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Errata

In the April 1971 issue, table 2 on page 30 should be corrected as follows (1967/68 column): Fertilizer use per development block in 2 wheat districts, 825 metric tons; in rest of 2 States, 383 metric tons. Also, on page 34, reference (*11*) in the second column should be reference (*8*).

AGRICULTURAL ECONOMICS RESEARCH

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Potential Effects of Fat-Controlled, Low-Cholesterol Diet on U.S. Food Consumption

By Corinne Le Bovit and Hazen Gale

If the entire U.S. population were to select one food pattern among those that meet the American Heart Association recommendations for a fat-controlled, low-cholesterol diet, calorie intake would decline about 13 percent compared with present consumption. The cost would be about a tenth higher, however, since beef, poultry, fish, and fruits and vegetables would partly replace lower priced foods such as pork, eggs, fats, and sugars. The farm value of the foods would be about the same as for current food consumption patterns. The total amount of agricultural resources required would change little but there would be shifts within the farm sector.

Key words: Food consumption; fat; fatty acids; cholesterol; diet; food economics; agricultural resources; food costs.

The influence of diet on the risk of coronary heart disease has been the subject of a long-simmering debate. And even for those who accept diet as an important causal factor, there is a range of opinions as to what changes should be recommended and for whom. The American Heart Association and other medical groups represented by the Inter-Society Commission for Heart Disease Resources *(8)*[1] urge that the public starting with the young, should markedly lower intake of cholesterol and saturated fats, and increase intake of polyunsaturated vegetable oils. They fear that otherwise many people will die or be injured unnecessarily while we wait for further evidence. On the other hand, some researchers believe that current evidence is inconclusive, and that any drastic dietary changes now would interfere with the orderly progress of research and perhaps jeopardize the success of more appropriate public health measures when and if such are clearly indicated by scientific evidence *(3, 6, 10)*. Some scientists believe that many Americans should make some reduction in total fat intake and some substitution of polyunsaturated for saturated fat. One factor on which there is general agreement is that ideal body weight should be maintained throughout life.

This paper does not attempt to judge the merits of any of the arguments or make any recommendations. It only considers the possible effects on food consumption in the United States if consumers adopted one particular diet pattern incorporating all of the American Heart Association (AHA) proposals. Other diet patterns which meet the AHA recommendations are of course feasible. Each would have somewhat different effects on food consumption and each could be analyzed in the same way.

The paper discusses some recent and prospective changes in consumption that may be health related. The potential impacts of dietary changes on consumer food budgets and on use of agricultural resources are considered briefly.

Recommendations of the Commission (*8*) include the following diet modifications for the general public:

(1) Reduce calorie intake to a point where it maintains body weight.

(2) Limit total fat ingestion to less than 35 percent of calories, considerably less than recent levels of 43 percent (*12*).

(3) Decrease the proportion of saturated fat to less than 10 percent and increase that of polyunsaturated fatty acids to not more than 10 percent.

(4) Reduce cholesterol intake to less than 300 milligrams per day, a sharp reduction from about 400 which is common in current diets.

Although high cholesterol content of foods is generally associated with high saturated-fat content, the relationship is not uniform. For example, seafoods such as lobster and shrimp are not high in saturated fat, but they are high in cholesterol.

Other researchers have suggested that carbohydrates should be composed of more starch and less sugar than at present. In terms of foods, the Commission states that

[1] Italic numbers in parentheses refer to items in the References, p. 57.

this pattern can be achieved by altering habits along the following lines (*8*):

(1) Use lean cuts of beef, lamb, pork, and veal, cooked to dispose of saturated fat and eaten in moderate portions.

(2) Use lean meat of poultry and fish.

(3) Use fat-modified (reduced saturated-fat and cholesterol content) processed meat products (frankfurters, sausage, salami, etc.).

(4) Use organ meats (e.g., liver) and shellfish in moderation since they are higher in cholesterol than muscle of red meat, chicken, and fish.

(5) Avoid fat cuts of meat, addition of saturated fat in cooking meat, large meat portions, and processed meats high in saturated fat.

(6) Use low-fat and fat-modified dairy products.

(7) Avoid high-saturated-fat dairy products.

(8) Use fat-modified baked goods (pies, cookies, cakes, sweet rolls, doughnuts, crullers).

(9) Avoid baked goods high in saturated fat and cholesterol.

(10) Use salad and cooking oils, new soft margarines, and shortenings low in saturated fat.

(11) Avoid butter, margarine and shortenings high in saturated fat.

(12) Avoid candies high in saturated fat.

(13) Avoid egg yolk, bacon, lard, suet.

(14) Use grains, fruits, vegetables, legumes.

Results of Diet Change

If the population were to follow the AHA dietary recommendations presented here, consumption patterns would differ from those reported in a 1965-66 household survey as follows (table 1):

Thirteen percent fewer calories.

Fifteen percent more pounds of food (because of substitution of lower for higher calorie foods).

Slightly over 10 percent more beef, veal, and lamb.

About 70 percent less pork.

About 50 percent more poultry and fish.

Almost no change in total meat, poultry, and fish.

Almost no change in total dairy products (excluding butter).

About 75 percent less eggs, margarine, and shortening.

About 30 percent less butter.

About 60 percent more salad and cooking oil.

About 20 percent less total fats and oils.

About 75 percent more fruits and vegetables.

Half as much sugars.

A little less grain products.

This consumption pattern would result in the ingestion of about 230 milligrams of cholesterol per day, which is within the AHA recommendation, compared with the estimated 400 milligrams in the 1965-66 survey.[2] Sources of calories in food ingested are distributed as follows:

	AHA diet	1965-66 survey[1]
	Percent	*Percent*
Protein	17	14
Carbohydrate	53	46
Fat	30	40
Fatty acids:		
Saturated	10	15
Monounsaturated (oleic)	10	16
Polyunsaturated (linoleic)	7	5

[1] These estimates relate to food ingested and differ from other estimates based on food use including waste.

In addition to these changes, some major shifts might occur within the product groups, including the following:

Beef, veal, lamb—more lower grades, leaner beef, more veal, less lamb.

Dairy products—increase in nonfat solids, but much less fat solids.

Margarine, shortening—mostly products containing liquid oil.

Flour and cereal products—very little sweet baked goods, snack items, or presweetened cereals.

All of these foods are currently available in U.S. markets.

One change that may surprise some people is the larger decrease for margarine and shortening than for butter. This is a coincidence and the more significant aspect is the relatively low level for table fats.

Recent Consumption Trends

Such drastic changes in consumption as presented here are unlikely to occur soon for the general population, even if the entire medical profession agreed with the AHA. However, some recent trends in consumption indicate that some related changes are occurring. Some of these are simple time trends which may or may not be linked specifically to diet and health considerations. Other changes are related to economic variables such as price and income. Two sets of data show some of these changes: (1) The time series of national consumption and (2) the results of the 1955 and 1965 surveys. We look at the time series first.

[2] A factor inherent in the method of computation could modify the results. The proportions of food groups in the 1965-66 survey were based only on food consumed at home, so the changes in table 1 may overstate decreases in eggs and bacon, breakfast items which are more important in at-home food, and understate decreases in sugars which are less important in food at home (*9*).

Table 1.—Weekly per capita food consumption: Actual quantities, 1965-66, estimated quantities in AHA diet, and percent change

Foods	Per capita consumption HFSC, 1965-66	AHA diet	
		Estimated per capita consumption	Change from HFSC
	Pounds	*Pounds*	*Percent*
Beef, veal, lamb	1.817	2.062	13
Bacon, lard	.315	.037	−88 } −67
Other pork, including lunchmeat	1.141	.448	−61 }
Poultry	.879	1.335	52
Fish, shellfish	.323	.488	51
Dairy products, low fat	7.623	7.653	0 } 2
Dairy products, other	.342	.379	11 }
Eggs	.769	.214	−72
Butter	.122	.082	−33
Margarine, shortening	.365	.081	−78
Oils	.259	.420	62
Nuts	.131	.209	60
High-fat baked goods	1.117	.475	−57 } −6
Other grain products	2.752	3.164	15 }
Dry beans, peas	.157	.175	11
Potatoes	1.944	2.223	14
Other vegetables	3.928	6.860	75
Fruits	3.997	6.907	73
Sugars	1.347	.741	−45
Alcoholic beverages	.643	.630	− 2
Miscellaneous (cocoa, coffee, leavenings)	.294	.294	0

Source: Household Food Consumption Survey *(14)*.

In the last 20 years, there have been pronounced trends toward consumption of lower fat dairy products and substitution of vegetable oils for animal fats (7). Some of these trends have accelerated in the past 5 years. These changes reflect in part economic motivation; but part of the change probably reflects a desire for fewer total calories for weight control, and perhaps some desire for medical reasons to avoid animal fats in favor of vegetable oils.

Fluid milk and cream—During the last 20 years, consumption of fresh fluid whole milk and cream has decreased while that of low-fat milks has increased. Moreover, these trends have accelerated within the last 5 years. The price of low-fat milks (skim, 1-percent, 2-percent, buttermilk) differs very little if at all from the price of fluid whole milk. Therefore, the choice of the lower fat milk probably was not economically motivated. Such choices may be based on a desire for fewer calories or for less dairy fat. The lower fat products often require some adjustments of taste, so the change would have to be a purposeful one (table 2 and figure 1).

Frozen dairy products—Consumption of all frozen dairy products has increased, but the increase has occurred primarily in the low-fat products, particularly ice milk which was a very minor product before 1950. Since ice milk is slightly cheaper than ice cream, price might play some part in the trends but probably not a major one (table 2 and figure 1).

Table fats—There was only a small decrease in consumption of total table fats over the last 20 years, but margarine has been replacing butter at a steady rate

Table 2.—Per capita food consumption, 1950 and 1970, and annual changes, 1950-69 and 1965-69

Foods	Per capita consumption		Change per year (least-squares trends)	
	1950	1970	1950-69	1965-69
	Pounds	*Pounds*	*Pounds*	*Pounds*
Milk, fresh fluid:				
Whole	296.0	231.0	−3.0	−7.5
Low fat	33.6	58.3	.7	4.8
Cream	11.8	5.6	−.3	−.4
Frozen dairy products:				
Ice cream	17.2	17.9	(1)	−.1
Ice milk	1.2	7.3	.3	.1
Sherbet	.7	1.6	(1)	0
Total dairy products:				
Nonfat solids	43.6	40.9	−.1	−.2
Fat solids, excluding butter	20.7	16.4	−.2	−.4
Fats and oils:				
Butter	10.7	5.1	−.2	−.2
Margarine	6.1	11.0	.2	.2
Total table fat	16.8	16.1	(1)	0
Lard	12.6	4.8	−.4	−.2
Shortening	11.0	17.9	.3	.6
Oils	8.6	17.4	.4	.6
Total:				
Animal	21.9	14.9	−.3	−.4
Vegetable	24.0	38.4	.6	3.4
Eggs	48.5	40.3	−.5	.1
Chicken	20.6	41.7	.9	1.3
Fish	11.8	11.3	(1)	.1
Beef	50.1	83.7	1.5	2.1
Pork:				
Bacon, salt pork	19.4	18.3	−.1	.6
Other	45.0	42.5	−.2	1.3

[1] Less than 0.05 pound.

Source: Hiemstra (*7*).

(table 2 and figure 1). Both spreads are identical in calorie content so weight-control interest could not contribute to the trend. The lower cost of margarine probably has been the principal factor. On the other hand, the soft and the corn oil margarines, introduced fairly recently, are more expensive types of margarine, and are taking an increasing share of the margarine market. Use of corn oil (the highest priced of the oils used in margarine manufacture) in margarine increased from less than 1 percent of the total prior to 1959 to about 10 percent since 1963. Safflower oil, which was not recorded as used in margarine manufacture prior to 1962, now makes up about 2 percent of the total oil used (*15*).

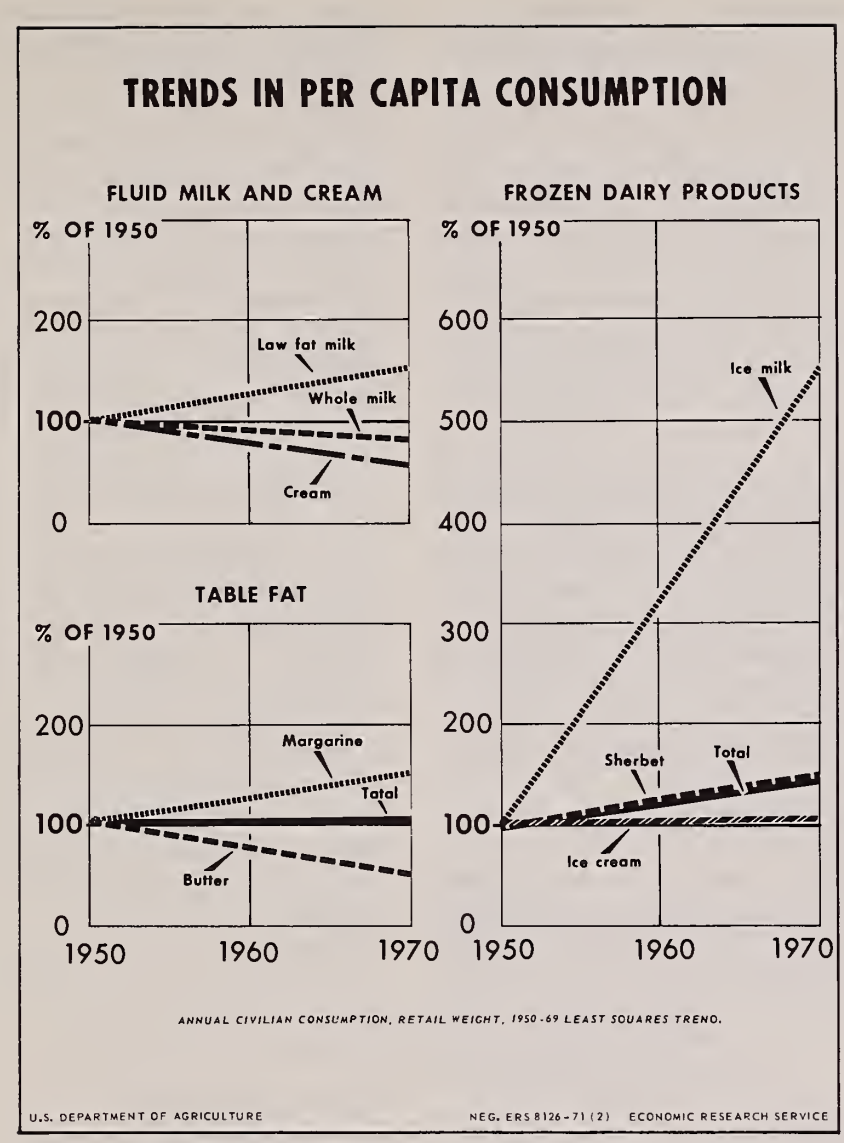

Figure 1

Both corn and safflower oils have been widely publicized for higher content of polyunsaturated fatty acids than other oils, and popularity of margarines containing these oils, despite their generally higher prices, is most likely related to a belief that they lessen the risk of heart disease. Some doctors have prescribed them. However, many people do not realize that hydrogenation often converts these oils to solid fats and in the process converts some polyunsaturated fatty acids to monounsaturated. The former tend to lower blood cholesterol; the latter have little or no effect. The polyunsaturated fatty acid content of corn or safflower oil is maximized when the oil is incorporated in the margarine in liquid form.

Other products—Decreasing lard consumption and increasing shortening and oil use may be related to increases in products such as potato chips, french fries, doughnuts, and other fried foods, and to greater popularity of salads. The decline in egg and bacon consumption may be related as much to decreased interest in breakfast or a trend to small breakfasts as to dietary considerations. Increases for chicken and for beef may be related to changes in price and income relationships. However, it is also possible that some of these shifts could be related to the desire for less animal fat and cholesterol in the diet.

Comparison of data from the 1955 and 1965 food consumption surveys gives some indication of the income effects on food consumption. These surveys show a 1-percent increase in dietary fat over the 10-year period (*13,14*). However, this increase hides other changes for certain income groups. Families in the highest income

quintile did not increase their fat consumption at all (table 3). In addition, changes in fat sources used by these families differed from changes made by other families, indicating choices were made for dietary reasons rather than because of income or price shifts. Total table fat (butter and margarine) use declined about 10 percent for all families (somewhat more than in the time series data) but declined 17 percent for the top income quintile. However, the percentage of margarine in the total table fat increased for all income groups—but more for the highest income group (38 percent compared with 30 percent for all families) indicating a shift from butter to margarine for other than economic reasons.

Cream consumption dropped 33 percent for all families, but 41 percent for the top income group. The proportion of milk fat in total milk solids (excluding butter) showed about the same rates of decrease for each income group. Changes in the lower income groups are very likely related to their increased use of nonfat dry milk, perhaps for economic reasons, but changes in the upper groups appear related to decreases in a number of higher fat milk products.

Egg consumption decreased 8 percent for all families but 20 percent for the top group.

Comparative Costs

Resistance to dietary changes of the magnitude indicated by the AHA recommendations may be great not only because of the time it takes people to change food habits, but also because the AHA diet is relatively expensive. In terms of constant 1957-59 prices, the selected pattern presented here costs 9 percent more than the average household diet in 1965-66. The large increase in fruit and vegetable consumption is a major factor in this higher cost. These and many of the other foods with significantly greater quantities—beef, poultry and fish—are higher priced than those they replace—pork, eggs, fats, and sugars.

These changes represent an increase in the food consumption index of about a tenth even though total calories would be lower. If the income elasticity of food consumption is 0.20 to 0.25 (a 10-percent increase in per capita income increases the per capita food purchased by 2 to 2½ percent) and if we rely solely on income to achieve this higher level of consumption, per capita income would have to be about half again as high as the 1965-66 income. Even if this increase in income occurs, there would be no guarantee that the AHA recommended pattern would be attained for individual commodities. Considerable publicity, consumer education, and perhaps other measures would be necessary to get consumers to change their diet in a reasonable time.

The farm value for the AHA diet might average about the same as for the 1965-66 consumption pattern. However, producers of poultry, beef, and a number of fruits and vegetables would stand to benefit most from the diet change. In addition, the demand for fish would increase.

Since food products from animal sources and fruits and vegetables generally require more agricultural

Table 3.—Changes in per capita consumption of food and nutrients, U.S. households by income quintiles, spring 1955 to 1965

Food and nutrients	All households	Income quintiles				
		Lowest	Second lowest	Middle	Second highest	Highest
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Fats and oils	-6	-3	-6	-4	-5	-13
Table fats	-9	-5	-8	-3	-6	-17
Margarine[1]	+30	+30	+22	+12	+24	+38
Eggs	-8	+3	0	-2	-14	-20
Milk solids, total	-14	-4	-10	-16	-15	-13
Fat[2]	-9	-9	-9	-6	-6	-6
Calories	+2	-1	+2	+3	0	+1
Protein	+3	+1	+5	+4	+2	+1
Fat	+1	-2	+2	+4	+3	0

[1] Change in proportion of margarine in table fats consumed.
[2] Change in proportion of fat in total milk solids consumed.

Sources: Household Food Consumption Surveys *(13, 14)*.

resources than food from grains and oilseeds, changes suggested by the AHA diet might require slightly more agricultural resources to provide the Nation's food supply than the 1965-66 diet required. Production of poultry, beef and veal, some dairy products, and fruits and vegetables would expand, but production of eggs and fat pork would decline. While these shifts probably are feasible with present agricultural resources, major production adjustments would be required and food prices would probably average materially higher during a transition period. Some sectors would benefit greatly as the market encouraged expanded output, while other sectors would undergo an extended and difficult adjustment period as resources were transferred to other uses.

These estimated costs to consumers and returns to farmers are based on the assumption that all foods would be available at the same relative prices as in 1957-59. In practice, some prices might average higher, while others probably would decline. Some people contend that a substantial increase in production of some farm commodities would require higher prices on the average, because less efficient resources would be used to produce the added output. On the other hand, expanded production of other commodities may offer opportunities for increased productivity and associated cost reduction. One approach to projections of changes in relative prices and resource use to achieve changes in national average consumption patterns was developed by Christensen (*2*). He points out the numerous aspects to be considered to determine the effect of consumption changes on the agricultural sector.

Implications for the Future

As long as the relatively sedentary way of life continues in this country, through dependence on laborsaving devices and on mechanized transportation instead of walking, obesity will continue to plague much of the population despite a desire to control it whether for cosmetic or health reasons. Weight control is the one factor in heart disease prevention on which the medical profession agrees. Therefore, whatever the outcome of the heart-diet controversy, a decrease in total calorie intake will be a goal for many people. Cutting down on fats which contain about 9 calories per gram has a greater impact on total calories than cutting protein or carbohydrate at 4 calories per gram. Therefore, the trend toward lower fat foods is likely to continue. But whether a higher ratio of polyunsaturated to total fats and less cholesterol are consumed will depend on the publicity given the AHA diet and on whether opposition to it continues.

It appears that people will rather readily make substitutions which do not have much impact on eating patterns. Examples of these are shifts from butter to margarine, from more to less saturated fat margarines, and from whole to skim milk, as well as increases in use of beef, poultry, and lean cuts of pork, and decreases in use of fat pork. Whether changes having a greater impact on food habits would be adopted is questionable. The AHA emphasis on consumption of more fish, less sugar, and more fruits and vegetables may not be heeded by large masses of people. Recent reports of mercury contamination of fish could provide an added impediment to increasing fish consumption.

Some additional changes might occur more readily if the food industry were to modify more products as it has margarine, fluid milk, and frozen dairy desserts. Other products that might be modified to contain less fat or different kinds of fat are frankfurters and lunch meats, cheeses, and baked goods. At present, anyone on an AHA diet may not eat any lunch meats and must bake at home from basic ingredients if he wants cake, pie, or cookies. It is possible technically (but it may not be economical) to produce commercial baked goods, frankfurters, and lunch meats containing less fat or different fats. Lower fat cheese has been produced but it apparently has not gained wide acceptance. Beef, pork, and other meats could be produced with a lower or modified fat content by changing feeding and breeding practices. On the other hand, two segments of the food industry are likely to face more difficult adjustment problems. It may take the dairy industry some time to adjust to a demand for a higher level of nonfat solids but less fat, if indeed it could. Perhaps the most promising answer to the butterfat question is found in current research toward breeding cows that will give milk with lower butterfat or modified fat.

A similar adjustment problem exists for eggs. Egg whites are acceptable in the AHA diet but yolks are not. At present several companies are manufacturing a dried product containing the white along with substitute materials in place of most of the yolk.

Appendix: Method of Calculating AHA Diet

As an example of a diet that might meet the AHA recommendations from currently available foods, the diet pattern selected for use in this article was one chosen by a group of about 50 men in the Twin Cities phase of the Diet-Heart Study (*1*). These men had been given dietary instruction aimed at reducing their intake of saturated fat and cholesterol. Their wives shopped in their usual food markets and followed customary home-cooking procedures. Table 4 presents the calculations step by step.

Column 1.—The percentage of calories from each food group from the diet of men in the Twin Cities (diet

Table 4.—Worksheet: Computation of AHA fat-controlled, low-cholesterol diet per capita and comparison with per capita consumption, 1 week, 1965-66

Foods	Food use in AHA diet						Used in 1965-66		Change in quantity	
	Ingested		Discarded		Total					
	Percent of total energy (1)	Energy value (2)	Fat from meats (3)	Other (4)	Energy value (5)	Quantity (6)	Quantity (7)	Energy value (8)	(9)	
	Percent	*Calories*	*Calories*	*Calories*	*Calories*	*Pounds*	*Pounds*	*Calories*	*Percent*	
Beef, veal, lamb	8.3	1,249	703	345	2,297	2.062	1.817	2,046	13	
Bacon, lard	.2	30	64	17	111	.037	.315	1,033	−88	−67
Other pork, including lunchmeat	1.4	211	248	18	540	.448	1.141	1,455	−61	
Poultry	2.4	361	178	95	634	1.335	.879	438	52	
Fish, shellfish	1.5	226		40	266	.488	.323	186	51	
Dairy products, low fat	10.2	1,535		271	1,806	7.653	7.623	2,471	0	2
Dairy products, other	2.6	391		69	460	.379	.342	415	11	
Eggs	.8	120		21	141	.214	.769	506	-72	
Butter	1.5	226		40	266	.082	.122	396	-33	
Margarine, shortening	1.5	226		40	266	.081	.365	1,263	-78	
Oils	10.6	1,595		282	1,314	.420	.259	811	62	
Nuts					563	.209	.131	354	60	
High-fat baked goods	4.7	707		125	832	.475	1.117	1,698	−57	−6
Other grain products	29.8	4,485		1,121	4,597	3.164	2.752	3,999	15	
Dry beans, peas					280	.175	.157	271	11	
Potatoes					729	2.223	1.944	638	14	
Other vegetables	15.4	2,318		409	1,173	6.860	3.928	708	75	
Fruits					1,554	6.907	3.997	899	73	
Sugars	7.1	1,069		189	1,258	.741	1.347	2,286	−45	
Alcoholic beverages	1.0	150		26	176	.630	.643	185	−2	
Miscellaneous (coffee, cocoa, leavenings)	1.0	150		26	176	.294	.294	176	0	
Total	100.0	15,049	1,193	3,197	19,439	34.877	30.265	22,234	15	

X of Diet-Heart Study) was subdivided into finer groups (bacon, other pork, other meat, poultry, rather than meat and poultry) from diets of men in the Coronary Prevention Evaluation Program *(11)*. Diets of a sample of individuals in the United States in 1965 *(12)* showed a similar distribution of calorie sources for the total population and for men, except for dairy products and the meat, poultry, and fish group. To adjust the calorie sources derived from the two fat-controlled diet studies from one suitable for men to one for the total population, the percentage from dairy products was adjusted upward by a ratio derived from the individual diet study. Meat, poultry, and fish totals were adjusted downward to compensate.

Column 2.—Total calories required for weight maintenance of the 1965-66 average population were estimated to be 2,150 per capita per day or 15,050 per week. This total is a weighted average based on the calorie recommendations of the Food and Nutrition Board, National Research Council, for each age and sex *(4)* with weights developed from the age and sex distribution reported in the 1965-66 Household Food Consumption Survey *(14)*. The number of calories per week contributed by each food was obtained by applying the percentages in the AHA diet to total calories. The 1965-66 survey data were used as a standard of comparison because the food items in the AHA diet could be matched with those in the survey.

Column 3.—All separable fat from meat and poultry would be trimmed off and discarded; all fat drippings would be discarded. Calories from such separable fat and drippings were estimated.

Column 4.—At present, food brought into the average U.S. household (*14*) and supplies available nationally at the retail level (*5*) both indicate a calorie content about 50 percent over the recommendations for ingestion. Some of this excess contributes to the production and maintenance of obesity, a national problem, and some represents food discarded before, during, and after preparation.

It has been assumed for this paper that people following AHA dietary recommendations would not consume any more calories than needed to maintain ideal weight, but that they would not change their normal waste patterns. Therefore, in addition to meat and poultry fat, they would further discard food equivalent to about 20 percent of the calories in starchy foods, and 15 percent of the calories in the rest of the available foods. This amount of waste would require food purchases substantially larger than the food ingested. We have estimated that total food use, including the discards, would be about 30 percent above the ingestion requirements.

Column 5.—Calories to be ingested and discarded were added together to get the total number of calories to be used. To match AHA classifications with survey food groupings, some groups such as oils and nuts, starchy foods, fruits and vegetables had to be broken down. For these allocations, the proportions found in the survey data were used.

Column 6.—Calories in each group (column 5) were divided by the calories per pound for comparable food used by households in 1965-66 (*14*). Where survey groups had to be combined to match AHA groups (as for lard and bacon), proportions reported in the survey data were used. The "high-fat baked goods" from AHA was matched with "bakery products other than bread." Similarly, the "other dairy products" group was matched with the cheese group from the survey. We arbitrarily matched low-fat dairy products in the AHA group with 2-percent milk.

Columns 7 and 8.—These were the quantities actually reported in the survey.

Column 9.—This shows the percentage change in quantity used if the population were to ingest food according to the pattern shown in column 1.

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Monthly Retail Demand for Bread

By Theo. F. Moriak and Samuel H. Logan

Researchers have found it difficult to estimate reliable elasticities of demand for bread. The reason for this difficulty undoubtedly has been the lack of data regarding consumption (production) levels for bread. This paper reports the results of a statistical demand analysis for bread and bread-type roll products using monthly production data derived from Government and industry sources. While there are data limitations in this case also, the results shed some light on the nature of the demand for these products.

Key words: Demand elasticities; bread.

Expenditures on bread and other bakery products are an important segment of the consumers' food bill, running consistently about 9 percent of total food expenditures (*4,5*).[1] Bread represents nearly half of this level. Despite its importance in the consumer food budget, there is little quantitative information on the nature of the demand for bread and bread-type rolls. Brandow (*1*, p. 38), for example, noted that "price elasticities of demand for bread, flour, and prepared cereals are so low that attempts to measure them statistically are seldom made."

One of the major reasons for the shortage of previous analyses undoubtedly has been the lack of reliable data regarding consumption and/or production levels for bread. Although price series are available (*13*), comparable quantity figures are not reported.

This paper reports the results of a statistical demand analysis for bread and bread-type products using monthly data obtained from Government and industry sources. While there are data limitations in this case also, the results should shed some light on the nature of the demand for this good.

Results of Previous Analyses

Many prior analyses have focused on the demand for wheat products; however, more recent studies have related to the nature of the demand for bread itself.

Meinken (*7*) utilized single-equation methods to estimate the retail price and income elasticities of demand for bread, rolls, and coffee cake from Census of Manufactures data for intermittent years during 1923-47. The equation was fitted with per capita consumption as a function of price, per capita disposable income, and a time variable. At the means, the results indicated a price elasticity of demand for bread of -0.6, and an income elasticity of 0.4. However, none of Meinken's coefficients was statistically significant.

Rockwell (*9*) used cross-section consumer household data to estimate separate income elasticities associated with different levels of income. His estimates consistently decline as the level of income increases. In fact, the elasticity changes from 0.20 for low-income groups to -0.08 for high income levels, lending credence to the hypothesis that bread is an inferior good.

Brandow (*1*, p. 38) did not estimate the price elasticity for bread directly, but used a figure of -0.15 as a "rough estimate, but it cannot be far wrong in absolute terms." He further specified the income elasticity to be zero. George and King (*4*) adopted the same assumptions.

The Analytical Model

Bread has no close substitute or complement. Although certain other starchy foods (e.g., spaghetti) may be similar in food composition to bread, the latter is frequently served with the former without substitution. None of the prior studies incorporated either type of economic goods into the analysis. Furthermore, Brandow's estimates of cross elasticities with other types of food indicate that while bakery products substitute for other goods, the cross elasticity coefficients are quite small. Consequently, the small cross effects and the nature of the product support the omission of possible substitutes or complements from the model.

Studies of the wholesale baking industry note that price competition is almost nonexistent. Rather, prices in a particular market are administered through a form of price leadership so as to yield a nearly uniform bread price without the danger of cut-throat competition

[1] Italic numbers in parentheses indicate items in the Literature Cited, p. 62.

(*3,8,14*).[2] "Price leadership, then, involves the selection of a price by a leader as opposed to the case in a purely competitive market where price would be determined by independent market forces. It is imperative that the price level be satisfactory to all members of the oligopoly groups in order to forestall open price competition. . . . The umbrella price is frequently set at a level to cover costs not only of the large baking company participants but also of any large independent bakeries with a sizable share of the market"(*14*, p.85). If quantity produced is not compatible with quantity demanded at the preset price, excess bread is returned to the baker as "stales." This bread typically is sold at a discount in bakery "thrift" stores.

Given the nature of the pricing policies of the industry, it would seem appropriate to consider price as predetermined when analyzing the demand for bread. This factor, then, permits the use of single-equation estimation techniques with quantity as the dependent variable and price as predetermined.

The effect of consumers' income may also be important, although previous analyses have indicated a low income elasticity for bread. This variable also was included as predetermined.

The nature of the particular function used to analyze demand for bread is highly dependent upon the length of time unit involved (i.e., weekly, monthly, annual). Seasonal patterns are frequently disguised by use of annual data. As indicated previously, data on quantities of bread produced and/or consumed are few. Census data are available only for selected years. In this analysis, use was made of production indexes obtained from the American Bakers Association for January 1954 through October 1969. The ABA has developed a weekly production index based primarily on output of member bakeries. The index in 1967 represented nearly 50 percent of the total industry weekly bread and other yeast-raised products produced. This index was considered to be representative for bread production for the entire industry, and was combined to obtain monthly output indexes.

This index series was then applied to the total output of the baking industry for the base year 1963 as reported by the 1963 Census of Manufactures, and quantity levels were obtained by months for 1954-69. Monthly production, therefore, was used to represent consumption. While this procedure may create errors in measurement, the annual quantities generated by this method compared favorably with the levels reported for particular years by the Census of Manufactures. In 1958, the census reported production of 12,719.0 million pounds whereas the ABA index application resulted in an estimate of 12,585.5 million pounds. For 1967, the census data registered 14,371.4 million pounds, and the ABA index estimate was 14,984.3 million pounds. The errors in estimation for these years are 1.0 and 4.3 percent, respectively.

There is an apparent fluctuation in production within each year as evidenced by figure 1. Output is generally highest in the spring and summer (with the arrival of "the sandwich season") and lowest during the winter. Such fluctuations could be taken into account with monthly dummy variables; however, harmonic analysis offers a measuring of cyclical variation with continuous variables—a sine and cosine. Although the use of monthly dummy variables could be incorporated into such a model, the use of the two continuous variables may be more feasible if the number of observations is small. The latter procedure was followed in this analysis.

Monthly per capita demand for bread, therefore, was formulated as a function of its own price, per capita disposable income, and the seasonal variation represented by $\sin \theta t$ and $\cos \theta t$ where θ equals 30 degrees (0.5236 radian) because each month represents 360/12 degrees ($2\pi/12$ radians) of the total cycle and t equals $1,2,\ldots,12$.[3] Thus, market demand can be represented as:

$$(1)\quad Q_t = a + b_1 P_t + b_2 Y_t + b_3 \sin \theta t + b_4 \cos \theta t + u_t$$

where u is the error term, with mean of zero and variance σ^2.

Retail prices of white pan bread were obtained from U.S. Department of Labor reports on food prices (*13*).

Monthly disposable income figures were generated from the U.S. Department of Commerce surveys of business (*12*). Disposable income is reported only on a quarterly basis; however, personal income, which is disposable income plus personal taxes, is reported monthly. The monthly disposable income figures were estimated by calculating the ratio of monthly personal

[2] Some price competition may exist in the sense that private label bread (i.e., bread sold under the grocer's own brand) may sell at prices under those charged for wholesale bakers' regular brand goods.

[3] The sine and cosine variables are needed to estimate the amplitude $\sqrt{(b_3)^2 + (b_4)^2}$ of the cycle and the phase angle [arctan (b_3/b_4)] where b_3 and b_4 are the estimated coefficients of $\sin \theta t$ and $\cos \theta t$ respectively. Estimates of these two elements are used to combine the sine and cosine variables into a single variable as $\sqrt{(b_3)^2 + (b_4)^2} \cos [\theta t - \arctan (b_3/b_4)]$ to represent fluctuation (*2*, p. 347).

Table 1.—Consumer demand parameters for bread and bread-type rolls

Equation	Q_t [a]	N	Coefficients [b]						D-W	R^2	$S_{\hat{y}}$	Elasticities [c]	
			Constant	P_t	Y_t	Sin θt [d]	Cos θt [d]	Auto-correlation				Price	Income
(1)	6.196	189	8.236	*−13.62	*0.0033	*−0.1262	*−0.1296	---	1.11	0.737	0.107	−0.415	0.086
	(.213)			(01.16)	(.0004)	(.0110)	(.0111)	---					
(2)	6.196	189	[e]4.393	*−12.08	*.0034	*−.0483	*−.1105	*.4455	---	.790	.096	−.372	.086
	(.213)			(01.90)	(.0007)	(.0155)	(.0105)	(.0671)					

[a] Mean values of the per capita consumption of bread and bread-type rolls are reported in pounds per month. Standard errors are reported in parentheses.

[b] Coefficients significantly different from zero at the 5 percent level are denoted by *. Standard errors of the estimates are reported in parentheses.

[c] Calculated at the means of the respective variables.

[d] θ equals 30 degrees (0.5236 radian) because each month represents 360/12 degrees ($2\pi/12$ radians) of the total yearly cycle. The integer value is represented by t for each month, i.e., t=1, 2,. . ., 12.

[e] This term includes adjustment with the autocorrelation coefficient.

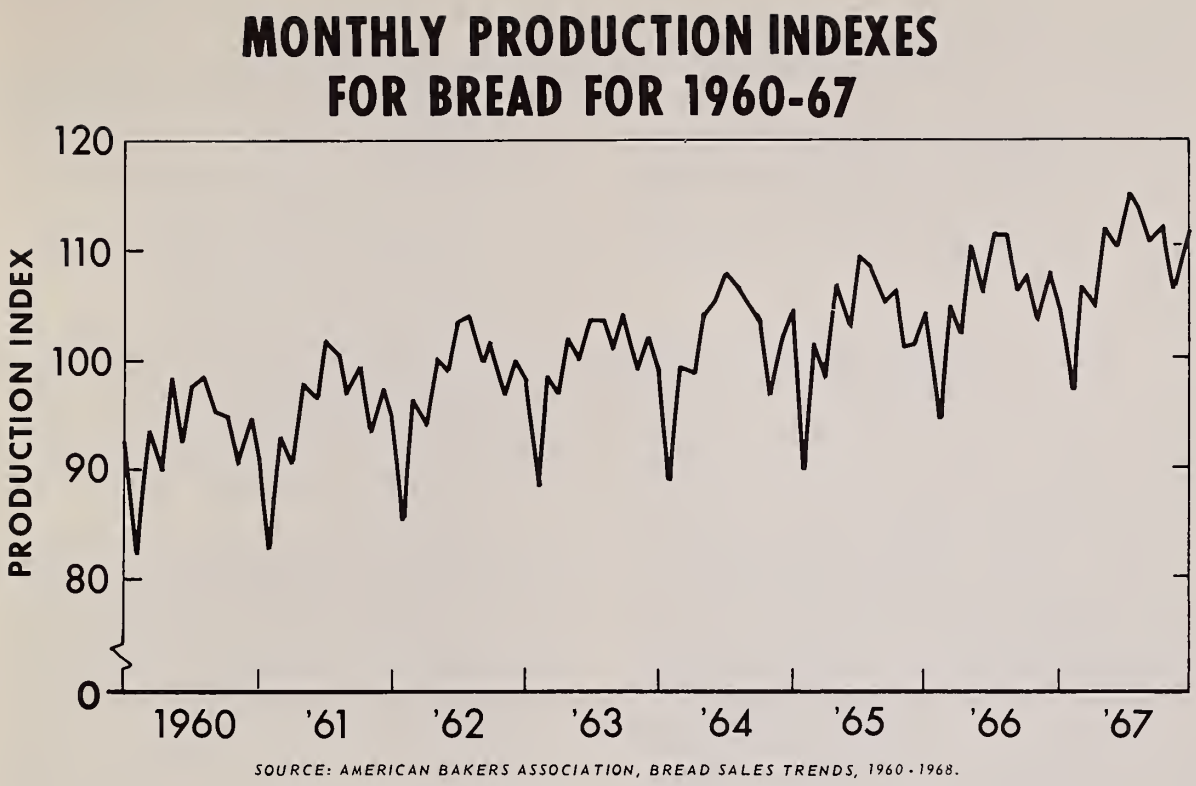

Figure 1

income to its quarterly levels and assuming the same ratio held for disposable income. Consumption and disposable income were put on a per capita basis by dividing by civilian population (*11*). Both prices and incomes were adjusted to 1958 levels with the consumer price index (*12*).

The estimated parameters of equation (1) in table 1 show positive autocorrelation. The Durbin-Watson statistic (1.11) is significantly below the lower bound (i.e., 1.59 for 100 observations and four independent variables), indicating either that relevant variables were omitted or that an autoregressive scheme should be considered. Since those variables were included which were considered theoretically relevant (with the possible exception of lagged values of the variables), the latter option was chosen for further study. Although the estimated parameters in (1) are unbiased, their sampling variances are underestimated and the statistical significance of the variables may be overstated. Thus, the reliability of our estimates may be improved by considering an autoregressive structure.

The model was reformulated as a first order autoregressive structure to obtain an estimate of the autocorrelation coefficient (ρ), i.e., $u_t=\rho u_{t-1} + e_t$. Thus the new form of equation (1) was:

$$(2)\quad Q_t - \rho Q_{t-1} = a(1-\rho) + b_1(P_t - \rho P_{t-1}) + b_2 (Y_t - \rho Y_{t-1}) + b_3 \sin \theta t + b_4 \cos \theta t + u_t$$

The parameters of this equation were estimated by using an iterative procedure developed by Martin (*6*). The parameters of equation (2) in table 1 are all highly significant.

Conclusions

The yearly consumption cycle is well represented by the trigonometric variables. As was shown previously, these variables may be combined into one variable; the

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results of this combination are -0.1188 cos (0.5236t - 0.415). Holding other things constant, this relationship is used to determine the minimum of the cycle (i.e., where cos (X) = -1.0) and the maximum of the cycle (i.e., where cos (X) = 1.0). Thus, minimum per capita consumption occurs in mid-January (t=0.79) and maximum per capita consumption in mid-July (t=6.68).[4] Such results are expected because consumers use more sandwiches for picnics and other occasions in the summer.

The elasticities are reported at the means. Price is inelastic (-0.372) as suspected, but is of a greater magnitude than previous estimates.[5] A 10-percent increase in price would be associated with a 3.7-percent decrease in bread consumption. Income is very inelastic (0.086), and conforms reasonably well with Rockwell's (*9*) estimate for medium-income consumers (0.12). Since the income coefficient is significantly different from zero, it does not include Brandow's zero estimate. A 10-percent increase in per capita disposable income would only be associated with a 0.86-percent increase in consumption. Thus, the demand for bread is somewhat responsive to price but nearly unresponsive to income changes. Although the above results indicate the relative inelasticity of bread with respect to price and income, the fact that the data used were aggregate U.S. levels prompts questions for future research projects. It may well be, for instance, that demand for bread is more responsive to price for low-income consumers than for middle- and high-income persons. If such differences in demand exist, they have strong implications for price discrimination policies permitting lower prices in low-income neighborhoods and higher prices in other areas where demand is less responsive to price. Similarly, derivation of income elasticities by income level rather than use of an aggregate figure would shed light on expected results of such Government programs as the Food Stamp Program.

[4] This allows integer values of t to lie at the midpoint of each month.

[5] Price elasticities at two standard deviations from the mean slope are -0.254 and -0.490.

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Use of Photography in Sampling for Number of Fruit per Tree

By H.F. Huddleston

The costs of obtaining a given level of accuracy in estimating yields of tree fruit might be lowered by the use of photographs or supplemental information on fruiting potential. A small-scale experiment of this sort is described for peaches and apples. A procedure for evaluating the relative cost and efficiency of different methods of estimation is given and some provisional judgments of results are offered.

Key words: Double sampling; remote sensing; fruit yields; photography; sampling frame.

The development of new methods of estimating yields of crops typically begins with investigations based on small samples to explore alternative techniques and characteristics to be measured. One such investigation, carried out by the Department of Agriculture, concerns the potential use of photography for estimating the number of apples or peaches per tree. This paper describes the study and presents some preliminary results.

Among the tree crops to which objective sampling techniques have been applied to estimate numbers of fruit in the United States are oranges, peaches, cherries, apples, almonds, pecans, walnuts, filberts, grapefruit, and lemons.[1] It is characteristic of most tree crops that the number of fruit per tree varies widely among trees classified by age and variety in commercial orchards. Normally, the number of fruit per tree contributes much more to the variability of yield per tree than size or weight per fruit. The counting of fruit on a large sample of trees is indicated unless auxiliary data on the yield potential are available to provide more efficient estimates of production per tree. Accurate visual counting of fruit on sample limbs by field crews is costly and difficult to achieve in large-scale surveys. In addition, there may be a problem of getting fieldmen trained and disciplined to carry out objectively the sampling and fruit counting procedures.

The investigation of the use of photography has two specific purposes:

(1) To obtain pictures of bare trees which can be used as a frame for rigorously defining sampling units for small portions of a tree, and which can provide a visual record designating sample limbs that field crews can find for making counts of fruit.

(2) To create auxiliary information on fruit set for individual trees—information that can be utilized either with counts of fruit made by field crews for a small fraction of a tree in the sense of double sampling, or as a variable which would be useful in ratio estimation. The work has progressed to a point where results for small samples of trees are available for several kinds of fruits. USDA plans to collect data for somewhat larger samples to evaluate these findings before making recommendations for operational surveys.

Constructing a Frame Using Photography

Pictures are taken early in the spring before leaves appear and may be used for several years. For each of two sides of a tree, approximately 180 degrees apart, a stereo transparency is obtained. In the office, a copy of one member of the stereo pair is reproduced for identifying the sampling units. Normally there are three branching stages for sampling a tree: (1) Primary limbs corresponding to the main scaffolds off the trunk, (2) secondary limbs originating from the primary limbs, and (3) terminal limbs branching from the secondary limbs. Terminal limbs correspond to the ultimate sampling units which are small enough to be counted by field crews in 1 hour or less. Generally the cross-sectional area of a terminal limb is 1 to 3 square inches. The total number of these units on a tree is a function of age, which is normally reflected by tree trunk size.

The photographs provide a complete identification of the limbs for the sample trees. This introduces the

[1] Studies of objective sampling techniques as applied to some of these crops include: R.J. Jessen, Determining the fruit count on a tree by randomized branch sampling, *Biometrics*, Vol. 11, pp. 99-109, 1955; R.P. Small, Research report on tart cherry objective yield surveys, U.S. Dept. Agr., Statis. Rptg. Serv., 1964 (unnumbered); R.R. Sturdevant, Research report on Virginia apple objective count surveys, U.S. Dept. Agr., Statis. Rptg. Serv., 1967 (unnumbered).

possibility of optimizing the sample design which otherwise would not exist.

For four alternative methods of selecting limbs, relative variances within trees of the number of fruit on terminal limbs are shown in table 1. The random-path method[2] with equal probability of selection at each stage of branching (EPS) requires only a count of the number of limbs at each branching stage; whereas random path with probability of selection proportional to size of limb (PPS) requires measurement of limb sizes at each branching stage. Single-stage method refers to direct selection of terminal limbs either by EPS or PPS after all terminal limbs on the tree have been defined. The random-path method can be used either in the field or in the office from photographs, whereas the single-stage method is possible only from a photograph (or mapping) for large trees.

Table 1.—Analyses of number of fruit per terminal limb for alternative sampling schemes

Items	Virginia peaches	Virginia apples	California peaches
Number of trees = K	9	6	16
Total number of terminal units (ΣN_i)	125	134	320
Variances relative to the mean squared within tree:			
Single-stage EPS	.519	.502	.341
Single-stage PPS	.293	.238	.493
Random-path EPS	.561	1.260	.924
Random-path PPS	.317	.240	.397

The within-tree variances were computed as follows:

Single-stage EPS:

$$\sigma_1^2 = \frac{\sum_{i=1}^{K} \sum_{j=1}^{N_i} (N_i X_{ij} - X_{i.})^2}{\sum_{i=1}^{K} (N_i - 1)}$$

Single-stage PPS:

$$\sigma_2^2 = \frac{\sum_{i=1}^{K} \sum_{j=1}^{N_i} P_{ij} \left(\frac{X_{ij}}{P_{ij}} - X_{i.} \right)^2}{\sum_{i=1}^{K} (N_i - 1)}$$

[2] See Jessen (cited in footnote 1).

Random-path EPS:

$$\sigma_3^2 = \frac{\sum_{i=1}^{K} \sum_{j=1}^{N_i} E_{i,j} \left(\frac{X_{ij}}{E_{i,j}} - X_{i.} \right)^2}{\sum_{i=1}^{K} (N_i - 1)}$$

Random-path PPS:

$$\sigma_4^2 = \frac{\sum_{i=1}^{K} \sum_{j=1}^{N_i} Z_{i,j} \left(\frac{X_{ij}}{Z_{i,j}} - X_{i.} \right)^2}{\sum_{i=1}^{K} (N_i - 1)}$$

where

X_{ij} = number of fruit on the jth terminal on the ith tree

P_{ij} = probability of selecting the jth terminal limb on the ith tree

N_i = number of terminal limbs on the ith tree

K = number of trees

$X_{i.}$ = number of fruit on the ith tree

$E_{i,j}$ = limbs at each of the j stages on the ith tree were selected with equal probability

$Z_{i,j}$ = limbs at each of the j stages on the ith tree were selected with probability proportional to size

$$\sum_{j=1}^{N_i} P_{ij} = 1$$

$$\sum_{j}^{N_i} E_{i,j} = 1$$

$$\sum_{j}^{N_i} Z_{i,j} = 1$$

The notation (i,j) in the subscripts to E and Z indicates that a variable number of stages, j, was required to reach the individual terminal or elementary units on the ith tree. The value of j is commonly 2 or 3, but may be 1 or occasionally 5 for a few limbs on each tree.

Conceptually, one might expect that the random-path PPS and the single-stage PPS would have approximately the same sampling error. The difference in sampling error for single-stage EPS and single-stage PPS is appreciable, but reverses the magnitude somewhat unexpectedly for California peaches (table 1). It is suspected this may be the result of the thinning of fruit to meet specific marketing order requirements to control production, which alters the correlation between limb

size and number of fruit. Three alternative schemes of sampling limbs are under consideration: (1) Estimate the limb size from the photograph, (2) try to define on the photographs terminal limbs that are as close to equal size as possible, or (3) use two-stage selection, choosing primary units with PPS and terminals within primary limbs with EPS.

It is feasible and desirable to use a two-stage procedure which is a slight variation from the random-path method and which will materially reduce the amount of time required to select terminal units whether the selection is made from photographs or completed in the field. This procedure will give quite efficient estimates of fruit per tree since the size of the primary limb is highly correlated with the total fruit on its terminal limbs. The closeness of the relative variances for single-stage PPS and random-path PPS is largely the result of this relationship.

Fruit Counts From Photographs

Eight 35-mm. slides were obtained of each tree when the field crews made counts of fruit by limbs. Four slides were obtained from each of two sides of the tree, 180° apart. Each side of the tree was divided into quarters by using vertical and horizontal aluminum poles which formed a "plus" sign. One slide covered each quarter with some overlap with the adjoining quarter to insure complete coverage. Four pictures of a side were more satisfactory for counting or interpretation purposes than one picture taken with a wide-angle lens.

Some individual fruit near the edge of a tree may be seen on pictures from both sides and hence counted twice. More importantly, some fruit cannot be seen at all. However, the problem under consideration is the possible use of fruit counts from photos in the context of double sampling or eventually in lieu of physical counts, if relationships between photo and physical counts can be found which do not vary among years.

The count of fruit from slides is highly correlated with the total fruit (last line of table 2); consequently, efforts to develop a practical statistical scheme of using this information are justified. For double sampling there may be better covariates than photo counts, in the sense of minimum variance per dollar, but finding qualified people for sampling work in the field may be an equally important consideration. The task of recruiting, training, and supervising a large field crew may be more difficult than hiring a very small field crew and a group of photo interpreters for counting fruit in a double sampling scheme. Some of the results to date indicate that stable relationships between photo and physical counts can be found.

Table 2.—Correlations between number of fruit per tree and different measures of tree sizes and fruit counted on photographs

Item	Virginia peaches	Virginia apples	California peaches
Trunk size	0.12	0.89	Not obtained
Sum of sizes for primary limbs	.33	.87	0.50
Sum of sizes for terminal limbs	.42	.90	.56
Number of terminal limbs	.26	.73	.52
Fruit counted on photos	.85	.98	.85

For the six apple trees reported in table 1, the linear regression coefficients (relating fruit counts on the trees to counts on photos) and the fraction of fruit visible were computed from 1967 data. These statistics were used to estimate the number of fruit on the same trees in 1968, based on a single random selection of one terminal per tree. The estimates are shown in table 3. These fragmentary results are encouraging inasmuch as the estimates utilizing the supplementary information (first three columns of table 3) are closer to the actual count than the single-stage EPS estimator. There may be reason to hope to eliminate the need for physical counts except for verification or occasional updating of the relationships. The estimators used for table 3 were:

Ratio estimator:

$$\hat{Y}_1 = X_i \div \hat{R}$$

where X_i = fruit counted on 8 slides in 1968

$\hat{R}$ = average fruit counted on 8 slides divided by actual fruit per tree in 1967.

Regression estimator:

$$\hat{Y}_2 = \hat{a} + \hat{b}X_i$$

where $\hat{a}$ = intercept derived from 1967 data

$\hat{b}$ = slope derived from 1967 data.

Composite estimator:

$$\hat{Y}_4 = X_i + (1 - \hat{R})\, y_i$$

where $\hat{y}_i$ = 1968 estimated fruit per tree = $N_i X_{ij}$; based on a random sample of one limb (N_i and X_{ij} are defined on page 64).

Single-stage EPS:

$$\hat{Y}_3 = \hat{y}_i.$$

Table 3.—Fruit numbers estimated by four methods, 1968, and actual counts, 1967 and 1968

Tree number	Estimated 1968				Actual count	
	Ratio estimator	Regression estimator	Composite estimator	Single-stage EPS estimator[1]	1968	1967
1	434	254	415	396	602	403
2	563	413	377	196	399	214
3	820	730	651	487	758	1,658
4	596	454	630	663	746	1,575
5	789	691	944	1,094	1,075	1,901
6	1,645	1,745	949	272	2,181	1,448
Total fruit	4,847	4,287	3,966	3,108	5,761	7,199

[1] Estimates in this column correspond to the results that would have been obtained using counts by field crews.

In table 4, "sides" refer to the two sides on a tree 180° apart; "diagonal" refers to a combination of the counts from two quarters of a side, either upper left and lower right or upper right and lower left. For diagonals there is one degree of freedom per side for each tree.

Use of Auxiliary Variables

The investigation of alternative measures of fruit set per tree is in the formative stages in the research. Table 2 shows correlation between each of four variables determined prior to fruiting with fruit set per tree. The photo counts are considered in a different context since a count of the visible fruit is obtained only after fruiting has occurred.

The best measure of potential fruit set prior to actual fruiting appears to be the sum of the sizes of all the terminal or elementary sampling units on the tree. The two principal factors which seem to influence the various measures of fruit set are (1) kind of fruit and (2) age of tree. However, the number and size of terminal units appear to be a more effective way of expressing tree age. The results in table 2 show that the sum of the primary limb sizes contains almost as much information on fruit set as the terminal limb sizes. Consequently, this variable is to be preferred because of the relative ease of securing the information. Normally, a bearing fruit tree will have about five primary (scaffold) limbs whose sizes can be measured easily. While this phase of the research is just getting underway, the use of auxiliary variables as a basis for tree selection or double sampling appears promising.

Table 4.—Nested analyses of variance of number of fruit counted from photographs[1]

Source variation	Virginia peaches		California peaches		Virginia peaches	
	degrees of freedom	mean squares	degrees of freedom	mean squares	degrees of freedom	mean squares
Total	71	320	55	211	23	5,028
Trees	8	1,561	6	540	5	21,462
Sides	9	142	7	490	6	548
Diagonals ..	18	98	14	73	12	421
Quarters ...	36	200	28	139		

[1] Nested analysis is described in: G.W. Snedecor and W.G. Cochran, *Statistical Methods*, 6th ed., Iowa State Univ. Press, 1967.

Cost and Efficiency Implications

The development of techniques using photography or other supplementary information to reduce either the variance of the estimator or the costs of acquiring data is the principal consideration in evaluating new tools. While the exploratory studies reported in this paper do not provide a satisfactory basis for judging these factors, some hypothetical relative costs and variances indicate what conditions are required to result in greater overall efficiency.

Three schemes of double sampling are considered, based on the use of three sources of additional or supplementary information: (1) Counting the fruit on the tree from colored slides, (2) measuring tree cross-sectional area based on either trunks or primary scaffolds, or (3) constructing a sampling frame from bare tree photography to define sampling units for use by field crews for each of n trees in a block and counts of fruit on n' trees by field crews using conventional limb selections and fruit counting procedures where $n \geq n'$. For (1) and (2) we can approximate the effect on the sampling error by:

$$S^2_{\bar{x}_n} \doteq \frac{S^2_x}{n'} \left[1 - \rho^2 \left(1 - \frac{n'}{n}\right)\right]$$

where S^2_x is the variance per tree of the conventional estimate of fruit per tree, ρ^2 is the correlation coefficient between the new information and the conventional estimate X, and n' is a random subsample from the n trees in the block.[3] For (3) the reduction in variance is expressed as the ratio of two variances such as those given in table 1. Table 5 illustrates the gains or losses that may be achieved with double sampling using regression estimation and a linear cost function ($c = c_1 n + c_2 n'$) for the same total costs. The values in the body of the table are given by

$$\left[\rho\sqrt{c_1/c_2} + \sqrt{1 - \rho^2}\right]^2$$

where c_1 = cost per unit for the information for the n first-stage units and c_2 = cost per unit for the information for the n' units subsampled.

The use of supplementary information results in gains in efficiency for the same costs for large values of ρ and small values of the cost ratio c_1/c_2. Based on the correlation values in table 2, apples are the most promising of the fruits studied. However, the counting of fruit on photos seems likely to merit further study for all fruits.

Based on the present methods of data collection, the most favorable cost ratio of the variables in table 2 is "trunk size" and the least favorable ratio "fruit counted on photos." The attainable cost ratios for these variables are probably of the order of 1/9 and 1/2. The consideration of factors other than costs and variances, such as control of nonsampling errors, and survey training and supervision, may provide additional gains using supplementary information.

[3] M. Hansen, W. Hurwitz, and G. Madow, *Sample survey methods and theory*. Vol. 2, Theory, John Wiley & Sons, Inc., 1953.

Table 5.—Ratio of variance with optimum double sampling design to the single sample for various values of ρ and c_1/c_2

ρ	Cost ratio: c_1/c_2						Gain or loss
	1	1/2	1/3	1/5	1/7	1/9	
.4	1.73	1.44	1.32	1.20	1.14	1.10	Loss
.5	1.87	1.49	1.33	1.19	1.11	1.07	
.6	1.96	1.50	1.31	1.14	1.05	1.00	
.7	2.00	1.46	1.25	1.05	.96	.90	
.8	1.96	1.36	1.13	.92	.81	.75	
.9	1.78	1.15	.91	.70	.60	.54	Gain
.97	1.47	.86	.64	.46	.37	.32	
1.0	1.00	.50	.33	.20	.14	.11	

BOOK REVIEWS

Foundations of Farm Policy

By Luther Tweeten. The University of Nebraska Press, Lincoln. 537 pages. 1970. $9.50.

It is seldom that one reads a textbook which ranges so broadly on the topic of farm policy. Tweeten's book would be worth having, if for no other reason, because the chapter and references provide leads to key literature on several topics of importance to agricultural economists.

If there are two criticisms that can be aimed at this particular work, they are the ones of (1) undertaking too broad a range of subject-matter materials in one book and (2) writing some portions of the book, particularly those relating to the sociological-psychological aspects of policy, at a level above that which many upperclassmen and some graduate students will be able to comprehend. These are relative criticisms, however, particularly if one accepts Tweeten's suggestion that "the three requirements for success in policy study are to: read, read, read."

If one wants a shorter treatise on farm policy, some topics might better be left to books in economic history of the United States or in general banking and finance. An example of fairly difficult terminology is a statement on page 87, "the propensities to save, invest, and be efficient will be high and economic growth most rapid in an area possessing social-psychological characteristics of secular asceticism and functional activism." The author does go on to define these terms but again in terms of a set of characteristics that are not easily unified.

The book includes sections on what agriculture wants from society and what society wants from agriculture. Needless to say, the objectives viewed from these two vantage points differ substantially. The section on goals and values from a rural perspective draws heavily on the work of John Brewster as well as others.

The author goes back in history to cite the early protest in U.S. farming, starting with the effort to voluntarily cut surplus tobacco production in the 17th century, the failures that resulted, and the activities of rioters who cut and destroyed tobacco in order to reduce supplies and improve prices. The history of early farm organization movements in New England draws heavily on work by Carl Taylor that traces the cooperative movement starting with New England dairy farmers in 1910. It is clear that problems of diversity of interest and the inability to coordinate a common farm organizational thrust have plagued farmers from an early date.

The author centers a good deal of attention on the key need for education of rural people in our changing economy. A table listing expenditures for agricultural research and development programs shows the high proportion which has gone for protection of forests, crops, and livestock; for efficient production of farm and forest products; and for product development and quality. On the other hand, it shows the small expenditures which have gone to assist developing countries, to expand export markets, to raise the level of living of rural people, and to improve community services and environment. The author presents a convincing case that some reordering of priorities is needed.

Sections discussing economic history, attitudes, institutions, and technology are exceptionally good. The author's estimates of equilibrium levels of inputs in farming seem reasonable—as evidenced, for example, by the rapid shifts of labor out of farming in recent decades, an adjustment suggested by his analysis.

Tweeten provides a brief history of farm programs since the 1920's and then lists five program choices of key importance:

(1) Should we continue heavy investments in technology? Here, the answer seems to be yes, because of the increased productivity which amounted to $75 billion in 1965 alone.

(2) Should we have free markets or income support for agriculture? His answer to this question is that some program help is needed but that program benefits should be tied more to people than to holding commodity prices above free market levels. The latter policy, according to the author, results mainly in capitalization of benefits into land prices.

(3) Do we need long-run or short-run programs? The answer here seems to be that we need some of both.

(4) Should we have voluntary or mandatory programs? The answer is suggested as being voluntary to the extent possible in keeping with the accomplishment of policy objectives.

(5) What voluntary programs should we have? Here, the answer varies somewhat by commodity and problem situation. The author does a good job of citing the slippage in past commodity programs, but may, in this

reviewer's judgment, overplay a bit the problem of improving the distribution and mobility of capital in agriculture.

With respect to the economic structure of farm production and input markets, Tweeten cites evidence that the family farm has held its own relatively well in the past, but probably faces increased competition from large industrial farms in the future primarily because of the hurdles of large capital and management requirements. He suggests that commercial agriculture is well along on the trend to 1 million farms and 2 million farmworkers.

Increased international trade is cited as a key place where farm producers' welfare can be helped. Recent expansion in trade for farm products is in keeping with the author's optimism. This reviewer believes, however, that Tweeten's long-run estimates of demand elasticities in foreign markets are high and do not adequately reflect the decisionmaking setting in other countries. The placing of formal or informal limits on the amounts of foreign exchange which can be spent for agricultural imports, protectionism, the likelihood of retaliation by competitors if prices are cut significantly, and so on, are all variables which have impacts on the aggregate elasticity of demand for U.S. exports.

The book includes a significant section on rural poverty. A number of key statistics are cited showing the location and incidence of poverty. This serves well to support the following sections, which review the effectiveness of poverty programs and find them lacking because (1) programs have typically been structurally unsound, e.g., they have missed the major poverty groups by utilizing a regressive commodity program mechanism, and (2) those people in poverty who most need help often do not make use of the help which is available. So the delivery system for poverty programs has been less than adequately effective.

A number of suggestions are made for prospective poverty program needs. These include (1) differentiation of people according to their degree of employability, (2) improved mobility and better factor markets for labor, (3) the multifaceted needs for improved education, and (4) the need for realism in appraising opportunities for industry in rural areas. Overall, programs need to be better tailored in terms of cost-effectiveness for specific categories of the poor.

A summary and conclusions section on public welfare efficiency discusses several criteria, including those termed Pareto, Kaldor, Hicks, and Scitovsky.

W. B. Sundquist

Organization and Competition in the Midwest Dairy Industry

By Sheldon W. Williams, David A. Vose, Charles E. French, Hugh L. Cook, Alden C. Manchester. Iowa State University Press, Ames. 339 pages. 1970. $12.50.

Dairying is a dynamic industry. That is one's first impression from this study and evaluation of changes in the Midwestern dairy industry in the past two decades. However, the nature of the industry and the availability of data make limiting any analysis of dairy market structure strictly to that region difficult if not impossible. Because of the importance of the Midwest to the total U.S. dairy industry, this book affords the reader considerable perspective regarding the changing national dairy scene.

The study is a wrap-up of the regional research project, "Changing Market Structure of Midwest Dairy Industries," of the North Central Dairy Marketing Research Committee. In this respect, the book is unique. Although several individual research publications often arise from a regional research project, this reviewer knows of no other project from which an overall publication has resulted. Many specialists contributed to this book. However, its authors were members of the steering committee which planned and carried out the study with guidance from the regional committee.

The first nine chapters of the book focus on changes in the structure and organization of the dairy marketing industry, and the conduct of firms operating in the industry. General chapters deal with market institutions and technological developments and procurement markets for milk.

Separate chapters effectively summarize changes in the number and size of plants and firms, market shares, business organization, product differentiation, private labeling, vertical integration, merger activity, economies of scale, and price competition for each of the major dairy industries. This study primarily used published information from university research studies, USDA, Bureau of the Census, and other sources. Many of the data used in this book are several years old, and only limited new information was obtained. The discussion and data are similar to those presented on a national basis by the National Commission on Food Marketing in a technical study, "Organization and Competition in the Dairy Industry." The dates of many of the research studies used as references for this book make one wonder if our dairy marketing research is keeping up with the changes in the industry. Although general relationships existing in the early 1960's may still hold today, I don't think we can be sure.

Three of the more significant recent changes in the dairy industry—growth of large regional farmer cooperatives, concentration of dairy product sales through retail food stores, and diversification by the large dairy companies—are well documented. The book thoroughly discusses the regional cooperatives as they represent farmers as sellers of milk, but it gives only limited attention to their role as buyers and manufacturers of milk and the accompanying effect on market structure. Currently, many mergers and acquisitions of dairy firms are by producer cooperatives, as the large dairy companies are moving into nondairy activities.

This book goes one step beyond the Food Commission dairy study by presenting an evaluation of the performance of dairy marketing. (The general report of the Food Commission, "Food From Farmer to Consumer," made an overall appraisal only of the performance of food marketing firms in general.) The authors, recognizing the value judgments involved, measure the performance of the dairy industry in relation to (1) technological efficiency and progressiveness, (2) margins and profits, and (3) sales promotion costs. The use of Stigler's survivor technique to estimate optimum plant size is unique to a dairy marketing study. In the early 1960's, a relatively low portion of plants were of optimum size; more current data would probably show an increasing proportion. The book suggests that, on the whole, dairy marketing has been progressive, and that gross margins, level of profits, and sales promotion expenditures in general have not been excessive when compared with other food products and industries.

In perhaps the most important chapter of the book (entitled "Some Implications"), the authors present a thought-provoking discussion of the implications of changes in the dairy industry for producers, cooperatives, handlers, institutions, retailers, consumers, labor, and government. The chapter raises many questions regarding the future of the industry—its control, the changing concept of a market, its attitude toward the public interest, the impact of substitutes, government controls, and the role of cooperatives, to list a few. These are significant signposts for the future direction of dairy marketing research.

This book very effectively brings together a vast amount of information about the changes taking place in the Midwest and U.S. dairy industries since World War II. Anyone involved with the dairy industry—student, researcher, marketer, Government worker, farmer—would benefit from reading this book.

Robert R. Miller

Economics and the Environment: A Materials Balance Approach

By Allen V. Kneese, Robert U. Ayres, and Ralph C. D'Arge. Resources for the Future, Inc., Washington, D.C. 120 pages. 1970. $2.50.

I would like to commend the authors on a much needed book on the development of a systematic and analytic way in which to study the interactions of the environment with economic activities. I say this because heretofore a large majority of the writings on the problems of the environment have been descriptive and have not dealt with the problems in the more meaningful, systematic way.

The book is divided functionally into four main sections as reflected in the four chapter headings. Chapter 1 gives an overview of the "residuals" problem. That is, it seeks to account for the overall pervasiveness of noxious externalities (pollution, etc.) in a developed economy. Chapter 2 is mainly descriptive in its discussion of the residuals or wastes that result from man's economic activities: Personal consumption (solid and liquid wastes); power generation (thermal and chemical pollution); transportation (air pollution); and industrial production (air and water pollution). Chapter 3 is a theoretical chapter in which the notion of the environment is incorporated explicitly in the Walras-Cassel general equilibrium model. Chapter 4 suggests ways in which to make the preceding analysis useful for regional environmental management, as well as suggesting needs for future research and improved data availability.

The authors emphasize that externalities such as pollution residuals are an intricate and pervasive part of the economic production and consumption processes. For example, there is no such thing as "consumption" really. Nothing is consumed or destroyed. It is merely transformed into another form (except waste or scrap residuals). Hence the notion of "materials balance," since in the absence of anti-matter nothing is destroyed but is merely changed. Heretofore, economic models, if they took pollution or residuals formation into account at all, have treated pollution in an "added on" fashion, and usually have treated the environment as an inexhaustible "sink" for residuals.

Second, the authors wish to emphasize that there are numerous tradeoffs between pollution types. For example, air pollution controls often utilize a technology that increases water pollution and vice versa. This is again consistent with the authors' materials-balance concepts. Hence, they see it as vastly inefficient to have separate groups engaged in air or water pollution control. A general environmental agency (such as has recently been formed) is necessary.

Third, using an "environment extended" Walras-Cassel model, they establish the Pareto optimum conditions for production and prices. If information on utility functions of individuals, production functions of firms, etc., were costless, the authors establish what would be the optimum consumer taxes and/or producer taxes needed in order to "force" the system to its Pareto optimum, given that the environment is not a costless or free "good" to the firm, and that the environment gives utility (or disutility) to the individual consumer. Their main point here is that everyday economic decisions could remain decentralized and still the economy (model) would reach Pareto optimum if the "rules of the game" (taxes, for example) were made such that environmental degradation costs had to be borne by the producers (via increased costs) and/or the consumers (via increased prices).

Fourth, the notion of "second best" is discussed as an optimization possibility, since the gains from perfect optimality when including the environment might be easily offset by the costs of gathering perfect and complete information. But this method also has its problems since the "second best" solution is indeterminate in the absence of complete information on utility functions, production capabilities, and private-social cost discrepancies.

Fifth, the authors conclude, therefore, that the "best" solution might be not to try for perfect optimality. (Given the model's restrictive assumptions, that is not possible, using this model, in the real world, anyway.) It might be best, rather, to try, in a consistent materials-balance way via such means as tax policy, to partially offset the private-social cost discrepancies and thus at least inch closer toward real optimality.

My criticisms of the book and the model lie mainly in the authors' presentation of the mathematics. In general, they have limited verbal explanation and justification of the equations. Equation 5b (page 78) is an example. Only when I added four or five steps of my own did this equation seem justified. Also, the precise notion and meaning they have given for recycling (the gamma γ introduced on pages 80 and 81) is confusing to me. I feel that the summation variable in equation 5a (page 78) should be M, not N; and I have some doubts about the direction of the inequality in equation 21.3 (on page 90).

But generally I find the book to be an excellent thrust toward the theory of the integration of economics and the environment. Because of this, I will be very interested in seeing some of the current work on this environmental issue going on at Resources for the Future as was indicated in several of the footnotes.

Daniel G. Williams

Benefits and Burdens of Rural Development

By Iowa State University Center for Agriculture and Economic Development. Iowa State University Press, Ames. 311 pages. 1970. $5.95.

This book is a comprehensive assortment of papers by economists and sociologists on various advantages and problems associated with rural development. These writings are useful in highlighting and explaining the specific problems of our rural economy, and particularly the complexity of the U.S. farm program; but unfortunately one finds little in the way of concrete suggestions for resolutions to the problems.

It has been known for some time that most of the direct benefits from the Government farm program accrue to the large commercial farmers. The $30 billion spent from 1933 to 1966 to support farm income bypassed the marginal farmers. Even benefits from research and education in land grant universities have mostly flowed to the large commercial farmers, thereby increasing the inequity of income between the small and large farmers. This predicament is due to the fact that program benefits continue to be distributed in proportion to production. Program benefits are becoming increasingly concentrated because farm production is becoming concentrated on about one-third of all American farms. To further aggravate the situation, the operation of the program has little flexibility. G. E. Brandow states that although the normal current cost of the farm program to the Government is about $5.3 billion, not more than one-fourth of the Government expenditure can directly absorb resources which can have alternative production uses.

Since the marginal farmer cannot compete with the commercial farmer, he is forced to earn a large proportion of his income in the nonfarm sector. J. Patrick Madden points out that there are still 2 million farm residents existing below the poverty level. Accordingly, off-farm work has been the most important variable in reducing short-run poverty in agriculture.

The Government program, which has largely ignored the marginal farmer, has also paid little attention to the plight of the rural nonfarm population. The large farmers are cared for; the urban population is cared for; but those in between—as Earl O. Heady notes—do not receive the bendfits of programs and aid. Those persons comprise no small number in our economy. They have been growing more rapidly than the Nation as a whole as outmigration from the farms increases from year to year. In 1960, there were 41 million rural nonfarm persons, or one-fourth of the national population. Significantly, Conrad Taueber explains that only one out of four of these persons lives in small towns; the remaining 30

million live in what is classified as "open country": crossroad settlements, developments along the highways—places where there is no clear delineation. This phenomenon gives evidence to Bruce Gordon's thesis that farm labor is much more mobile than had been generally believed, and thus suggests that it may no longer be wise to treat the welfare of farmpeople as an independent problem for which special kinds of public policies are required.

Jack Ben-Rubin

A Century of Russian Agriculture: From Alexander II to Khrushchev

By Lazar Volin. Harvard University Press, Cambridge. 644 pages. 1970. $18.50.

Lazar Volin spent most of a lifetime studying Soviet agriculture. Perspectives gained from a 40-year career devoted to his subject are contained in this volume. Students of Soviet agricultural matters, the Soviet economy, and Soviet affairs in general are richer to have available these perspectives—for which most of us strive, but which not all of us attain.

A Century of Russian Agriculture is an excellent economic history of the rural sector and of agricultural organization and production in 19th-century Russia and in the USSR. Despite the price, it should be on the reference shelf of the specialist on the Soviet economy or the historian of Soviet political affairs. The book is comprehensible and should be read, at least in part, before being placed on the shelf.

The usefulness of this economic history of Russian and Soviet agriculture should not be limited to the Soviet specialist. The Soviet Union has emerged into the industrialized world more recently than the United States and most countries of Western Europe. Although still behind the United States, it has achieved a higher average level of material well-being than most countries of Africa, Asia, or Latin America. For these and other reasons, many consider its experience more relevant to the central economic issue at this time in the world—the economic development of the nations, regions, and groups that have been left behind. Development economists will find much to enlighten them in this detailed account of Soviet policies toward the rural sector and the shortcomings and strengths of these policies.

Although the Soviet Union has joined the ranks of industrialized countries, it remains much more heavily agricultural than the United States. The share of rural population is much greater than for most other countries possessing a similar level of per capita GNP. There are still more farmers in the USSR than anywhere in the world, except China and India.

Equally important, the USSR is the second-leading agricultural producer in the world; the closest rival to American agriculture in terms of total output. The student of American agricultural affairs may find Volin's study an extremely interesting source for comparison.

Part 3, entitled "Collectivized Agriculture Under Khrushchev," provides a good account of agriculture in recent years, and may be read separately, although the previous parts place the recent situation in much better perspective. The reader will have to look elsewhere, however, for an analysis of the current situation in Soviet agriculture. Volin mentions in part 3 the beginning of the policy changes under the current Soviet leadership, headed by Brezhnev, but the full meaning of these reforms and the results of these changes could not yet be analyzed when he wrote this book. The agricultural policies of the post-Khrushchev regime from 1965 through 1970 were the most dynamic of any in the Soviet economic area.

The book has one other flaw as a reference work. It does not contain statistical tables giving the long historical series on most major agricultural variables and relationships. One cannot find even a table presenting the production data on a major agricultural commodity such as grain. Nowhere can the reader evaluate for himself the changes in output attained by the agricultural plant. These data are available and, despite Volin's misgivings about their reliability, would have made a very useful contribution to his work.

Despite this lack, Volin's work is the most comprehensive, yet readable, study of Soviet agriculture available today.

David M. Schoonover

The Negev: The Challenge of a Desert

By Michael Evenari, Leslie Shanan, and Naphtali Tadmor. Harvard University Press, Cambridge. 1971. $15.

Driving through the Negev, it is hard to believe that anything can survive or that people lived there for thousands of years. The Negev is arid, bleak, foreboding, and yet beautiful. But life exists, as is illustrated in this work. In fact, life is ubiquitous. For thousands of years traders have crossed from the Mediterranean coast near Gaza to the barren deserts of Arabia to the Far East. The Nabateans and Nazarinis survived in the desert as is noted in the scrolls found in the desert caves and sand. And what is this Negev? How did the ancient people survive? And how will modern Israel adapt the desert for its population?

This book, which is a culmination of a long effort to study this unique part of the world, examines the many facets of life in the desert as it was and as it is today. It is a carefully considered work, well written and concise, presenting sound analyses. It is approximately half narrative: the remainder consists of numerous photographs, maps, charts, and diagrams of all kinds. The theme of this work is that life in the desert is a matter of searching for water. The kinds of animal and vegetable life which survive in the desert have done so by adapting their physiological makeup to the changing temperatures and rainfall of the desert. The people who lived there (and those who still inhabit the desert) found water even during the most severe droughts. If the water did not come from above, it came from below, from wells. The book presents elaborate diagrams, photographs, and sketches of the many water systems used in the Negev and gives an excellent account of the ingenuity of the inhabitants in finding water for themselves, their flocks, and their agricultural crops. Here lies the interest for the agriculturists.

To study the crops and to try and duplicate the life of the ancient people, two farms were established; one was near Avdat, approximately 20 miles south of Beersheba. Crops known to have been grown 2,000 years ago were planted, and the cultivation methods used were those described in the scrolls. Wheat, for instance, did quite well. A variety called Nanasit yielded 65 bushels per acre. The authors state that this compares favorably with yields obtained in the rest of Israel. (This is an understatement. This yield is more than twice the average obtained in Israel.) The average yield for barley planted by the Bedouins is 8 to 11 bushels per acre; the experimental farm yielded 90 bushels, with just the available water and good cultivation practices. In this low-rainfall area, different crops were tried and most proved successful. However, summer crops such as sesame, cotton, and sorghum failed. Asparagus, artichokes, and perennial crops were quite successful. While extensive research was performed on plant life, animal life was also investigated. It was found that many animals exist under these dry conditions. Land snails were found in huge numbers clinging to the tops of dwarf bushes. Animals were also found underneath stones where there was protection from solar radiation, relatively low soil temperatures, and reduced evaporation. The desert is a classical habitat of spiders, centipedes, scorpions, fishtails, and many other invertebrates. It is also a refuge for reptiles, especially snakes and lizards. The chapters on life in the desert give an excellent account of the adaptation of the systems to the desert life. There are 18 chapters in this work which can be considered a text on the Negev ecology. A discussion of the geological history of the Negev is included, and a discussion of the Nitzana papyri which offer many clues to the Negev's past.

In the epilog, the authors note some of the shortcomings of the study and some of the work yet to be done. "How did evolution work in the desert in developing plants and animals with such intricate and complicated survival mechanisms as those we have described?" Are there still untapped water resources in the desert? And can man return to the desert and live there again, as his ancestors did, working in harmony with the desert and making it green again? These and other questions are still to be answered by future students. The authors do point out that if man is to survive in the desert, he must work with it—not against it. This is a good maxim for our world today. For any student of the desert, this is an excellent account of desert survival, as well as an insight into the way early man lived and survived in this desert known as Negev.

Michael E. Kurtzig

African Food Production Systems: Cases and Theory

Edited by Peter F. M. McLoughlin. The Johns Hopkins Press, Baltimore. 318 pages. 1970. $12.50.

This book presents a dramatic and poignant plea for in-depth case study analyses of African countries' food production problems. It fills a void in African food supply research. Seven case studies on food production in Africa are presented and analyzed in depth, focusing on the food problem in an African environment.

The authors attempt to find solutions to the following questions: (1) How should the problem of Africa's food supply be studied? (2) What are the similarities and differences among the diverse African societies? (3) What general theories about traditional and tribal society, and agricultural development, are applicable in the African context?

Food production is the most critical problem facing African societies and nations. Agricultural production is not only the dominant economic activity in Africa south of the Sahara, but it permeates every aspect of life—social, political, economic, and cultural.

The food production systems for five African tribes are studied in detail: the Haya in Tanzania, the Karimojong in Uganda, the Zande in Sudan, Congo, and Central African Republic, the Yalunka in Sierra Leone, and the Diola in Senegal.

African population has doubled in this century and the rural economy has fed this population; however. what about the next 30 years? There will be twice again as many to feed in the year 2000. Can the agricultural

sector more than double its food output over the next generation? The problem cannot be solved by merely expanding farmland. The best farming areas are presently overcrowded. In many places, cash crops often compete with food crops for space on the same farm. To feed itself, Africa must raise its yields per acre. Different agricultural systems exist in Africa under contrasting ecological, demographic, social, political, and economic conditions. Each of these systems is unique and requires individual research and policy formulation for development.

This book is also concerned with the means whereby technological change may be introduced into African food production systems. Agricultural change requires improved farm technology and a farmer or herder willing to adapt to these new changes and supply the necessary farm management. The central theme throughout the book is that African subsistence agriculture is not directed toward economic growth but toward a prestige-oriented economy where surplus produce is convereted as soon as practicable into items that bring prestige—large numbers of cattle, many wives, tribal status, and command over people. This has resulted in social development but not in economic growth. Economic goals are secondary to political and sociological ones.

Special attention is given to the role of economic incentives because of the failure to recognize the importance of psychological, philosophical, sociological, and anthropological factors involved with African subsistence farmers. The creation of an incentive for economic gains is an essential step needed to bring about agricultural development in Africa. There is really little incentive for a farmer to get ahead, because of close tribal and family connections. The problem is how to get the African subsistence farmer to grow more food crops and improve his yields.

This study should prove valuable as a benchmark for future research in food production systems in African societies.

Carey B. Singleton, Jr.

Agriculture and Related Industries in Pakistan

By F. Kahnert, C. Carmignani, H. Stier, and P. Thomopoulos. Development Center of the Organization for Economic Cooperation and Development (OECD), Paris. Paperback. 452 pages. 1970. $5.50.

A reader would expect this book to be primarily about agricultural production, including associated product and factor industries. However, the title is misleading in this respect. The book really is the report of a study of requirements for a 5-year plan for food self-sufficiency. In it the authors move the analyses in the direction of an overall 5-year plan for Pakistan's agriculture. In fact, the last chapter, chapter VI, of the volume is entitled "A Suggested Action Programme for Agricultural Development." Food self-sufficiency became a secondary consideration as the need grew for examination of the direction and depth of general agricultural development.

Viewed in this broader context, the book is an addition to our knowledge of agriculture in developing countries. In particular, Pakistan's economic growth is reviewed and agriculture's role is highlighted. The various components needed for increasing the rate of development are fairly well stated and projected through 1975. Such projections are always subject to certain limitations; data credibility and methodology, for example. However, given the fairly good statistics of that country and the methodology used, I would be inclined to accept the authors' prognosis. However, this is true only in the technical sense. That is, one can be fairly sure that, in words of the authors, "technical means for overcoming food shortages are available"; that "advances in agricultural technology will be able to provide the breathing space" needed for other programs.

Yet having recognized the above point, this reviewer is not inclined to be over-optimistic about the reality of the situation. And the authors, having made their optimistic bow in the direction of Pakistan's "determination to tackle" deficiencies and flaws and to come up with needed remedies, proceed in their conclusions to list a number of policies and issues which have to be resolved if that country is to achieve its food production and agricultural development objectives. When one studies these policy and program issues (assuming the authors have properly identified them) and questions whether they will be faced and resolved, one can only conclude: well, *maybe.*

Students of developing economies, particularly those with agricultural interests, will find this book rewarding. It is a recommended addition to the growing volumes of country and sector development studies.

John H. Southern

Towards Full Employment

A program for Colombia prepared by an Interagency Team. International Labor Office, Geneva. 471 pages. $4.

The International Labor Organization (ILO) launched a world employment program in 1967 under which special studies were to be made of unemployment in selected countries. Colombia requested that it be the first country to be studied, and ILO organized a large

team which visited Colombia in early 1970 and prepared the report being reviewed.

The studies were to be made in particular types of countries. Colombia represented a country with serious unemployment that showed a secular uptrend during the decade of the 1960's. The threat of even higher rates of unemployment during the 1970's loomed, although a slight reduction in unemployment occurred in 1969 and 1970 as economic recovery was strengthened by soaring prices for coffee, Colombia's principal export.

The ILO team estimated that at least one out of six persons in the active urban labor force was seeking work but unable to find it, and that probably as many again would like to work if jobs were available. No recent estimates of rural unemployment were available, but the general idea that open unemployment was not high but that underemployment was serious was confirmed in a subsequent survey by the Colombian national statistics agency (DANE).

No quick solution for the serious unemployment situation seemed feasible. The team decided that it would take about 15 years to reach a full-employment solution, given the high initial rate of unemployment in 1970 and the expected 3.5-percent average annual rate of growth in the labor force. Accordingly, a full-employment model was developed for 1985 and the measures required and the growth rates implied were detailed and analyzed for feasibility and consistency.

To achieve the 1985 goal of full employment, the total number of jobs would have to increase at a 4.8-percent rate from 1964 to 1970. A preliminary step was to calculate whether all the jobs could be found outside of agriculture, as Lachlin Currie had proposed in a widely publicized plan. They concluded that such a plan was not feasible for Colombia. Agriculture would need to provide jobs at a rate of 1.8 percent annually, compared with a growth rate of 1.4 percent in the past. This would leave a requirement that nonagricultural jobs increase 7 percent annually, more than double the rate of increase in recent years. To find so many jobs, it would be necessary to provide some shift toward labor-intensive and capital-saving types of production, so that output per person employed in nonagriculture would slow to 1.8 percent annually for the 15-year period, from 2.5 percent in the past several years. It is interesting that agricultural output per man would have to increase to 3.5 percent annually compared with 2.0 percent annually in the past, primarily to meet the demand for food and raw materials in a full-employment economy.

The team contrasted the employment or job model with the usual growth model focusing on total output or GNP. Nevertheless, the result and the recommendations were not so very different. For example, the GNP growth rate required was 8.1 percent annually—not a bad growth target—compared with around 5 percent in the past. Included in the recommendations are two in which Colombia has made slow progress in the past. The team stresses that much faster progress in land reform is essential to achieve the growth target as well as for equity reasons. Tax rates will have to be increased and collections will have to be improved to provide some of the saving required for investment. The equity of introducing progressiveness in taxation is stressed as one means of reducing the inequality in income distribution.

Many of the other recommendations are the same as those made by "maximum growth" economists—realistic exchange rates, higher interest rates (especially for savings), restraint in the rise of wages in the modern sector, and rural and small city development. Some of them go further in tipping the scales toward substitution of labor-intensive methods—discouragement of supermarkets, computers, and imported capital equipment. Finally, a few of the suggestions for improved agricultural productivity are long-term aims toward which progress has been disappointing in Colombia. A major role is envisioned for cooperatives and farmers' organizations, similar to the successful Japanese and Taiwanese farmers' organizations. Training centers on a practical farm are suggested as a more effective way to diffuse modern commercial practices to small farmers.

This careful study has wide application for the great number of developing countries struggling with unemployment, rapid population increase, and inadequate output growth. There is clearly some compromise between a maximum growth rate and a full-employment solution, but either goal makes a strong contribution to the other. Meanwhile, the continued rapid population growth adds a sense of urgency.

L. Jay Atkinson

Regional Economic Development: The River Basin Approach in Mexico

By David Barkin and Timothy King. Cambridge University Press. London and New York. 262 pages. 1970. $10.50.

This book packs a great deal of information into a relatively short space. Based largely on two doctoral dissertations, it is similar in organization to a thesis. The major objective of the book is to evaluate the river basin commission as an instrument for achieving regional development. It begins with a capsule review of the objectives of regional and national economic development and the major theories explaining regional growth, followed by a general discussion of the history

and problems of regional development in Mexico. The case-study method is used to assess the performance of the Tepalcatepec River Basin Commission. The Tepalcatepec experience provides much of the basis for the authors' evaluation of the strengths and weaknesses of river basin planning as a means of regional development, although several other river basin efforts are described in less detail.

Regional development projects in Mexico date back to the early years of independence from Spain, when the new government attempted to colonize some of the sparsely populated areas. Most of the early colonization efforts were at best ineffective and, in some cases, actually detrimental to national welfare. More recently, Mexico has been concerned with regional development as a step toward more complete integration of backward areas into the national political and economic scene. Since 1946, river basin projects have been used to stimulate economic activity in areas outside the Mesa Central. Four of these projects constitute the bulk of the post-World War II regional development efforts.

The Tepalcatepec River Basin Commission administered one of these projects from 1947 until its absorption into the larger Balsas River Basin Commission in 1960. Irrigation was the most important component of the commission's program, but a substantial portion of the government's total investment was for road construction. Large-scale irrigation and the associated improvements in management transformed subsistence farming into a commercial agricultural industry where cotton, melons, lemons, and other cash crops are produced for export. One of the strong points of the development from a national standpoint is its contribution to foreign exchange. Foreign capital has been attracted to the area, releasing some of the Mexican Government funds for investment in other parts of the country. The regional economy also has gained from the sale of inputs such as fertilizer and pesticides, and from processing of farm products. Substantial gains have been recorded in public health, education, and other measures of personal well-being.

While progress has been generally satisfactory, the authors' analysis reveals that some of the developmental objectives had not been achieved when their study ended in the early 1960's. Some of the changes in land use and farm production might have occurred in the absence of the project through land reform and other institutional adjustments. From the standpoint of regional economic development the area continues to be dominated by agriculture, and broad diversification of the economy has not been attained. Total population has risen rapidly, but the more remote areas of the basin have not shared in the increase.

The authors conclude that "a more positive strategy than river basin schemes is needed to achieve the development of lagging regions." They point out that in the Tepalcatepec, and in other basins as well, the projects made little progress in decentralizing economic activity or stemming the flow of migration to crowed urban areas. They suggest that government may have to limit investment in the more developed regions and go further in stimulating private investment in the underdeveloped areas. The results of the studies in Mexico may apply in more highly developed nations in addition to those in the earlier stages of development.

William H. Heneberry

Food Consumption Statistics, 1960-68

By Organization for Economic Cooperation and Development, Paris. 596 pages. 1970. $19.

The OECD has fulfilled the need for the consolidation of annual food consumption statistics for several countries into a central source document with this update of a volume published in 1968 (see the January 1971 issue of this journal for a review). The new edition contains some revisions, but of course it contains preliminary data for 1967 and 1968. Those interested in the most recent developments, 1969 and 1970, will have to go elsewhere. However, the OECD statistics are much more current than the comparable FAO data which are published only about every 3 years.

The format is the same: (1) Separate chapters for each of 20 countries, (2) tables for each of 40 to 60 commodities, (3) nutrient value per 100 grams, (4) total nutrient availability, (5) supply, use, and per capita consumption for each commodity. With fewer years to cover, this volume is 100 pages shorter than the earlier one (welcome news for those with limited file space) despite the inclusion of Finland and Yugoslavia for the first time.

Apparently inflation is rampant in OECD, because the price of the volume has risen from $12 to $19, more than an 80-percent increase in cost per page. As a result, this is a valuable publication, monetarily and statistically. It is one of the more expensive statistical publications available. We hope the rate of increase will not continue for future editions.

Hazen Gale

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