, 1963.

Balintfy, Joseph L. "Linear Programming Models for Menu Planning." *Hospital Industrial Engineering*, ed. H. E. Smalley, J. R. Freedman, pp. 402–08. New York: Reinhold, 1966.

Calkins, Peter H. *Shiva's Trident: The Impact on Income, Employment and Nutrition of Developing Horticulture in the Trisuli Watershed, Nepal*. Ph.D. thesis, Cornell University, 1976.

Hall, Connie Rene. *Activity Analysis Applied to Menu Planning*. M.S. thesis, Iowa State University, 1977.

Mohinder S. Mudahar. *Dynamic Models of Agricultural Development with Demand Linkages*. Mimeographed. USAID Employment and Income Distribution Project Occ. Pap. No. 49, Cornell University, 1973.

I. J. Singh. "Recursive Programming Models of Agricultural Development." *Studies in Economic Planning over Space and Time*, ed. G. G. Judge and T. Takayama. Amsterdam: North-Holland Publishing Co., 1973.

Smith, Victor Earle. *Efficient Resource Use for Tropical Nutrition: Nigeria*. Int. Bus. and Econ. Stud., Michigan State University, 1975.

Stimson, David H., and Stimson, Ruth H. *Operations Research in Hospitals*. Chicago, Hospital Research and Education Trust, 1972.

United Nations, Food and Health Organization (FAO). *Food Composition Table for Use in East Asia*. Bethesda, Md.: National Institute of Health, 1972.