WHEAT STUDIES

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WHEAT IN NATIONAL DIETS

M. K. Bennett

Wheat is one of the more important foodstuffs in a group designated herein as cereal-potato foods. This study presents analyses of the quantitative position of this group in the average diets of 52 nations (1933–38), the quantitative position of wheat calories among total food calories and among the cereal-potato calories of these nations, and changes in the position of wheat between 1923–28 and 1933–38. The survey is nearly world-wide, since the populations of the 52 nations constituted some 88 per cent of the world total in 1935.

Calories from cereals and potatoes constitute as little as 30 per cent of total food calories in some countries, as much as 90 per cent in others. Income status largely determines the relative importance of this group of cheap foods. The ratio of cereal-potato calories to total food calories is itself a rough index of income status, and a rougher index of quality of diet.

Wheat contributes less than 5 per cent of total food calories in several countries, mostly Oriental or tropical; and as much as 40–50 per cent in others. The interrelated factors of climate, food preference, and income status seem to explain these contrasts. They also explain differences in the importance of wheat calories among cereal-potato calories. Wheat contributes around 75 per cent of the cereal-potato calories in some nations, including the United States. Here, and in some 17 other countries, wheat dominates among the cereal-potato foods, furnishing over half of the cereal-potato calories. But in other countries, rice, rye, or corn is dominant.

Changes in national per capita disappearance of wheat flour from 1923–28 to 1933–38 were in some instances of large magnitude and are usually difficult to explain. They did not tend toward equalization of divergent levels.

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This study presents a statistical investigation of the place of wheat in the national diets of 52 countries which included some 88 per cent of the estimated total population of the world in 1935.

The principal series presented and analyzed are averages covering the five crop years from 1933–34 to 1937–38, of food calories per adult male per day, for (1) all food, (2) cereals and potatoes, and (3) wheat in terms of flour. In substantial degree each series represents a set of estimates, naturally more accurate with reference to the specific item wheat calories than with reference to total food calories or to food calories derived from cereals and potatoes. Each series refers to national average *disappearance* of calories, not to *consumption* or to *ingestion*. Ingestion is food eaten, consumption is roughly food purchased and therefore includes household waste, while disappearance includes in addition food that is lost, wasted, or diverted to nonfood uses in the distributive process. On the assumption that the foregoing estimates are reasonably trustworthy, derivative estimates are made with regard to (4) calories from other foods than cereals and potatoes, and (5) calories from other cereal-potato foodstuffs than wheat. The five series then provide a basis for a general view of prominent differences in the composition of national diets, covering most of the world.

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Calories per adult male per day derived from all foods, in terms of disappearance, are not precisely known but may range roughly from 2,800 to 4,000 from nation to nation. Statistical adult males of national populations differ especially in regard to size of body, climatic environment, and bodily activity; and the populations that they represent differ with respect to extent of waste and loss of food. Disappearance of food calories per adult male is probably highest in such countries as the United States, Canada, the United Kingdom, Australia, and New Zealand. It is probably lowest in such countries as Java, Ceylon, French Indo-China, and the Philippine Islands.

Cereal-potato calories constitute as little as 30 per cent of total food calories in some countries, as much as 90 per cent in others. This ratio provides a rough (inverse) index of general economic status of national populations, and, even more roughly, an index of the quality of their diets. The cereals and potatoes as a group are the world's cheapest foods. Populations heavily dependent upon cereals and potatoes are lower in income status, and tend to consume less well-balanced diets, than populations that depend only moderately upon cereal-potato foods and subsist on diets more largely derived from dairy products, meat, vegetables, fruits, nuts, sugar, and vegetable oils.

There is some ground for assuming that national diets are not likely to be nutrionally superior when the cereals and potatoes contribute more than 50–60 per cent of total food calories. If this be true, over 80 per cent of the world's population lives, even in time of peace, on diets likely to be inferior in quality or composition. Whatever the extent and seriousness of nutritional deficiencies in this country, Americans enjoy an average diet probably better in composition than is found in all but a few other national groups in the world today. This is not to say, however, that all groups within the United States (such as groupings of persons by income, by expenditure, by occupation, by race, or by region) necessarily enjoy average diets better in composition than the diets of comparable groups

within other nations. This study is restricted to national averages, and does not deal with contrasts in diet more or less prominent that exist between different groups within a single country, or between comparable groups in different countries.

In some countries wheat calories constitute as much as 40–50 per cent of total food calories. Bulgaria, Italy, Eire, and France were conspicuous for the prominence of wheat in national diets in 1933–38. On the other hand, wheat calories were insignificant in the diets of many countries. In Nigeria, Madagascar, Indo-China, Java, Ceylon, the Philippines, Mexico, and Japan, wheat calories probably constituted less than 5 per cent of total food calories. The basic causes of such differences were presumably differences in climate, income status, and food preference.

The same set of causes gives rise to differences in the contribution of wheat calories to cereal-potato calories. Wheat was notably prominent in the cereal-potato fraction of the national diet in Switzerland, Australia, the United Kingdom, Canada, the United States, Eire, and France. Here wheat calories may have reached or exceeded 75 per cent of cereal-potato calories. The contribution of wheat was naturally lowest, as a rule, in the countries which showed the smallest contributions of wheat to total food calories. Questions involving the specific nutritive properties of wheat, such as might be raised concerning national dietary advantage or disadvantage of low or high contribution of wheat calories to cereal-potato calories, are not considered in this study.[1]

Wheat is never the sole item in the cereal-potato segment of national diets. It dominates, in the sense of contributing 50 per cent or more of cereal-potato calories, in 18 of the 52 countries here considered. Rice is dominant in the same sense in eight countries, all Oriental; rye dominates in only two; corn, in four. Wheat contributes less than 50 per cent of cereal-potato calories, but in combination with rye contributes more than 60 per cent, in 10 countries, all in central, northern, and eastern Europe. Wheat and corn together dominate, providing more than 60 per cent of the cereal-potato calories, in four countries; wheat and barley together dominate in three. We find no clear evidence that two-cereal combinations providing 60 per cent or more of cereal-potato calories (with no single cereal providing as much as 50 per cent) exist nationally in other forms than the combinations wheat-rye, wheat-corn, and wheat-barley. But we have not ascertained the types of dominance prevailing nationally in Cuba, Brazil, Nigeria, and Manchukuo.

The position of wheat in national diets is changeable, not constant. Estimates are available of changes in per capita disappearance of wheat-flour calories between 1923–28 and 1933–38 in 49 countries. Change occurred in all except four, but in 13 others were so small as hardly likely to seem perceptible to the populations. The remaining changes in 32 countries were divided about equally between increases and reductions, but without definite tendency toward equalization of national levels of per capita wheat-flour disappearance. The influences responsible for such changes seem extremely difficult to isolate so long as information remains meager on change in disappearance of total calories and of calories derived from other foodstuffs than wheat. Accordingly, the explanations offered are tentative.

The World War now in progress has already resulted in further changes in the dietary position of wheat and further confusion of the influences at work. In due course, these will call for scientific analysis. But the time is not yet ripe for attempting to consider them in detail, or to answer questions as to residual effects that will persist after the postwar transition period.

At numerous points in these pages, challenges to further research are deliberately indicated by admissions of uncertainty as to facts, inferences, and conclusions. We shall be gratified if others will take up these challenges, and look forward to the day when a more definitive analysis can be made.

[1] On wheat as a source of nutrient materials, see A. E. Taylor, "The Place of Wheat in the Diet," WHEAT STUDIES, February 1929, V, 154–64. The present study was suggested by, and represents an expansion of, a few paragraphs in Dr. Taylor's work (pp. 149–52) on the quantitative importance of wheat in the national diets of seven countries, especially the United States.

I. RELATIVE LEVELS OF WHEAT-FLOUR DISAPPEARANCE PER CAPITA

As is well known, per capita food disappearance of wheat (here measured approximately in terms of wheat flour)[2] differs widely from country to country. To millions of the world's inhabitants, food products made from wheat are completely unknown or very rarely eaten, whereas to other millions wheaten products appear in every meal and often constitute the principal food. Average per capita disappearance of wheat flour for the "world" covered by 52 countries for which estimates are available was 4.7 ounces daily in the five-year period 1933–34 to 1937–38. The range of per capita disappearance was from less than 1 ounce of flour per head per day in Nigeria, Madagascar, Indo-China, Java, Ceylon, and the Philippine Islands, to more than 13 ounces in Bulgaria and between 11 and 13 ounces in Eire, France, Italy, and Hungary.

No particular level of per capita daily disappearance of flour within the wide range is found much more commonly than any other level, as is suggested by the black portions of the bars in Chart 1 (p. 40). From nation to nation, the progression from lowest to highest per capita disappearance is fairly regular.

Relatively low per capita disappearance of wheaten products, however, is more characteristic than high or moderate disappearance if consideration is given to number of population rather than to number of nations. Per capita wheat-flour disappearance may be called low (less than 4.5 ounces per day) in 20 of the 52 countries covered by our estimates; moderate (from 4.5 to 9 ounces per day) in 19 countries; and high (more than 9 ounces per day) in 13 countries. The 13 countries of characteristically high disappearance, 25 per cent of the number of countries, contained only 19 per cent of the aggregate population considered.[3] The 19 countries of characteristically moderate disappearance, 37 per cent of the number of countries, contained only 16 per cent of the population considered. But the 20 countries of characteristically low disappearance, 38 per cent of the number of countries, contained 65 per cent of the population considered. With approximate allowance for probable but unmeasured wheat-flour disappearance in other countries, and for wide differences from region to region in the level of per capita disappearance in such large and heterogeneous countries as China, India, Brazil, and the USSR, it can be said that per capita disappearance of wheat flour is low—below 4.5 ounces per capita per day—among something like one-half to two-thirds of the population of the world. High disappearance—above 9 ounces per capita per day—is found among only about a fifth to a fourth of the world's population.

Causes of Differences

It is no simple matter to explain satisfactorily the differences in national average per capita disappearance of wheat flour. A significant correlation, however, exists between per capita production of wheat and per capita disappearance of wheat flour.

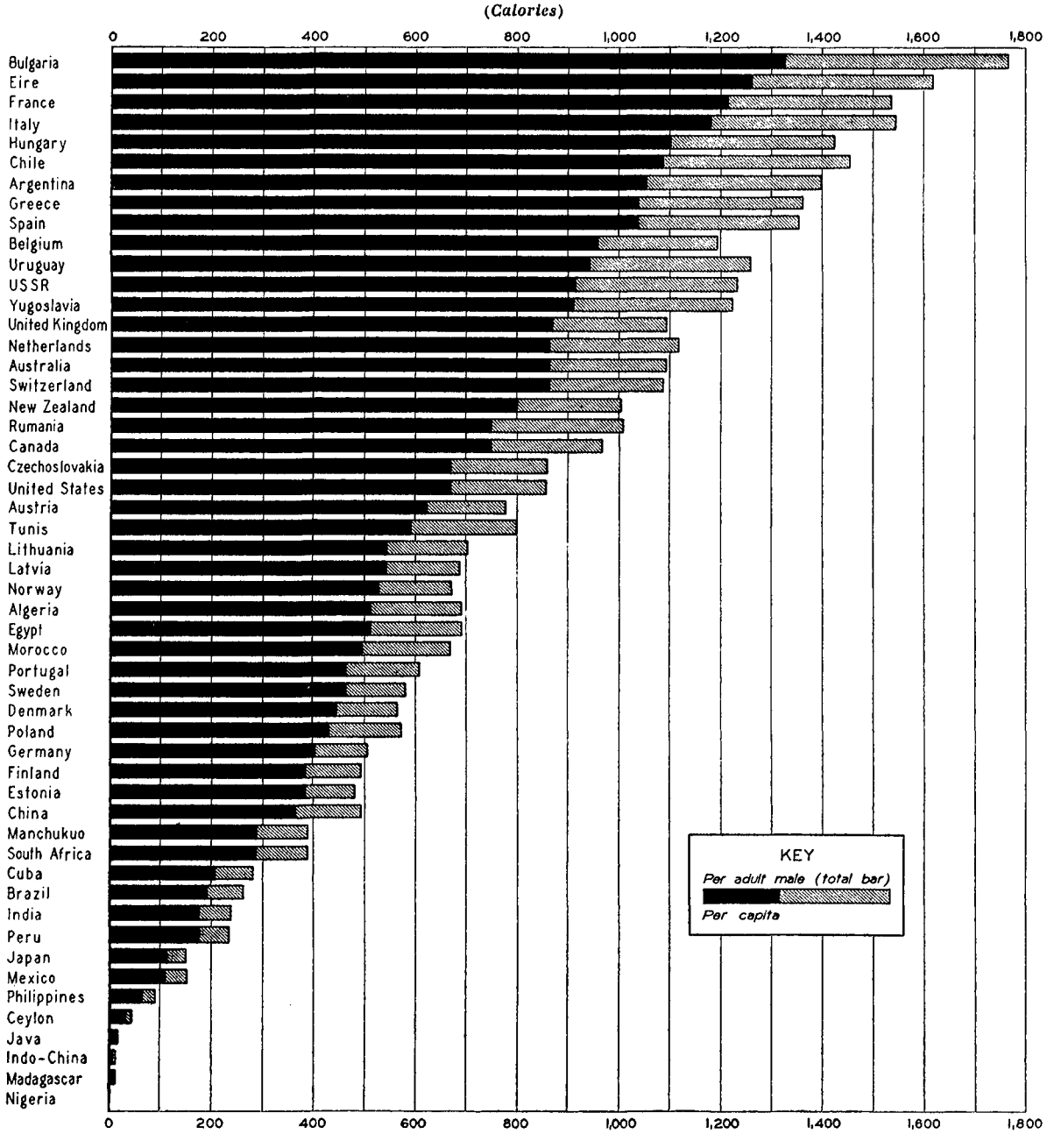
The coefficient of correlation between the two variables, per capita production ex-seed and per capita wheat-flour disappearance as shown in Chart 1, is +.53, a significant figure. Broadly, the world's wheat has a tendency to be consumed within the country of production,[3a] so that per capita wheat-flour disappearance tends to be high where per capita production is high, and vice versa. In fact, if one omits from the correlation analysis three great wheat exporters (Australia, Argentina, and Canada) where per capita production far exceeds per capita disappearance, the correlation coefficient rises to +.82. And if one also omits six European importers whose per capita disappearance far exceeds per capita production (United Kingdom, Eire,

[2] See below, p. 45, for further distinctions between "disappearance," "consumption," and "ingestion"; and notes to Table I for methods of measuring disappearance of wheat in terms of wheat flour.

[3] The 52 countries covered by our estimates of per capita disappearance contained about 1,840 million people in 1935, some 88 per cent of the estimated world total of 2,095 million in that year.

[3a] Moreover, within many countries where transportation is poorly developed, wheat has a tendency to be consumed in or near the locality where it is produced.

CHART 1.—WHEAT-FLOUR DISAPPEARANCE PER CAPITA AND PER ADULT MALE PER DAY IN 52 COUNTRIES, 1933–38*



* See Table 1. Data expressed in calories may be read as ounces by regarding 100 calories as equal to an ounce of wheat flour. Averages apply to the five crop years from August 1933 to July 1938. Variations in the calorie content of flour, presumably small, are disregarded.

Belgium, the Netherlands, Switzerland, and Greece), the correlation coefficient rises to +.98.

The general tendency for per capita production and per capita disappearance of wheat to coincide is strongly modified by a complex group of influences, largely economic but partly physical. Perfect correspondence of per capita wheat-flour disappearance with per capita wheat production would be expected

to occur only in a group of nations isolated from international trade.

Even among such nations the *levels* of per capita wheat-flour disappearance would differ, as would the levels of per capita wheat production. The diverse levels both of disappearance and of production might reflect differences either in climate; or in levels of real income; or in age and sex composition, body size, bodily activity, and possibly race of populations; or, perhaps, in food preferences.

No country is in fact fully self-sufficient economically. Concrete evidence is scanty especially regarding the national differences in real income, food preferences, and physical status of population. Hence the contrasts in per capita wheat-flour disappearance shown in Chart 1 present many intricate problems of interpretation. At the present state of the inquiry, only a few of the contrasts need be interpreted, for purposes of illustrating the complexity of the factors which give rise to the contrasts.

Per capita wheat-flour disappearance in Bulgaria runs about 13.3 ounces per day; in Java it is barely 0.1 ounce. In this extreme contrast, climate and the economic circumstances depending upon it undoubtedly weigh heavily. As compared with competing crops, wheat thrives in Bulgaria but not in Java, and the commercial and subsistence farmers alike of Bulgaria find it a relatively remunerative crop while those of Java do not. Presumably a difference in average body size of the population is of some importance, for Bulgarians average larger than Javanese, and might consume less wheat flour if they were of the same size. Differences in food preference may well have some significance, though this seems uncertain because such preferences presumably depend heavily upon experience growing out of climatic and income factors. In this contrast of wheat-flour disappearance per capita, differences in level of real income are perhaps not of major importance. But if real income in both countries were markedly higher, it seems probable that the levels of wheat-flour disappearance would be somewhat higher in Java, somewhat lower in Bulgaria, and therefore less diverse than actually they are.

In Cuba, per capita disappearance of wheat flour is some 2.1 ounces per day as against barely 0.1 ounce in Java. Climate can be of no direct significance here, since both islands import all of their wheat flour and wheat has no place in their domestic agriculture. Cuba presumably has the higher level of real income, a higher proportion of people accustomed for generations to use of wheat in the diet, and a population larger in average size of body; and these factors would seem to explain the difference in per capita wheat-flour disappearance. If, on the other hand, the high level of Bulgaria be contrasted with the much lower level of Cuba, differences in body size and food preferences would seem unimportant, differences in real income of moderate significance, and differences in agriculture dependent upon climate of large importance.

Illustrations of the effects of real income are provided by contrasts of Bulgaria and Canada, Eire and the United Kingdom. Neither climate, body size, nor food preference could reasonably be assigned much importance in explaining the diverse levels of per capita wheat-flour disappearance as between the members of each of these pairs of countries. Bulgaria, a much poorer country than Canada, consumes more wheat flour per capita mainly because the population cannot afford as large a proportion of the more expensive foods in the diet; both countries are wheat exporters, and have ready physical access to larger wheat supplies than are used. Similarly, the basic reason why per capita wheat-flour disappearance is 12.6 ounces daily in Eire but only 8.7 ounces in the United Kingdom—both countries importing the bulk of their wheat supply—is the lower level of real income in Eire.

The general relationship appears to be—as between countries approximately similar in climate and in body size and food preferences of populations—that per capita disappearance reaches a maximum at a particular but not definable level of real income. It declines with reduction in real income, with the population depending more heavily on other cereal-potato foods (corn, rye, barley, potatoes) that are cheaper than wheat; and it declines also with increase in real income, with the population enabled to depend more heavily upon

other foods (sugar, milk, meat, fruits, vegetables) that are more expensive per 1,000 calories than wheat.[4]

In general, the combination of circumstances most conducive to a *low level of per capita disappearance of wheat flour* appears to be a climate unfavorable for the competitive position of wheat in domestic agriculture, and a very low level of per capita real income. With these the same in two hypothetical countries, one would expect minor differences in level of disappearance to be attributable to degree of economic isolation (itself associated with level of real income), food preferences (probably associated with both real income and climate), and body size (perhaps also associated with both climate and real income).

The circumstances most conducive to a *high level of per capita disappearance of wheat flour* are not, however, the opposite—namely, favorable wheat climate and high level of income. The level of disappearance is only moderate in the United States, though this is a high-income country with a climate sufficiently favorable for the competitive position of wheat to place wheat in the category of export commodity; and the level of disappearance is high in Eire, where the real income per capita is much lower and the climate is obviously unfavorable to the competitive position of wheat in agriculture. Hence a moderate level of real income would seem to be the circumstance most favorable to high level of per capita wheat-flour disappearance, though, as between countries of the same moderate per capita income level, one would expect to find differences of appreciable magnitude traceable to climate, food preferences, and body size.

There is probably no reasonably imaginable set of circumstances under which national levels of per capita wheat-flour disappearance would become identical. Hypothetically, approximate identity of levels might be expected if there were generally high levels of per capita real income, similarity of food preferences, and similar climates in the different nations of the world. But existing climates, and such types of agricultural production and such elements of food preference as rest upon them, cannot be expected to change. An increase in levels of per capita income, with approach to substantial uniformity in terms of national averages, is more readily imaginable if highly improbable.

At uniformly high levels of per capita income, nations which now consume little wheat flour would use more, and nations which now consume a great deal would use less. The present range of differences in national average levels of per capita wheat-flour disappearance would be considerably narrowed. But rather large differences would persist. One would expect particularly that in Oriental countries, where climate and preference would continue to encourage the use of rice rather than wheat, the use of wheat would rise, but not to the levels now prevalent in prosperous Occidental countries. In the now less prosperous Occidental countries, however, where wheat is the preferred cereal food and is heavily consumed, the level of wheat-flour disappearance would fall substantially. With increases in some countries, reductions in others, and persistence of differences, the average world level of per capita wheat-flour disappearance that might emerge in a uniformly prosperous world seems altogether conjectural.

The conclusions above are phrased with reference to *per capita disappearance* of wheat flour per day. Strictly, they withstand logical analysis better if phrased with reference to *ingestion of wheat flour per adult male per day*. Distinctions between disappearance, consumption, and ingestion either of wheat flour, any particular food, or food in general are important (though often neglected) in comparisons of diets of nations or of groups within nations (see below, p. 45); and distinctions between data expressed per capita and per adult male, though perhaps less important, carry some weight.

Disappearance per Capita and per Adult Male

Chart 1 (p. 40) gives data on wheat-flour disappearance both per capita and per adult male for 52 countries. The data, plotted in terms of calories, can also be read as ounces,

[4] See further, M. K. Bennett, "World Wheat Utilization since 1885–86," Wheat Studies, June 1936, XII, 339–404.

since an ounce of flour contains close to 100 calories. In all countries, disappearance per adult male, whether in ounces or in calories, must obviously exceed disappearance per capita. The excess of disappearance per adult male, however, differs from country to country. It is largest in the Oriental, African, eastern European, and South American countries, often running to 25 per cent or above in these; and smallest in certain western European, North American, and Australasian countries, where it runs between 19 and 23 per cent above.[5]

[5] There is only one way of enumerating the total population of a country—by count or estimation of a count. But many ways are available for calculating the "adult-male equivalent," from the point of view of food use, of the number of persons in a given country. Thus the population of the United States, 122.8 million persons in 1930, is equal to 96.2 million adult males according to the scale of conversion recently sponsored by the League of Nations; 96.4 million according to Atwater's prewar scale; but 102.6 million according to the scale adopted by the Commission scientifique interalliée du ravitaillement during the first World War.

The scale sponsored by the League of Nations compares as follows with the scale used in this study:

League of Nations			Food Research Institute		
Age	Male	Female	Age	Male	Female
Under 2	.2	.2	Under 5	.28	.28
2- 3	.3	.3			
4- 5	.4	.4			
6- 7	.5	.5	5- 9	.52	.52
8- 9	.6	.6			
10-11	.7	.7	10-14	.78	.78
12-13	.8	.8			
14-59	1.0	.8	15-59	1.00	.80
Over 60	.8	.8	Over 60	.80	.80

Modification of the League scale was necessary because the age distributions of national populations were given in our source of population statistics (League of Nations, Economic Intelligence Service, *Statistical Year-Book, 1936/37*, 1937. II. A. 7, Geneva, 1937), only in terms of age groups of under 5, 5–9, 10–14, 15–59, and over 60. The modified scale gives practically the same result as the League scale when applied to the United States population of 1930.

For a discussion of the problem of appropriate scales and comparisons of several, see Edith Hawley, *Dietary Scales and Standards for Measuring a Family's Nutritive Needs* (U.S. Dept. Agr., Tech. Bull. 8, June 1927).

[6] A calorie is the amount of heat required to raise the temperature of one *kilogram* of water one degree on the centigrade scale. This is the "large," "greater," or "kilogram" calorie, often written Calorie to distinguish it from the small calorie—the amount of heat required to raise the temperature of one *gram* of water 1° C. In this study we do not capitalize the word, but refer in all instances to the large calorie.

Nation-to-nation comparisons of levels of wheat-flour disappearance in some instances yield somewhat different results on the per adult-male basis than on the per capita basis. Thus France exceeds Italy in disappearance per capita but not in disappearance per adult male; and the same is true of Belgium and Soviet Russia, New Zealand and Rumania, Denmark and Poland. But on the whole, whatever could be said in explanation of differences in national levels of wheat-flour disappearance per capita could be said also of differences in disappearance per adult male. The importance of reducing the data to the per adult-male basis lies in the fact that subsequent discussion of total diet can then proceed more intelligibly.

Populations differ in their composition of young, mature, and old persons, and in distribution by sex within each of these age groups. It is clear from experimental evidence that the number of food calories[6] required for bodily maintenance, under constant conditions of external temperature and of bodily activity, is higher per unit of body surface (*a*) of males than of females of identical age, (*b*) of young than of mature and old persons of either sex, and (*c*) of mature than of old persons of either sex. Furthermore, adult males have normally more body surface and weigh more than females of the same age. Therefore the maximum food-energy requirement in any given population group (ignoring external temperature and bodily activity) is found among the adult males before they reach old age. The requirements of children of both sexes, of adult females, and of elderly males are smaller. Hence it is conceivable that two populations found to consume the same number of food calories *per capita* per day might not in fact be on identical levels of caloric intake, if it happened that the one population contained relatively more adult males but fewer children, while the other contained relatively fewer adults but more children. It is therefore common in studies of human nutrition to use the concept of consumption "per adult male" and to avoid expression of quantities of food used in per capita terms.

Taken alone, our estimates of disappearance per adult male of calories derived from

wheat, as given in Chart 1, have no bearing on relative "adequacy" of national diets, either in the sense of quantitative adequacy or in the sense of qualitative adequacy.

A national diet may be adequate quantitatively whether or not it contains calories derived from wheat; the pertinent question is whether it contains enough calories from all sources to supply the population with energy sufficient for its normal needs. In subsequent calculations involving estimates of disappearance of total food calories per adult male, we specifically assume that all nations considered were obtaining enough food calories to stand above a level of general famine, starvation, or hunger, though it would be absurd to suppose that peripheral instances of severe inadequacy of food calories did not occur. This being the assumption, the question of relative quantitative adequacy of national diets does not emerge in subsequent discussion.

A national diet may be qualitatively adequate whether calories from wheat constitute a small or a rather large fraction of total food calories. The proportion of total calories supplied by wheat flour could constitute evidence of malnourishment (qualitative inadequacy or imbalance of diet) only if it were palpably so high that deficiency of noncereal components of the diet were obvious. Malnourishment can be appraised only in terms jointly of maldistribution of food calories between protein, fat, and carbohydrate calories; quality of proteins and fats; and deficiencies of vitamins and minerals. Neither our estimates of calories per adult male derived from wheat, nor ratios of wheat calories to total food calories, have any significant bearing upon the question of relative qualitative adequacy of national diets.

At a later stage, however, an approximate index of the relative quality of national diets is proposed. This is the ratio of calories per adult male per day derived from cereals and potatoes (or their tuberous or rooty equivalents) to total food calories per adult male per day. The cereals and potatoes as a family of foods are nutritionally rather similar; they are prominent chiefly as sources of energy rather than as contributors of protein, vitamins, or minerals. It is therefore reasonable to infer that national diets tend, though only broadly and with important qualifications resting upon the respective composition of their cereal-potato and non–cereal-potato components, to be more satisfactory qualitatively when the cereal-potato component is small than when it is large (see pp. 51–52).

II. WHEAT IN TOTAL DIETS

The place occupied by wheat flour in total national diets is approximately ascertainable if measurement can be made respectively of disappearance per adult male per day of calories in wheat flour, and of disappearance per adult male per day of calories in the total diet. A more exact result would emerge if these measurements could be expressed in terms of *ingestion* per adult male per day; but this is impossible. No result can be interpreted except as of specified time periods, here the five-year period ending about a year before the outbreak of war in September 1939. The place of wheat in national diets is subject to change in times of peace (see below, pp. 63–72); and in some countries changes may be large and rapid in a few years or even months of war.

Data concerning wheat-flour disappearance per capita and per adult male per day, expressed in ounces, have already been presented for 52 countries. In the present section these same data are expressed in terms of calories per adult male per day, and related to estimates of *disappearance* (not consumption or ingestion) of total food calories per adult male per day. Some problems arise in estimating disappearance of total food calories per adult male per day, because many reasons appear for supposing that there are large differences from nation to nation, and information concerning the probable diverging levels is decidedly scanty.

In consequence, if appraisal is to be made of the position of wheat flour in national diets, it must be made in terms of the relationship of wheat-flour disappearance to total food disappearance, and not in terms of relationship of

wheat-flour disappearance to total food consumption or total food ingestion. This subject is considered next.

Disappearance, Consumption, and Ingestion

Within a given time period, national disappearance of flour would exceed consumption, because some flour must be "lost" in the distributive process between threshold of mill and threshold of dwelling or refectory. Such "loss" would include spoilage, as by moulding or exposure or weevil damage; destruction, as by fire or wreck; and diversion to nonfood use, as for feed, adhesives, and sizing. Consumption would exceed ingestion by the quantities "lost" between thresholds of dwellings or refectories and the mouths of eaters. Kitchen and table food scraps containing flour are burned, fed to animals, thrown into garbage cans, washed into sewers.

These distinctions apply to food in general as well as to wheat flour. The quantitative differences respectively between diappearance and consumption, consumption and ingestion, and disappearance and ingestion can hardly be identical from commodity to commodity, or from country to country. Little is known about these differences. In general it seems clear that both disappearance and consumption tend to exceed ingestion by wider margins in prosperous countries than in poor ones, at least if one refers to the calorie content of all the food used, "lost," and diverted to nonfood uses, and probably if one refers to wheat flour. But information is too scanty to permit us to present credible estimates respectively of disappearance, consumption, and ingestion per capita of wheat flour, for the 52 countries for which estimates of disappearance per capita and per adult male are given in Chart 1.

Distinctions between wheat-flour disappearance, consumption, and ingestion will assume even larger importance in subsequent pages. Briefly, disappearance (which might more accurately be called domestic disappearance) means the quantity of flour available to a nation at point of emergence as flour (outgoing threshold of mills, or at docks if imported) in a definite time period, minus exports, if any, and minus also accumulation of stocks within the period, if any, but plus withdrawals from stocks, if any. The data thus far discussed refer to disappearance in this sense. They do not refer to consumption. Consumption of flour would be the quantity passing inward over the thresholds of homes and refectories within the same time period, with account taken of increase or decrease of stocks held in such households and refectories. Ingestion of flour would be the quantity of wheat flour (processed into humanly edible items) that passes into the stomachs of the population.

National Differences in Total Food Calories per Adult Male per Day

Given reasonably reliable data on disappearance of wheat flour per adult male per day in 52 countries, expressed in calories, the first problem that must be faced, if the place of wheat flour in national diets is to be measured, is to ascertain the disappearance of total food calories per adult male per day in the same countries.

This is a difficult problem, not at present to be solved on the basis of reliable statistical information or without a large element of guesswork. It is common practice for writers on human nutrition to assume—though in fact most vaguely—that an adult male of "average" size living in a temperate climate "requires" about 3,000 food calories per day if he is doing "moderately active work." But what is a temperate climate and an average adult male? And does requirement mean requirement for disappearance, or for consumption, or for ingestion? And what is moderately active work?

It is in fact altogether clear that this commonly accepted standard requirement of 3,000 calories[7] refers to the adult male mainly of

[7] On this point the Committee on Nutrition of the British Medical Association definitely states that the standard of 3,000 calories refers to "food-stuffs as purchased," which means consumption as defined above. But the same standard as set forth by the Technical Commission on Nutrition of the Health Organisation of the League of Nations seems to refer to ingestion. See "Report of Committee on Nutrition," *British Medical Journal (Supplement)* (London), Nov. 25, 1933, pp. 1–16; and E. J. Bigwood, *Guiding Principles for Studies on the Nutrition of Populations* (League of Nations, Health Organisation, Technical Commission on Nutrition, C.H. 1401, Geneva, March 1939), pp. 90–97.

northwestern Europe and North America, doing work something like that of a carpenter for eight hours a day, and to his requirement either for consumption (food as purchased) or for ingestion. The standard clearly does not apply to disappearance of food, nor to adult males of Oriental populations. It may not be intended to apply to the populations of southern and eastern Europe.

To relate our estimates of disappearance of wheat-flour calories per adult male per day to this standard of 3,000 calories per day of all food might well be expected to yield unreliable results. First, in any country disappearance of food calories per adult male must exceed either consumption or ingestion, and more so in prosperous than in poor nations; and second, ingestion per adult male per day, the largest component of disappearance, would necessarily be higher in populations large in size of body than in populations small in size of body, at least if physical activity and climatic environment of populations be similar. That well-to-do populations waste more food than poor ones seems beyond dispute. And statistical evidence is adequate enough to prove that the adult male of southeastern Asia averages only about 50 kilograms in weight, whereas those of western Europe and North America average 65–70 kilograms. This is a substantial difference of 30–40 per cent. It is therefore not at all improbable that disappearance of food calories per adult male per day might run 50 per cent or more larger in a country like the United States, known to have a population relatively prosperous and relatively large in size of body, than in a country like Java, known to have a population relatively poor and relatively small in size of body.

Furthermore, a dozen or more careful statistical studies are available either of nations or of large groups within nations, containing bases for calculating estimates of disappearance (sometimes consumption) of total calories per adult male per day. Examples of the ranges that emerge are as follows: Java, 2,607; India, 3,122; Italy, 3,709; United Kingdom, 3,965; United States, 4,022.[8] These are physiologically available calories in food disappearance per adult male per day, from studies unambiguous as to the terms "disappearance," "consumption," and "ingestion," and so presented that critical analysis gives good ground for acceptance of the results.

To what extent these variations may be due to influences other than (*a*) differences in real income and (*b*) differences in size of body is problematical. Perhaps race is a factor; and climate may well be because, of two men of equal size doing identical physical work, the calorie expenditure (and hence ingestion requirement) would presumably be higher for the one subjected to cold conditions of external temperature than to the other subjected to warm conditions of external temperature.

More important still among additional factors explaining national differences in calorie disappearance per adult male per day might be possible differences in physical activity of the populations. On this subject no specific statistical evidence has come to the writer's attention. But the probability is strong that of two nations equally prosperous, equal in body size of the statistical adult male, and living in similar climates, greater physical activity in the one would give rise to larger calorie disappearance per adult male per day than in the other.

How large this difference might conceivably be is suggested by data mainly pertaining to consumption per adult male per day, from rural and urban families respectively, within a few countries. Rural populations are quite generally supposed to engage in more arduous physical labor than the aggregate of neighboring urban populations. Hawley gives data for the United States indicating that calorie consumption per adult male per day ran 20–30 per cent higher among rural than among urban families.[9] For Soviet Russia, certain

[8] Calculated from data given in A.M.P.A. Scheltema, *The Food Consumption of the Native Inhabitants of Java and Madura* (National Council for the Netherlands and the Netherlands Indies of the Institute of Pacific Relations, Batavia, 1936); "India's Food Problem," *Economist* (London), Dec. 26, 1936, pp. 627–28; *Proceedings of the International Congress for Studies on Population* (Rome, 1934), II, 457–95; J. B. Orr, *Food, Health and Income* (London, 1936); J. P. Cavin, "Consumption of Agricultural Products," *Agricultural Situation* (U.S. Dept. Agr., Bur. Agr. Econ.), January 1939, XXIII, 13–15.

[9] Edith Hawley, *Economics of Food Consumption* (New York, 1932), p. 75.

official data show a difference of 23 per cent.[10] Studies of Chinese urban populations summarized by Lindstedt, in comparison with Buck's study of rural population, suggest a difference of 19 per cent in China.[11] Calorie disappearance per adult male per day in Bulgaria has been calculated as about 29 per cent higher in the rural than in the urban population.[12] Perhaps these substantial differences cannot be fully ascribed to differences in physical activity, but that factor seems important. Countries are known to differ in proportions of population respectively urban and rural, so that levels of calorie disappearance per adult male per day may conceivably differ for reasons of differences in physical activity, the more highly urbanized populations being the less active. Yet there seems to be no dependable way to measure the extent of difference in physical activity. Even if it could be measured, its effects on national differences in total calorie disappearance per adult male per day would tend to offset effects due to differences in real income, for prosperous countries where disappearance tends to be high because of food wastage tend to be highly urban, while poor countries tend to be rural.

Allowing as best we can for differences between countries in levels of real income, body size of population, climate, and bodily activity of populations, we reach the assumption that the 52 countries here considered can be divided into five groups with reference to probable level of total calorie disappearance per adult male per day.

The first group, for which 4,000 calories are assumed, includes the United Kingdom, the United States, Australia, Canada, and New Zealand; and the principal reason for placing these countries in the highest-calorie group is that they were relatively prosperous and hence probably wasteful of their food calories. To the second group, for which 3,800 calories are assumed, are assigned the other countries of Europe, including Soviet Russia, except those in the extreme south; Chile and Argentina in South America; and Nigeria and South Africa in Africa. At the level of 3,600 calories fall the southern European countries of Spain, Portugal, Italy, and Greece; the northern African countries from Egypt on the east to Morocco on the west; and Cuba, Mexico, Brazil, Uruguay, and Peru in South America. For China, Manchukuo, Japan, India, and Madagascar, a level of 3,200 calories is assumed; and for the Philippine Islands, Java, Indo-China, and Ceylon a level of 2,800.

Relation of Wheat Calories to Total Calories

Chart 2 (p. 48) shows, country by country, (*a*) the ratio of wheat-calorie disappearance per adult male per day to total calorie disappearance, when total calorie disappearance is taken as ranging from 2,800 to 4,000 per day as estimated above; and (*b*) the ratio of wheat-calorie disappearance per adult male per day to total calorie disappearance, when total calorie disappearance (consumption? ingestion?) is taken at the 3,000-calorie level commonly assumed in studies of human nutrition.

The rank of the 52 countries from highest to lowest is of course the same with reference to percentage of total calories derived from wheat in a 3,000-calorie diet per adult male per day as it is with reference solely to disappearance of wheat flour per adult male per day expressed either in ounces or in calories. But when total calorie disappearance per adult male per day is taken as varying from 2,800 to 4,000 in the different countries, the relative rank of the countries with respect to percentage of total calorie disappearance contributed by wheat becomes somewhat different. Twelve countries rise in relative rank, and 15 countries fall.

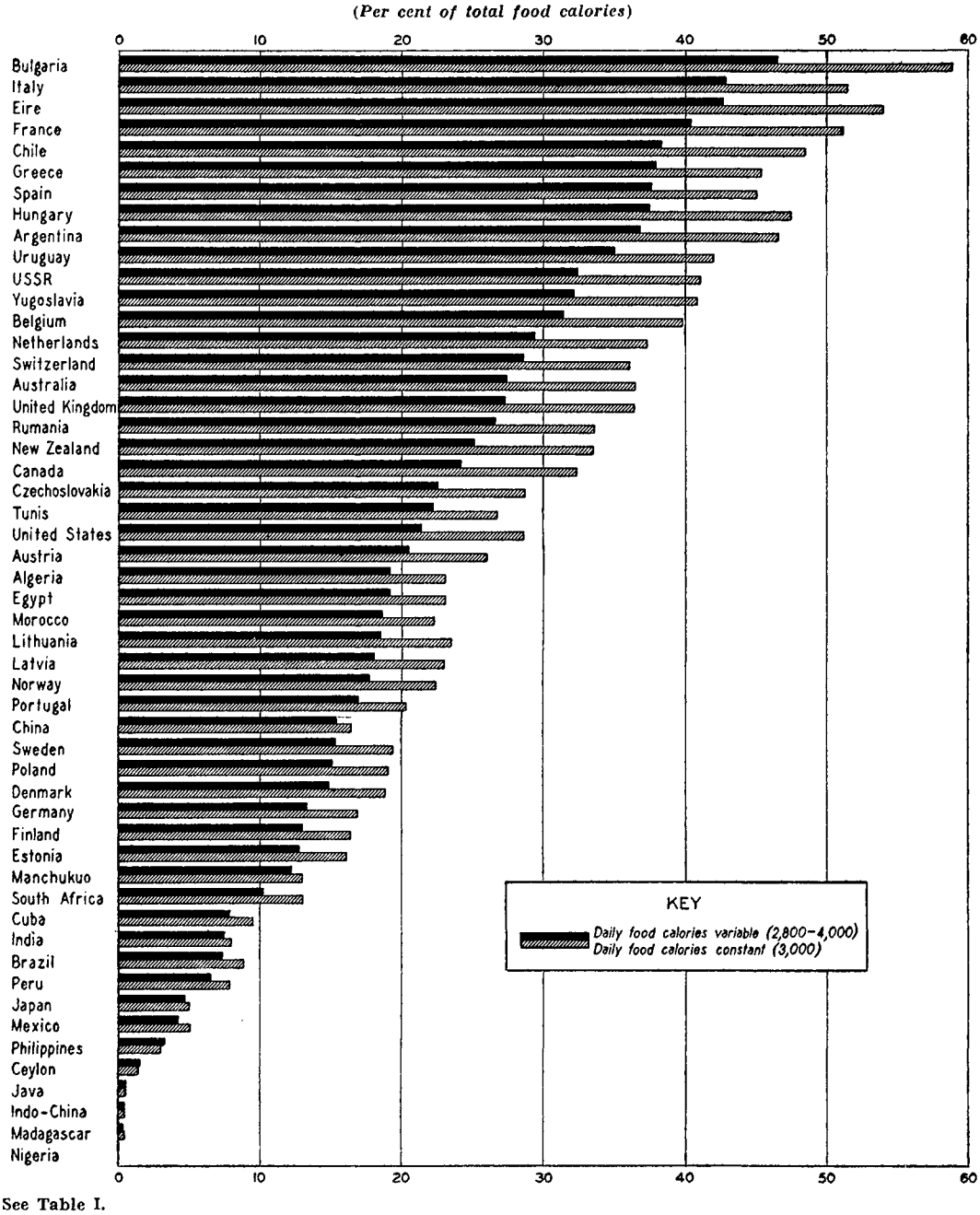
But these changes in rank are not very striking. Only three countries—China, Morocco, and Lithuania—have their rank changed by more than two. Using the specific estimates

[10] USSR Central Statistical Administration, *Statistical Handbook of USSR for 1928* [translated title] (Moscow, 1929), pp. 848–49, 854–55.

[11] H. Lindstedt, "Food Consumption Habits in the Far East," *International Review of Agriculture* (International Institute of Agriculture, Rome), September 1938, XXIX, 399E–413E, and "Food Consumption Habits in China," *ibid.*, August 1939, XXX, 363E–89E; J. L. Buck, *Land Utilization in China: Statistics* (Nanking, 1937), pp. 66–73.

[12] Unpublished calculations by the writer's colleague, Pavel Egoroff, based on official Bulgarian statistics.

CHART 2.—RATIO OF PER CAPITA WHEAT-FLOUR DISAPPEARANCE TO PER CAPITA DISAPPEARANCE OF TOTAL FOOD CALORIES IN 52 COUNTRIES, 1933–38, ASSUMING TOTAL CALORIES (*a*) VARIABLE FROM COUNTRY TO COUNTRY IN THE RANGE 2,800 TO 4,000, AND (*b*) CONSTANT AT 3,000*



* See Table I.

of calorie disappearance given above in place of the uniform figure of 3,000 calories per day, the rank of China rises from 36th to 32d, that of Morocco, from 30th to 27th, and the rank of Lithuania falls from 25th to 28th.

The probable quantitative importance of wheat in the diet of the world and of most nations is less if one accepts the hypothesis of variability in level of daily calorie disappearance per adult male per day (at the range of 2,800–4,000) than it is if one accepts the hypothesis of uniformity (at the level of

3,000). On the hypothesis of uniformity, our data would indicate that wheat calories provide more than half of total calories in four out of 52 countries, and more than a third in 19 countries. On the hypothesis of variability of total calorie level, wheat fails to provide as much as half of the total calorie disappearance in any country, and provides more than a third in only 10. The average percentage (weighted by adult male populations) of total calorie disappearance supplied by wheat calories in the 52 countries is 20.7 on the hypothesis of uniformity in national total calorie disappearance, but only 17.2 on the hypothesis of variability at the levels assumed. It is only in four countries—the Philippine Islands, Ceylon, Java, and Indo-China—that wheat becomes more important in national diets on the hypothesis of variability than on the hypothesis of uniformity.

Uncertainties regarding the measurement of the importance of wheat in national diets remain under either hypothesis. Neither can be supposed to summarize the facts with precision; estimates of disappearance of wheat calories per adult male per day cannot be exact; and, even with exactness in estimates of total calories and calories from wheat, appraisal of the quantitative importance of wheat would probably be more meaningful if the appraisal could be framed in terms of ingestion rather than in terms of disappearance.

The causes of differences from nation to nation in the ratios of wheat-calorie disappearance to total calorie disappearance must be in part the same as the causes of national differences in absolute levels of wheat-calorie disappearance per capita. Those causes are variations in climate so far as it affects domestic agriculture, variations in levels of real income, and variations in food preferences. As we have seen, differences in wheat-calorie disappearance per capita may also reflect differences in age and sex composition of populations, in body size of adult males, in climate so far as it directly influences food habits, and in bodily activity. These factors cannot, however, be regarded as causes of differences in ratios of wheat-calorie disapearance per adult male per day to total food-calorie disappearance, at least if our assumptions concerning levels of daily disappearance of total calories per adult male are valid.

The lowest ratios of wheat-calorie disappearance to total calorie disappearance would be expected to occur in countries of low real income, where climate is unfavorable to the competitive position of wheat in agriculture, and where wheat does not rank as the preferred cereal food. The highest ratios would be expected particularly in countries of moderate levels of real income, where wheat ranks as a preferred cereal food and climate favors the competitive position of wheat in domestic agriculture. A general rise of levels of real income would be expected to raise the lowest ratios and to lower the highest ratios. But unless food preferences should become identical and the competitive position of wheat in agriculture become about the same throughout the world, differences in the quantitative importance of wheat in national and regional diets would persist.

III. CEREALS AND POTATOES IN NATIONAL FOOD-CALORIE DISAPPEARANCE

Wheat, though of large importance in the diets of some nations, is only one member of a family of foodstuffs whose dietary functions are similar. Rice, corn, rye, barley, oats, and sorghums and millets are other cereals belonging to this family; and white potatoes, sweet potatoes, and cassava or manioc may be regarded as members also. All of these foodstuffs are cheap sources of carbohydrate calories. Together, they provide the great bulk of the world's food. Animal products of all kinds, sugar, vegetables, and fruits together rank far below the cereal-potato group in their contribution of food calories to mankind at large. The importance of the cereal-potato group of foodstuffs varies greatly from country to country, as is true of wheat alone. The importance of this group as a source of vitamins and minerals is generally less than its importance as a source of food calories, though recent nutritional research has raised the scientific rating of several of these raw

foodstuffs as actual or potential sources of vitamins and minerals.

The present section is addressed to the questions: what is the place of the cereal-potato family of foodstuffs in the diets of nations, and what are the basic reasons for national differences in ratios of cereal-potato calories to total food calories? In the section that follows on pages 58–63, consideration is given to the place of wheat among the cereals and potatoes used by different nations—why it ranks high in some but low in others.

In earlier sections we have presented, for 52 countries, estimates of daily disappearance per adult male of food calories derived from wheat; and rough approximations of daily disappearance per adult male of all food calories. Here are presented estimates of food calories derived from the family of foodstuffs called cereals and potatoes. Analysis will then permit consideration of national diets in terms of three major components: calories from wheat; calories from other cereals and potatoes; and calories from all other foodstuffs.

For most countries of the world it is impossible to make direct estimates of the number of calories derived respectively from rice, corn, rye, barley, oats, sorghums and millets, white potatoes, sweet potatoes, and cassava; to add such estimates to those already available for wheat; and thus to reach totals representing daily disappearance per adult male per day of calories derived from the cereal-potato family of foodstuffs in various countries.

The only feasible alternative procedure for reaching such totals appears to lie in obtaining, from a broad survey and analysis of published statistical materials bearing on national and family-group nutrition, approximations to the *percentage* of total calories supplied by the cereal-potato group of foodstuffs. Given these percentages country by country, it becomes possible, by applying them to our rough approximations to daily disapearance of total food calories per adult male (pp. 46–47), to calculate daily disappearance (*a*) of cereal-potato calories per adult male; and (*b*) of calories per adult male derived from all other foods than cereals and potatoes. From the calculations concerning cereal-potato calories, one can measure roughly the number of calories derived from nonwheat cereals and potatoes, and, in connection with our estimate of wheat calories, the percentage of cereal-potato calories derived from wheat.

Six quantitative categories are thus eventually involved: (*a*) calories from wheat, directly estimated; (*b*) total calories, approximated; (*c*) nonwheat calories (derived by subtraction, $b - a$); (*d*) cereal-potato calories, approximated; (*e*) calories from nonwheat cereals and potatoes (derived by subtraction, $d - a$); and (*f*) calories from other foods than cereals and potatoes (derived by subtraction, $b - d$).

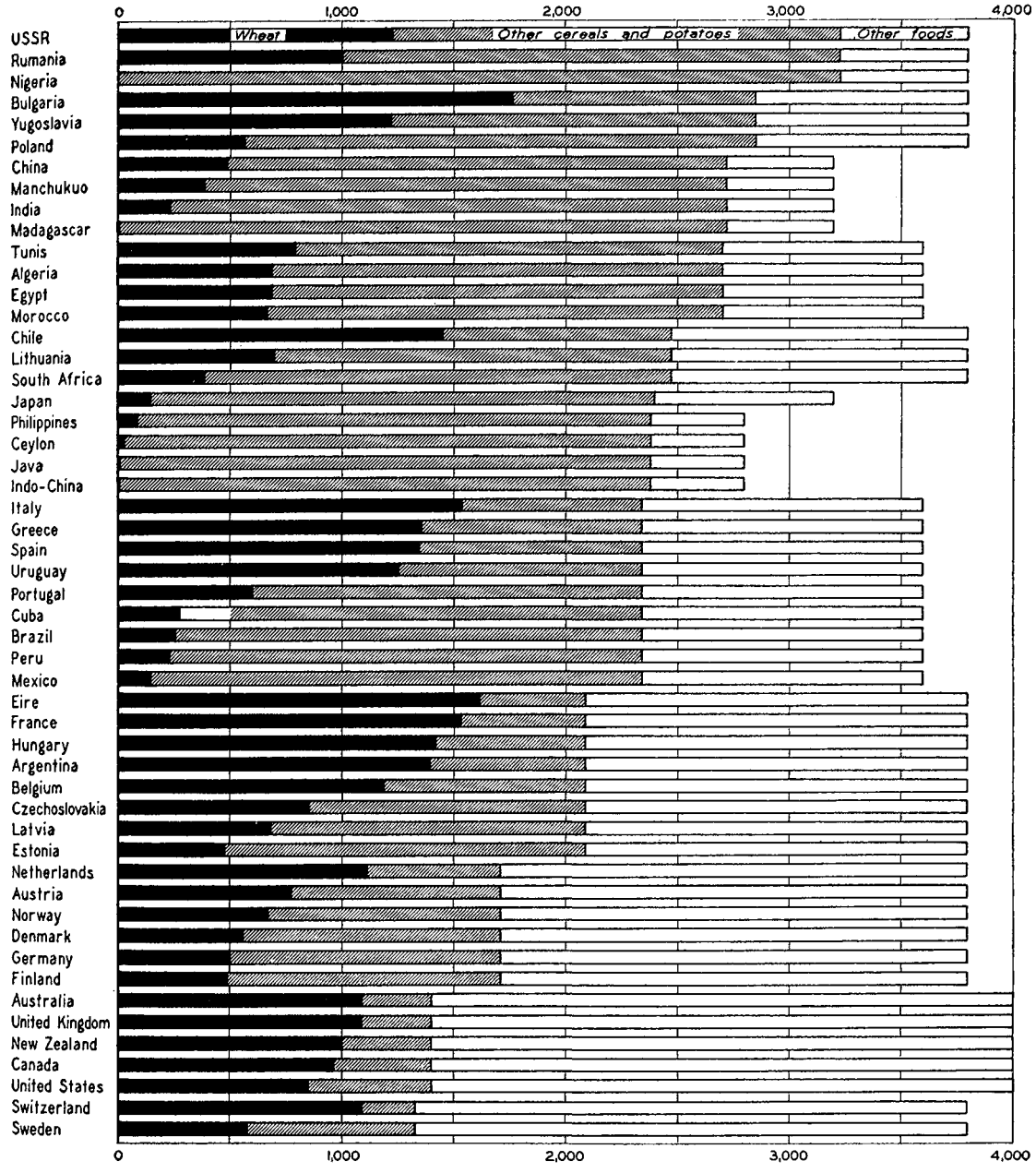
Chart 3 provides a general view of the results of our calculations for the 52 countries previously considered, expressed in terms of calories and of disappearance per adult male per day. The full width of the bars represents total calorie disappearance (item *b*); the black portion, wheat-calorie disappearance (item *a*); the hatched portion, disappearance of calories derived from nonwheat cereals and potatoes (item *e*); and the unhatched portion, disappearance of calories derived from all other foods than the cereals (including wheat) and potatoes (item *f*). The summation of the black and the hatched portions of the bars represents disappearance of calories derived from all cereals and potatoes (item *d*); and the summation of the hatched and unhatched portions represents calories derived from all foods except wheat (item *c*). The arrangement of countries accords first with number of calories derived from cereals and potatoes, and second, where these are appraised crudely as identical, with number of calories derived from wheat. Chart 4, p. 54, shows the various countries ranked according to the proportion of total food calories derived from cereals and potatoes.

Significance of Cereal-Potato Calories

The estimates of food calories derived from the family group of cereals and potatoes have sufficient general significance to warrant analysis. The proportion of food calories derived from cereals and potatoes in various nations constitutes a general index (*a*) of the relative

CHART 3.—TOTAL FOOD-CALORIE DISAPPEARANCE PER ADULT MALE PER DAY IN 52 COUNTRIES, 1933–38, DIVIDED RESPECTIVELY BETWEEN WHEAT, OTHER CEREALS AND POTATOES, AND OTHER FOODS*

(*Calories*)



* See Table I. The blank space in the bar for Cuba next to the black portion should be crosshatched.

quality of national diets, and (*b*) of the relative economic status of national populations.

All over the world, the important groups of foods may be classified as (1) cereals and "potatoes"; (2) sugars; (3) vegetable oils; (4) fruits, nuts, legumes, and relatively non-starchy and leafy vegetables; and (5) meats, animal fats, dairy products, eggs, and fish.[18] Of these five groups, the first and second are

[18] Many different classifications can be made, some of them more logical than the one that is used here largely for convenience of exposition.

rich in carbohydrate calories, but relatively poor in proteins, certain vitamins, and certain minerals. The third, vegetable oils, are rich in fat but again not in proteins, vitamins, or minerals. The so-called protective foods are usually those found in the fourth and fifth groups, and the fifth group is a major source of the better proteins.

It could be said beyond any question that a (hypothetical) national diet that consisted wholly of foods in the first three groups, and not at all of foods in the last two groups, would be a diet of poor quality, seriously defective. A population subsisting on such a diet would almost certainly show symptoms of some or several of the so-called deficiency diseases. No nation lives on such a diet, but some Oriental nations approach it somewhat closely. On the other hand, a population subsisting entirely upon the foods within groups 4 and 5—meat, eggs, dairy products, fish, nonstarchy and leafy vegetables, legumes, fruits, and nuts—could obtain a nutritionally satisfactory diet by proper combinations of these. Probably no nation lives on such a diet, but some high-income groups within nations, and some primitive tribes of hunters or pastoral peoples, may approach it closely.

It follows that the relative quality of a national diet can be appraised, though not at all closely, by reference to the percentage of total food calories supplied by the cereals and potatoes. If that percentage is high, it is clear that the protective foods and superior proteins cannot be abundant in the diet. If the percentage is low, the protective foods and superior proteins *may* be abundant.[14] Differences in these ratios from nation to nation are therefore meaningful, though considerably less meaningful when the ratios are similar in magnitude than when they differ widely. High ratios point toward national diets of poor quality, deficient in some of the protective food elements; low ratios point toward national diets of relatively good quality, relatively well supplied with the protective food elements. According as the ratios lean toward high or low, the probability increases of defective diet on the one hand and adequate diet on the other (sufficient total food calories assumed).

The proportion of total food calories derived from cereals and potatoes also provides a useful, though again a rough, index of differences in economic status of national populations. It can reasonably be said that the first care of mankind is to fill the stomach with food calories sufficient to appease hunger, regardless of the sources of calories; and that the closer to poverty a nation lies, the greater is the probability that its food calories will tend to con-

[14] The indicator is a very rough one. Hypothetically, of two nations each deriving 50 per cent of its total calories from cereals and potatoes, one of the nations might conceivably derive the remainder of its total calories from sugars and vegetable oils. In this case the diet would be qualitatively poor. The other nation might derive the remainder of its calories from meats, milk, leafy vegetables, fruits, and nuts. In this case the diet would be qualitatively good.

Yet such extreme contrasts cannot be expected to occur. In any country, the fraction of the diet not derived from cereals and potatoes must be expected to consist—and does consist—of a mixture of groups 2, 3, 4, and 5. There will not be presence of groups 2 and 3, consisting of nonprotective foods, to the exclusion of groups 4 and 5, the protective foods, or vice versa. Except among pastoral peoples or hunters, or very-high-income groups, there can rarely be marked predominance of groups 4 and 5 as against groups 2 and 3, proximately for reasons of price, if one refers to masses of people rather than to individuals or small aggregations. Certain foods in groups 2 and 3 will be as expensive per 1,000 calories as certain foods in groups 4 and 5. The importance of the two nonprotective-food groups in the fraction of the diet not derived from cereals and potatoes will no doubt vary from country to country; and therefore the ratio of calories derived from cereals and potatoes to total food calories must remain only a rough indicator of quality of diet. But if no large or marked degree of difference exists in the composition of the noncereal and nonpotato fractions of national diets, then our indicator of dietary quality can be expected at least to suggest where significant differences are likely to be found.

A further qualification of the indicator of quality lies in the fact that the cereals and potatoes are not precisely equivalent in dietary function. Wheat flour is usually superior to the flour or meals of other cereals in either quantity and/or quality of protein content; potatoes, both white and sweet, are richer in content of certain vitamins (C in both, and A in sweet potatoes) than any of the cereals. Theoretically there would be better and worse combinations of the several cereals and potatoes with reference to content of proteins, vitamins, and minerals. But the full difference between best and worst would be unlikely to emerge in actual dietary practices of nations. Differences in the combinations that do exist, while tending to lessen the precision of the ratio of calories derived from cereals and potatoes to total food calories as an indicator of dietary quality, do not altogether invalidate its significance.

sist of foods that are cheap per 1,000 calories contained.

It is not difficult to demonstrate that the cereals and potatoes, in simply processed or unprocessed forms, tend generally to be the cheapest foods per 1,000 calories available to large populations. Thus in the United States, where wheat flour is consumed in larger quantities than any other cereal food, two other relatively cheap and widely used foods—lard and sugar—cost respectively about 24 and 43 per cent more per 1,000 calories than does wheat flour;[15] and such familiar items as milk, inferior cuts of beef, eggs, and cabbage cost respectively some 8, 11, 15, and 17 times as much per 1,000 calories as does wheat flour.[16] In Germany, where rye bread is widely consumed, sugar and lard cost respectively about 35 and 63 per cent more per 1,000 calories than rye bread (and still more in relation to potatoes, which are cheaper per 1,000 calories than rye bread in Germany); and milk, inferior cuts of beef, eggs, and cabbage cost respectively about 3, 10, 9, and 10 times as much per 1,000 calories as does rye bread.[17]

Poverty-stricken nations must be expected to derive their food calories in much larger degree than prosperous nations from cheap sources of calories. The cereals and potatoes in simply processed forms are quite generally the cheapest sources of food calories. The proportion of food calories derived from cereals and potatoes must therefore broadly indicate national poverty if high, and national prosperity if low.

Again, however, one cannot expect small differences in the ratios to indicate true differences in national-income status. Food preferences as well as relative prices of foods may be supposed to affect the ratios; and relative food prices per 1,000 calories, though generally ranking the cereals and potatoes lowest in the price scale, cannot be supposed to rank the other foods in exactly the same relationships to the cereals and potatoes in all countries. Furthermore, two nations having substantially the same ratios of cereal-potato calories to total food calories might differ appreciably in economic status, because (*a*) national choices might differ concerning emphasis on the food sector of the economy in relation to other sectors; and (*b*) in the one the cereals might be consumed in more highly processed and more expensive forms than in the other.

Despite necessary qualifications, accurate statistics pertaining to the percentage of total food calories derived from cereals and potatoes in different nations can be expected to yield suggestive evidence concerning differences in the quality of national diets, and moderately trustworthy evidence concerning differences in economic status.

Calculation of Ratios

It has proved difficult to accumulate for many countries quantitative evidence concerning the percentage contribution of cereal-potato calories to total calorie disappearance; and since at best only approximate results can be presented, it seems desirable to consider briefly the nature of the statistical evidence. Chart 4 (p. 54) provides a basis for discussion.

In this chart, the probable proportion of total calorie disappearance provided by cereals and potatoes is indicated, for each country, by the 10-point range at the right-hand end of the horizontal bars. To the writer it appears probable that the basic data justify the evaluation of the ratios only within a range and not at a point, although in Chart 3 (p. 51) mid-points of ranges were used in order to calculate the approximate absolute number of calories per adult male per day derived from cereals and potatoes.

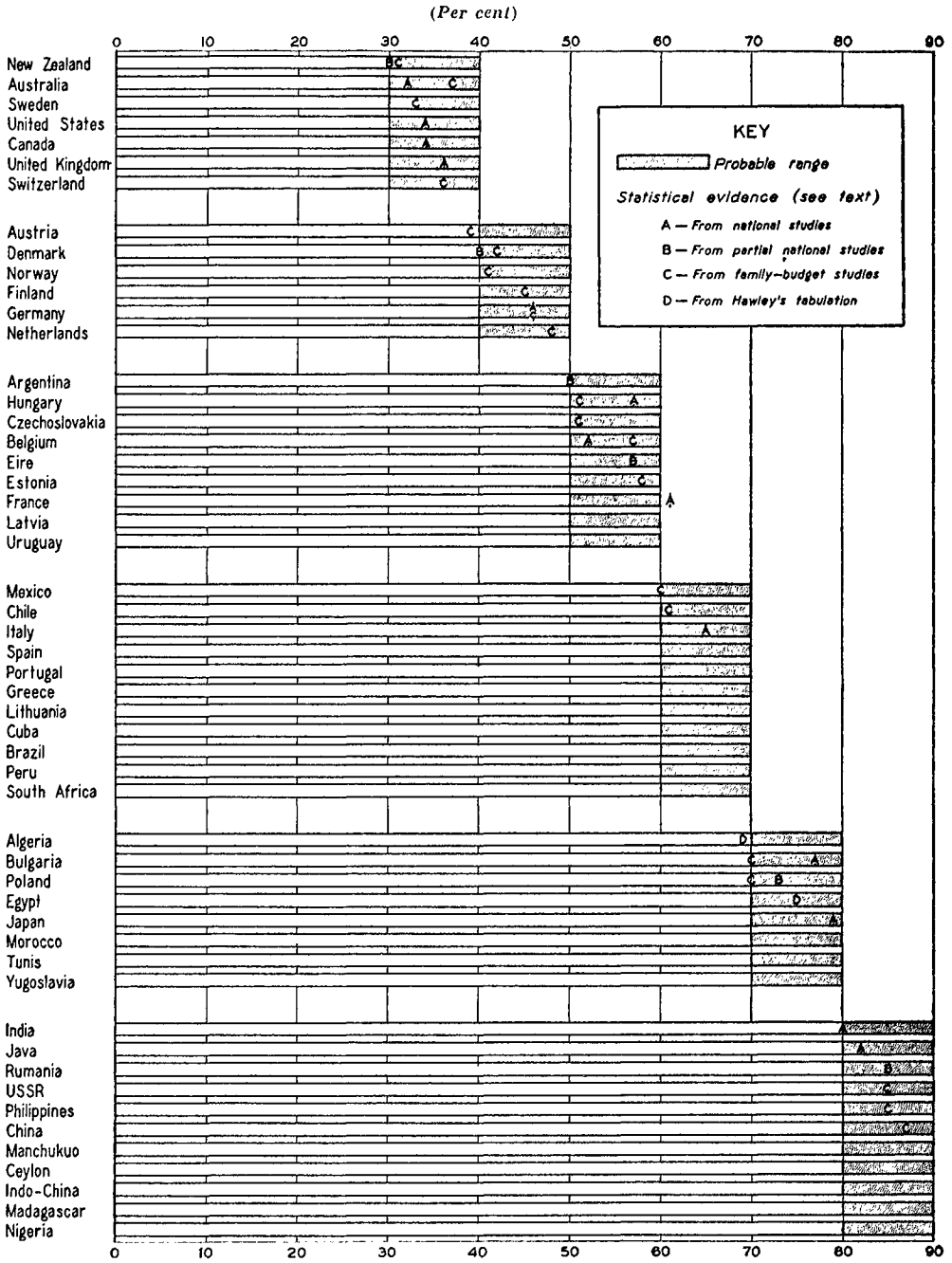
The letters *A* to *D* within individual bars of Chart 4 refer to types of statistical information concerning ratios of cereal-potato calories to total food calories. The *B* in the bar representing New Zealand is plotted at a ratio given in or derived from a statistical inquiry; and so with all letters in all bars. All *A*'s

[15] This contrast would be lessened if one were to consider cost at the table rather than retail price. Wheat flour must be processed more or less expensively into edible items. Sugar and lard need not be.

[16] Derived from data in Hazel K. Stiebeling and Medora M. Ward, *Diets at Four Levels of Nutritive Content and Cost* (U.S. Dept. Agr., Circ. 296, November 1933), pp. 7–9.

[17] Derived from data in Hans von der Decken, *Entwicklung der Selbstversorgung Deutschlands mit landwirtschaftlichen Erzeugnissen* (*Berichte über Landwirtschaft*, N.F., Sonderheft 138, Berlin, 1938), p. 55.

CHART 4.—APPROXIMATE PROPORTION OF CALORIES DERIVED FROM CEREALS AND POTATOES IN TOTAL FOOD CALORIES IN 52 COUNTRIES, 1933–38*



* See Table I, and text discussion on pp. 53–55.

refer to what may be called national nutritional investigations, in which statistics of production and trade, covering the whole range of foodstuffs, provide the basic material.[18] All *B*'s refer to the inquiries similar in method, except that the basic statistics pertain only to the cereals and potatoes, and the

[18] Of these investigations, 13 in number, 10 are based on publications from various countries: for Belgium, Fernand Baudhuin, "L'alimentation de la Bel-

level of total calorie disappearance is assumed.[19] All *C*'s refer to "family-budget" studies of the food consumption mainly of urban working classes.[20] The *D*'s, two in number, refer to Hawley's tabulation, "Proportion of Energy Supplied by Eight Foods in Foreign Diets, Based on 3,000 Calories per Man per Day."[21]

The fundamental data often required adjustment for comparability and conversion of weights of food to calories; also, they are not equally representative of national dietary circumstances and do not apply to the same dates. Hence vagueness of interpretation is inevitable, and expression of ratios as ranges rather than points is desirable. When letters fall outside the indicated probable range (as with Austria, France, and Algeria), reasons have appeared to justify placing the range above or below the indication.[22]

When the bars contain no letters, the indicated probable ranges rest on argument by analogy. Thus, if we have statistical data for a given country which is one of several that are similar in geographical location, climate, industrial development, and agricultural production, it may be assumed of those for which no statistical data are available that the proportion of calories derived from cereals and potatoes is not far different from what it is in the country for which statistical data are available. With data at hand for Italy, one may reasonably suppose that dependence upon cereals and potatoes is approximately similar in Greece, Spain, and Portugal; that the situation is much the same in Tunis and Morocco as the data suggest it to be in Algeria and Egypt; about the same in Manchukuo, Ceylon, and Indo-China as indicated in China, India, the Philippines, and Java; and so on. Of all the 18 countries for which rough appraisal of the extent of dependence upon cereals and potatoes has had to be based on argument by analogy, the argument seems weakest with reference to Cuba, Brazil, Peru, South Africa, Madagascar, and Nigeria.[23]

Conclusions Regarding Cereal-Potato Calories

If the measures of dietary dependence upon cereals and potatoes summarized in Chart 4 be accepted as correct, it can be said that the ratio of cereal-potato calories to total food

gique. Les données du problème en cas de blocus," *Bulletin de l'Institut de recherches économiques* (Université catholique de Louvain, École des sciences politiques et sociales, Louvain), August 1939, X, 375–88; for France, Commission scientifique interalliée du ravitaillement, *Rapport général: Les ressources et les besoins alimentaires des pays alliés. Annexes au premier rapport* (Paris, October 1918), pp. 7–16; for Germany, von der Decken, *op. cit.;* for Hungary, Ungarisches Institut für Wirtschaftsforschung, "Angaben über Volksernährung," in *Daten über die Entwicklung der Ungarischen Volkswirtschaft, 1924/25–1937/38* (Sonderheft 15, Budapest, 1938), pp. 34–38, 48; for India, "India's Food Problem," *Economist, loc. cit.;* for Italy, *Proceedings of the International Congress for Studies on Population,* II, 457–95; for Japan, E. C. Grey, *The Food of Japan* (League of Nations, Health Organisation, C.H. 681, Geneva, May 1928); for Java, Scheltema, *op. cit.;* for the United Kingdom, Orr, *op. cit.;* for the United States, Cavin, *op. cit.* Two investigations (those for Australia and Canada) represent the unpublished work of two of the writer's students, W. S. Richards and W. R. Stott; and one (for Bulgaria), calculations by the writer's colleague, Egoroff.

[19] These six inquires, unpublished, are the writer's calculations.

[20] These studies, 21 in number, have mostly been published by the International Labour Office: see especially *Worker's Nutrition and Social Policy* (Studies and Reports, Ser. B, No. 23, Geneva, 1936), and "An International Survey of Recent Family Living Studies: II. Food Expenditure and Consumption Habits," *International Labour Review* (International Labour Office, Geneva), June 1939, XXXIX, 822 ff. Studies were found elsewhere pertaining to New Zealand, Lillian B. Storms and E. Neige Todhunter, "The Adequacy of Some New Zealand Dietaries," *Journal of Home Economics* (Baltimore), November 1928, XX, 817–24; to Australia, Australia, *Final Report of the Advisory Council on Nutrition Together with Appendices* (1938); to Chile, Carlo Dragoni and Et. Burnet, "L'alimentation populaire au Chili. Première enquête générale de 1935," *Revista Chilena de Higiene y Medicina Preventiva* (Santiago), October–December 1938, I, 407–611; for the USSR, *Statistical Handbook of USSR for 1928, loc. cit.;* for the Philippines, H. C. Lava, *Levels of Living in the Ilocos Region, Philippines* (unpublished Ph.D. thesis, Stanford University, Calif., 1939); for China, Buck, *op. cit.*

[21] *Economics of Food Consumption,* p. 123.

[22] Thus the indicated percentage for France (61) is regarded as lying above the probable range because it refers to the situation in 1909–14 and there is ample evidence that the ratio must have declined appreciably in 25 years.

[23] With regard to the African countries, however, an unpublished study covering both the scanty quantitative evidence and the qualitative evidence, by W. O. Jones, one of the writer's students, affords strong support to the probability that cereal-potato calories provide about the proportion of total calories suggested in Chart 4.

calories ranges from about 30 to nearly 90 per cent from country to country throughout the world. If our earlier analysis of the significance of this ratio is correct, the ratios differ from country to country principally in reflection of differences in economic status. Dependence upon cereals and potatoes is greatest in low-income countries, least in high-income countries.

Yet this relationship can hardly be pressed so far as to say that at lowest conceivable levels of prosperity, a nation would derive all of its calories from cereals and potatoes; or that at highest conceivable levels of income a nation would abandon cereals and potatoes altogether. No large population group could survive indefinitely if cereals and potatoes alone provided the food calories. Proteins, vitamins, and minerals in excess of those contained in cereals and potatoes would be required in the purely physiological sense. The physiological requirement must set some upper limit to the proportion of food calories derived from cereals and potatoes, regardless of income. Income and population must adapt themselves so as to meet the physiological requirement.

Again, the highest ratios of cereal-potato calories to total food calories may depend in some degree upon food preferences. It seems conceivable, at least, that some or many self-sufficient farmers, particularly in the Orient, might if they chose, or had the knowledge, without increasing their outlay of physical effort or capital, alter their production and consumption habits in such a way as to reduce intake of cereals and potatoes and increase intake of fruits, vegetables, and animal products. If this be true, mere preferences (including those based on religious scruples) may play some role in determining between nations the degree of dependence upon cereals and potatoes.

Preference may conceivably be even more important at the lower end of the scale. There is no physiological reason why, given the income, a nation might not dispense with cereals and potatoes altogether. The physiologically necessary balance between calories, proteins, fats, carbohydrates, vitamins, and minerals could be obtained—cost disregarded —from other sources than these. Actually, however, dependence upon cereals does not fall nationally below 30 per cent. And observation of the food habits of notably high-income groups, where cost of food can have only negligible influence on food selection, confirms the presence of cereals and potatoes as routinely accepted and desired components of the diet. If all Americans were millionaires, the probability is strong that national dependence upon cereals and potatoes would fall below the present national level of some 35 per cent, but certainly not to zero and indeed perhaps not as low as 20 per cent.

Nevertheless, difference in income seems likely to be the principal explanation of differences in national dependence upon cereals and potatoes. Food preference may help somewhat in explaining why cereal-potato calories play as important a role as they do both in China, where the ratio is very high, and in the United States, where it is very low. Preference may also explain why the ratios are moderately higher in Belgium and France than in Germany, Switzerland, or Holland. But the large differences between western European and Oriental countries, or the United States and South American countries, or central European and African countries, must be attributed mainly to differences in economic status. Income determines the broad picture of relative national dependence upon cereal-potato calories; food preference modifies the picture.

The picture of relative national economic status afforded by the ratios in Chart 4 need not be considered here, beyond indicating the broad outlines. Geographically, there are three centers of relative prosperity: northwestern Europe, the United States and Canada in North America, and Australasia. All of Asia, on the other hand, is relatively poor, with Japan standing above the general level. So also is Africa, with South Africa in the most favorable position. Southern, central, and eastern Europe, and Central and South America, represent areas of intermediate levels, ranging up to the position of western Europe and down to the position of Asia. This is a picture which accords broadly, but by no means in detail, with Clark's estimates of

per capita money income of nations expressed in "international units."[24]

The general view of relative quality of national diet afforded by the ratios also warrant further comment. Geographically, the distribution of presumptively best, poorest, and intermediate national diets is the same as the distribution of richest, poorest, and intermediate countries.

The following tabulation summarizes the populations (millions in 1935) of each of six groups of countries arranged according to probable percentage contribution of cereal-potato calories to total food calories. If one could determine what proportion of cereal-potato calories in national diet indicates a diet satisfactory in general composition and what proportion indicates a diet unsatisfactory in general composition, inferences could be drawn concerning the proportion of the world population probably malnourished and the proportion probably well nourished.

Group	Percentage cereal-potato calories	Population			
		Total		Non-Oriental	
		Number	Percentage	Number	Percentage
I	30–39	205	11.1	205	23.8
II	40–49	93	5.1	93	10.8
III	50–59	93	5.1	93	10.8
IV	60–69	169	9.2	169	19.6
V	70–79	156	8.4	86	10.0
VI	80–89	1,125	61.1	215	25.0
Total	.....	1,841	100.0	861	100.0

No particular percentage of cereal-potato calories to total food calories, however, could be said to differentiate qualitatively satisfactory from qualitatively unsatisfactory diets. Much would depend upon the composition of that fraction of the diet not supplied by cereals and potatoes, and something would depend upon the composition of the fraction supplied by the cereals and potatoes. On the basis of current standards of physiologically well-balanced diet, it is conceivable that a diet containing two-thirds or slightly more of cereal-potato calories would be physiologically well balanced, provided that the other third consisted entirely of lean meat, eggs, milk, fruits, and leafy vegetables. Actually, however, a national diet made up precisely in this way would be unthinkable, because it leaves no room for sugars and vegetable oils. To the extent that these items entered a diet composed two-thirds of cereals and potatoes, they would make it considerably less satisfactory physiologically if they displaced non–cereal-potato items, but would disturb its balance less if they displaced cereals and potatoes.

It is perhaps a reasonable inference that national diets, including (as all of them do) sugars and vegetable oils, may be presumed to be nutritionally satisfactory in their balance when they contain less than 50 per cent of calories derived from cereals and potatoes, and nutritionally rather poorly balanced when they contain more than 60 per cent. Somewhere between 50 and 60 per cent of calories derived from cereals and potatoes may lie a differentiation between diets likely to be inferior and superior respectively in quality or composition.[25]

If this rather vague and ill-established line of differentiation be accepted, the inference follows that only 16–21 per cent of the world's population seems likely to subsist on a well-balanced diet, while 79–84 per cent may subsist on an ill-balanced diet. If Oriental populations are excluded from consideration, some 35–45 per cent of the non-Oriental world population may exist on diets of superior quality, some 55–65 per cent on diets of inferior quality. Of the national populations with the qualitatively superior diets, that of the United States is the largest; this country contains from 33 to 43 per cent of all the national populations in the world that may be presumed to have superior composition of their food. Within every country, of course, are found some groups standing in different positions; thus the proportion of the American population widely asserted to be "ill fed"

[24] Colin Clark, *The Conditions of Economic Progress* (London, 1940), p. 54.

[25] This may be a conservative appraisal. Stiebeling describes her "restricted diet for emergency use" of Americans as one that "provides approximately the minimum requirements of the body for the various nutrients, but allows little margin for safety"; and this diet contains only about 47 per cent of calories derived from cereals and potatoes. See Stiebeling and Ward, *op. cit.*, pp. 2–4.

(also "ill housed" and "ill clothed") runs to a third. Yet the evidence here presented suggests that the United States may hold within her borders a larger absolute number of people (not necessarily a larger proportion) whose diets are nutritionally satisfactory in composition than can be said of any other single country.

IV. WHEAT AMONG ITS COMPETITORS

Wheat is only one of the cereal-potato family of foodstuffs. It is never the only member of the family occurring in national diets. It is the outstanding member in some countries, but is an unimportant member in others. In this section we seek to measure the place of wheat in the cereal-potato segment of national diets, and to ascertain why its importance varies from country to country. Further to illuminate the position of wheat, an attempt is here made to show how and why nations differ in the composition of that fraction of the cereal-potato segment of the diet which is derived from nonwheat cereals and potatoes.

Wheat Calories and Cereal-Potato Calories

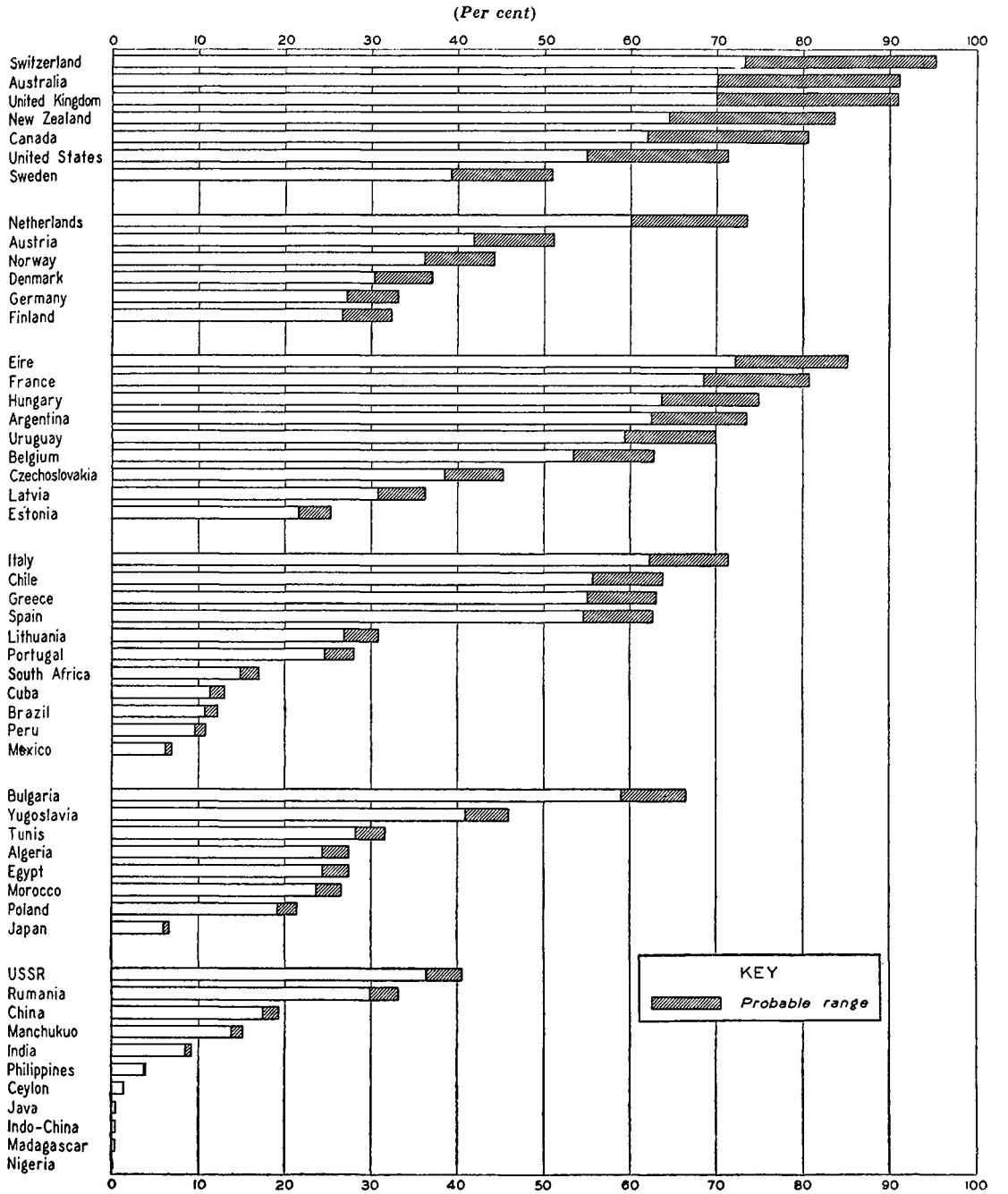
The importance of wheat among all of the cereal-potato foodstuffs in 52 nations is indicated by Chart 5. For each country, the chart shows the approximate percentage contribution of wheat calories to total cereal-potato calories, in terms of disappearance per adult male per day. Ranges are shown because our estimates of calories derived from cereals and potatoes are too inexact to justify the determination of points. The ratios are arranged by order of magnitude of lower limit of ranges, within each of six groups of countries themselves arranged in order of level of prosperity or, specifically, by order of proportion of total food-calorie disappearance supplied by cereals and potatoes.

The maximum contribution of wheat to all cereal-potato calories is probably about 85 per cent. Even where the proportion is highest, as in Switzerland, Australia, the United Kingdom, and Eire, nonwheat cereals and potatoes retain a place in national diets. The minimum contribution of wheat falls below 1 per cent, as in Java, Indo-China, Madagascar, and Nigeria.

The position of wheat in the cereal-potato fraction of national diets is presumably determined jointly by level of income, food preference, and climate. If income is low, if climate is such as to favor production of nonwheat cereals on subsistence farms, and if preference for wheat is weak, the contribution of wheat to all cereal-potato calories is bound to be low, even though disappearances of cereal-potato calories be high. Of these three influences, preference would appear to be the least powerful. A poverty-stricken country located in a climate where rice (for example) grew well but wheat poorly would use very little wheat even if preference for wheat could be called strong; the preference could not be exercised. The reason why the inhabitants of China, Manchukuo, and India give wheat a larger share in their cereal-potato disappearance than the Indo-Chinese, Madagascans, and Nigerians do is probably mainly climatic. Their incomes are probably roughly similar; their preferences are probably immaterial; but parts of China, Manchukuo, and India are characterized by climates where wheat competes favorably in agriculture, whereas the other countries have not such climates.

Conversely, preference could be exercised in a prosperous country, and to such an extent as to outweigh climatic disadvantages in wheat production. Yet it would not necessarily follow that in such a country the ratio of wheat calories to cereal-potato calories would be high. Preference might work either to hold wheat to a subordinate position among the cereals and potatoes, or to push it into a dominant place. Neither income nor climate can explain why wheat is so much more important among the cereal-potato foodstuffs in Switzerland than in Sweden, in Australia and the United Kingdom than in the United States. Preference appears to constitute the significant explanation of these differences. Preference also seems mainly to explain the greater importance of wheat in Holland than in Den-

CHART 5.—APPROXIMATE PROPORTION OF CALORIES DERIVED FROM WHEAT IN CALORIES DERIVED FROM CEREALS AND POTATOES IN 52 COUNTRIES, 1933–38*



* See Table I.

mark, two countries in the second-highest-income categories.

But as one passes to the lower-income categories, the relative weight of influence respectively of climate and of preference becomes more difficult to infer. Perhaps preference would chiefly explain the larger importance of wheat in Eire than in Belgium of the third-highest-income group; but climatic conditions might be the more important in placing wheat

in a higher position in Hungary than in Czechoslovakia and Latvia. In the fourth category of income levels, the influence of climate seems to loom still larger. South Africa, Brazil, Peru, and Mexico are much more handicapped by climate in their ability to produce wheat in competition with other grains than are Italy, Chile, Greece, and Spain. In the fifth category of income levels, the same may be said of Tunis, Algeria, Egypt, Morocco, Poland, and Japan as compared with Bulgaria and Yugoslavia.

At high levels of prosperity, then, preference appears the principal influence determining the position of wheat among the cereal-potato foodstuffs in national diets. At low levels of prosperity, climate becomes the major influence and preference a secondary one. At intermediate levels of prosperity, the influence of preference probably increases with increase of income, while the influence of climate declines.

A Classification of Diets

The position of wheat in national diets can be made somewhat clearer by reference to the composition of that fraction of the cereal-potato segment of national diets which is derived from nonwheat cereals and potatoes. The cereal-potato segment itself is derived from wheat, rice, rye, corn, barley, oats, millets and sorghums, and "potatoes" defined to include white potatoes, sweet potatoes, and cassava. Many different types of combination of these 10 basic materials may and do exist. Full statistical description of the contribution of each to the total cereal-potato segment of 52 national diets is not feasible; but broad indications can be given, partly on the basis of qualitative information.

These indications are summarized in the accompanying table. Here each country is classified (*a*) as to proportion of total food calories supplied by all cereals and potatoes, and (*b*) as to "dominance" of one or another of the 10 basic materials in the cereal-potato fraction of the diet. If any one of these 10 foodstuffs provides 50 per cent or more of the cereal-potato calories, that foodstuff is regarded as "dominant." Out of the 52 countries considered, 32 have diets in which a single foodstuff is dominant within the group of cereal-potato foods. These 32 countries appear in the first four rows of the table. In the remaining 20 countries, no single foodstuff seems to provide as much as 50 per cent of the cereal-potato calories. But in 16 of these, two foodstuffs dominate in the sense that together they appear to furnish 60 per cent or more of all cereal-potato calories. These 16 countries are listed in the fifth, sixth, and seventh rows of the table. There remain four countries listed in the eighth row as "uncertain." In Cuba, apparently, no single foodstuff dominates and no two foodstuffs dominate, but three foodstuffs must be necessary to provide 60 per cent of the cereal-potato calories.

This classification indicates that only four foodstuffs, namely wheat, rice, rye, and corn, are dominant in the cereal-potato segment of national diets, in the sense of providing 50 per cent or more of the cereal-potato calories. Oats, white potatoes, and sweet potatoes certainly, and millets and sorghums and cassava possibly, do not provide as much as half of the cereal-potato calories in any of the 52 countries here considered. Uncertainty as to the possible prominence of millets and sorghums and of cassava exists because the millets and sorghums are certainly of substantial importance in Manchukuo and Nigeria, and cassava may be important in Nigeria and Brazil.

In countries where no single foodstuff furnishes 50 per cent or more of all cereal-potato calories, there are potentially many combinations of two foodstuffs that provide 60 per cent or more of the cereal-potato total. Yet only the combinations wheat-rye, wheat-corn, and wheat-barley emerge clearly in *national* statistics. Unless either corn or cassava is dominant in Brazil, the combination corn-cassava probably prevails there. Unless millets dominate in Manchukuo, the dominant two-foodstuff combination may be millets and sorghums with either corn or wheat. A two-foodstuff combination either of millets and sorghums with corn, or millets and sorghums with cassava, or corn with cassava, may dominate in Nigeria; but here it seems possible that either millets and sorghums or cassava

DOMINANCE OF SINGLE FOODSTUFFS AND TWO-FOODSTUFF COMBINATIONS IN CEREAL-POTATO FRACTIONS OF NATIONAL DIETS, IN 52 COUNTRIES, 1933–38, ARRANGED ACCORDING TO LEVELS OF PROSPERITY (OR FRACTION OF TOTAL FOOD CALORIES DERIVED FROM CEREALS AND POTATOES)

Type of dominance[a]	Percentage of total food calories derived from cereals and potatoes[b]					
	30–39	40–49	50–59	60–69	70–79	80–89
Wheat	Switzerland Australia United Kingdom New Zealand Canada United States	Netherlands	Eire France Hungary Argentina Uruguay Belgium	Italy Chile Greece Spain	Bulgaria	
Rice					Japan	China India Philippines Ceylon Java French Indo-China Madagascar
Rye			Estonia		Poland	
Corn				South Africa Peru Mexico		Rumania
Wheat-rye	Sweden	Austria Norway Denmark Germany Finland	Czechoslovakia Latvia	Lithuania		USSR
Wheat-corn				Portugal	Yugoslavia Egypt	
Wheat-barley					Tunis Algeria Morocco	
Uncertain[c]				Cuba Brazil		Manchukuo Nigeria

[a] Dominance of single foodstuffs means that 50 per cent or more of all cereal-potato calories are supplied by the indicated cereal; dominance of two-foodstuff combinations means that the indicated pair supply 60 per cent or more of all cereal-potato calories, but neither of the pair supplies as much as 50 per cent.

[b] See Chart 4 and pp. 49–58.

[c] The principal sources of cereal-potato calories in these countries seem to be as follows: Cuba—wheat, rice, corn; Brazil—wheat, corn, cassava; Manchukuo—millets and sorghums, wheat, corn, rice; Nigeria—millets and sorghums, cassava, corn.

might furnish half or more of the cereal-potato calories.

A different and much more illuminating picture of the composition of the cereal-potato segment of diets would doubtless emerge if detailed study by regions within nations were feasible. Indeed, certain nations where rice is dominant have also an important consumption of wheat, but this is usually a matter of regional dominance of one or the other. In China, for example, rice loses its dominant position as one moves north and northwest, and wheat particularly, but millets and sorghums, and corn as well, increase in importance. In India similarly, rice declines in dietary importance from the east to the west, northwest, and southwest, and in various regions either wheat (the northwest), or millets and sorghums (the center) may occupy the dominant position. In restricted locali-

ties of both countries, either barley or corn may be dominant. In Soviet Russia, where nationally wheat and rye together dominate, the truer picture is dominance of wheat in the south, of rye in the north. In Java, where rice dominates nationally, it may lose its dominance to corn in some localities of the eastern part of the island.

Judged on the basis of number of countries, the commonest type of single-foodstuff dominance is that of wheat. Wheat dominates among all cereals and potatoes in 18 countries, all Occidental in civilization. Ten of these 18 lie in southern and southwestern Europe, geographically contiguous. Three lie in temperate South America; two in North America; two in Australasia. In relatively high-income countries, dominance of wheat is characteristic, with Sweden the sole exception. Rice dominates in eight countries, all Oriental except Madagascar. Corn dominates in four countries—Mexico and Peru in tropical America, South Africa, and Rumania. Rye dominates only in Poland and Estonia.

Dominance of wheat and rye together, however, is more common than with any other two-foodstuff combination. It is found in 10 countries of central and northern Europe. The rarer wheat-corn combination occurs in Portugal, Yugoslavia, and Egypt, and the wheat-barley combination only in Tunis, Algeria, and Morocco of the 52 countries here under review.

In the 18 countries where wheat dominates, the starchy foodstuff next in importance is most commonly the potato. This seems to be the situation in Switzerland, Australia, the United Kingdom, New Zealand, Canada, the United States, the Netherlands, Eire, France, Argentina, Belgium, and Chile. In Hungary, however, the starchy foodstuff next in importance to wheat is rye; and in Italy, Spain, and Bulgaria, and probably Uruguay, it is corn. Either corn or rice may be the starchy foodstuff of secondary importance in Greece.

The potato is also the starchy foodstuff next in importance to the wheat-rye combination in the 10 countries where that combination is dominant. Some other foodstuff than the potato, however, may be the one of secondary importance in the three countries where the wheat-corn combination dominates and the three where the wheat-barley combination dominates; the facts are not clear.

Judged on the basis of national populations, dominance of rice is more common than dominance of wheat. The following tabulation shows populations of 52 nations, in millions in 1935, arranged according to dominance of a single-foodstuff or a two-foodstuff combination in the calories derived from cereals and potatoes:

Wheat dominant	368
Rice dominant	946
Rye dominant	35
Corn dominant	54
Wheat-rye dominant	283
Wheat-corn dominant	38
Wheat-barley dominant	16
Uncertain	100
Total	1,840

The population of countries where rice dominates is more than half of the total. The populations of wheat-dominant and wheat-rye–dominant countries are respectively a fifth and a little more than a seventh of the total. Other populations, where type of dominance is various, constitute only about an eighth of the total.

If analysis could be made on the basis of regions within nations, the principal effects would probably be (*a*) to diminish the populations where rice dominates, (*b*) to diminish the populations where the wheat-rye combination dominates, (*c*) to increase the populations where wheat dominates, and (*d*) to increase the populations where rye dominates. Perhaps also populations where millets and sorghums dominate would emerge especially in India and China. Large fractions of the Russian population would pass from the position of wheat-rye dominance to positions respectively of wheat dominance and rye dominance. Substantial fractions of the huge Chinese and Indian populations would pass from positions of rice dominance to positions of wheat dominance, and smaller fractions would pass to positions of dominance of millets and sorghums. Precisely what results would emerge if such regional analysis could be made is conjectural, but one broad effect would certainly be to elevate the importance

of wheat among the world's starchy foodstuffs.

The factors influential in determining what foodstuffs shall dominate in the cereal-potato fraction of national diets are again income, preference, and climate. In the two highest-income brackets, either wheat or the wheat-rye combination dominates. This does not prove that wheat is the "preferred cereal" in the sense that it would dominate everywhere if income levels were sufficiently high. Rye retains an important place among relatively prosperous populations in north-central Europe. Rice in the Orient might well remain dominant among the cereal-potato foodstuffs even if income should there rise to levels comparable with those in northwestern Europe; climate would continue to favor the dominance of rice in agriculture, and this would tend to hold preference for rice strong. But at sufficiently high levels of income, all cereals other than wheat and rice might well lose the degree of dominance that they now hold.

In low-income countries, climate is necessarily the major factor in determining dominance of particular foodstuffs in the cereal-potato fraction of the diet. Poor countries are populated very largely by farmers close to a stage of self-sufficiency in food, who produce and consume whatever starchy foodstuffs can be produced with the least effort. In warm and very dry climates (without irrigation), barley, wheat, and millets and sorghums reward peasants' efforts best. In warm and very wet climates, at least on the flatter land where paddies can be built, rice thrives best. Corn finds its place between these extremes and probably on the rough terrain of warm and very wet climates, and rye in cooler areas not too moist. If large populations at low-income levels happened to live in areas distinctly cool and moist, oats might well emerge there as the dominant starchy food; but such areas are not common, and where they exist the populations are either scanty or moderately prosperous.

V. RECENT CHANGES IN THE POSITION OF WHEAT

The position of wheat in national diets is fairly stable but by no means constant. It changes more or less from decade to decade and even from year to year. Changes in per capita daily disappearance of wheat flour might occur either with or without concurrent change in per capita daily disappearance of food calories, or in per capita daily disappearance of calories derived from other cereals and potatoes. Adequate explanation of changes in per capita disappearance of wheat flour (or food calories derived from wheat) between any two periods in any nation is hardly feasible in the absence of more or less precise knowledge about changes in total diet and in the nonwheat components of the total diet.

Assuming at the outset a level of quantitative adequacy of total food calories per capita, an increase in wheat-calorie disappearance might in one country be accompanied by increase in total food-calorie disappearance and by increase both in calories derived from nonwheat cereals and potatoes, and in calories derived from other sources than cereals and potatoes. This might be an improvement in the *quantity* of total diet, without improvement in *quality*. If the increase were larger in calories derived from non–cereal-potato foodstuffs than in calories derived from wheat, there might be improvement in both quantity and quality of diet. If the increase were larger in wheat calories than in calories derived from non–cereal-potato foodstuffs, there might be improvement in quantity of diet but deterioration in quality.

In another country, increase in wheat-calorie disappearance might occur in the absence of change in disappearance of total food calories. In this case quantity of diet would remain unchanged; but quality of diet might deteriorate if the increase in wheat calories meant decrease in calories derived from other foodstuffs than the nonwheat cereals and potatoes. Or the increase in wheat calories might mean little nutritionally if that increase were wholly at the expense of some other cereal. Thus a given quantitative increase in wheat-calorie disappearance may signify, so far as general status of diet is concerned, any one

of several quite different things. The concurrent changes in other components of the diet need to be known before the significance of increase in the wheat component can become clear.

So it is also with reduction in per capita disappearance of wheat calories. (*a*) Such reduction may accompany reduction in total food-calorie disappearance, itself reflecting a broad trend toward curtailment of physical labor as machines come to do the work of men. In this case diet will probably not have changed significantly in the quantitative sense, and will have improved in the qualitative sense if reduction in wheat calories has been accompanied—as is likely—by increase in the *proportion* of calories derived from protective foods. (*b*) Reduction in wheat calories may also accompany reduction in total food calories not in reflection of reduced human output of physical energy. In this case the reduction in wheat may signify primarily deterioration in the quantitative aspect of diet, and perhaps also in the qualitative aspect if reduction of wheat calories has been smaller than increase of calories derived from another cereal. (*c*) Total food calories per capita may remain unchanged, so that no change in quantity of food is evident. In this case a reduction of wheat calories may mean either an improvement in quality of diet (when wheat calories are supplanted by calories derived from protective foods), or little change in quality of diet (when wheat calories are supplanted by calories derived from other cereals and potatoes).

Interpretations are further complicated by the fact that food-calorie "disappearance," and also wheat-calorie "disappearance," include waste and loss. A minor change in per capita wheat disappearance in either direction might have practically no nutritional significance if the change were merely in waste or loss; ingestion of food, including wheat, might then be unaffected.

In the present section we present the available evidence concerning changes in per capita utilization of calories derived from wheat in 52 countries, as between two five-year periods (1923–24 to 1927–28 and 1933–34 to 1937–38) of which the middle years are a decade apart. It has not proved feasible to present equally detailed and comprehensive evidence concerning changes either in total food-calorie disappearance per capita, or in the proportions of total calories derived respectively from cereals and potatoes and from other sources. Under these circumstances our interpretations of changes in per capita disappearance of wheat calories must in part be speculative.

Expression of changes in terms of wheat-calorie disappearance per capita may be regarded as serving present purposes as well as would expression in terms of disappearance per adult male. Over an interval as short as a decade, changes in age and sex distribution of populations would presumably be too small to give rise to meaningful differences in measurement of changes in the position of wheat in national diets.

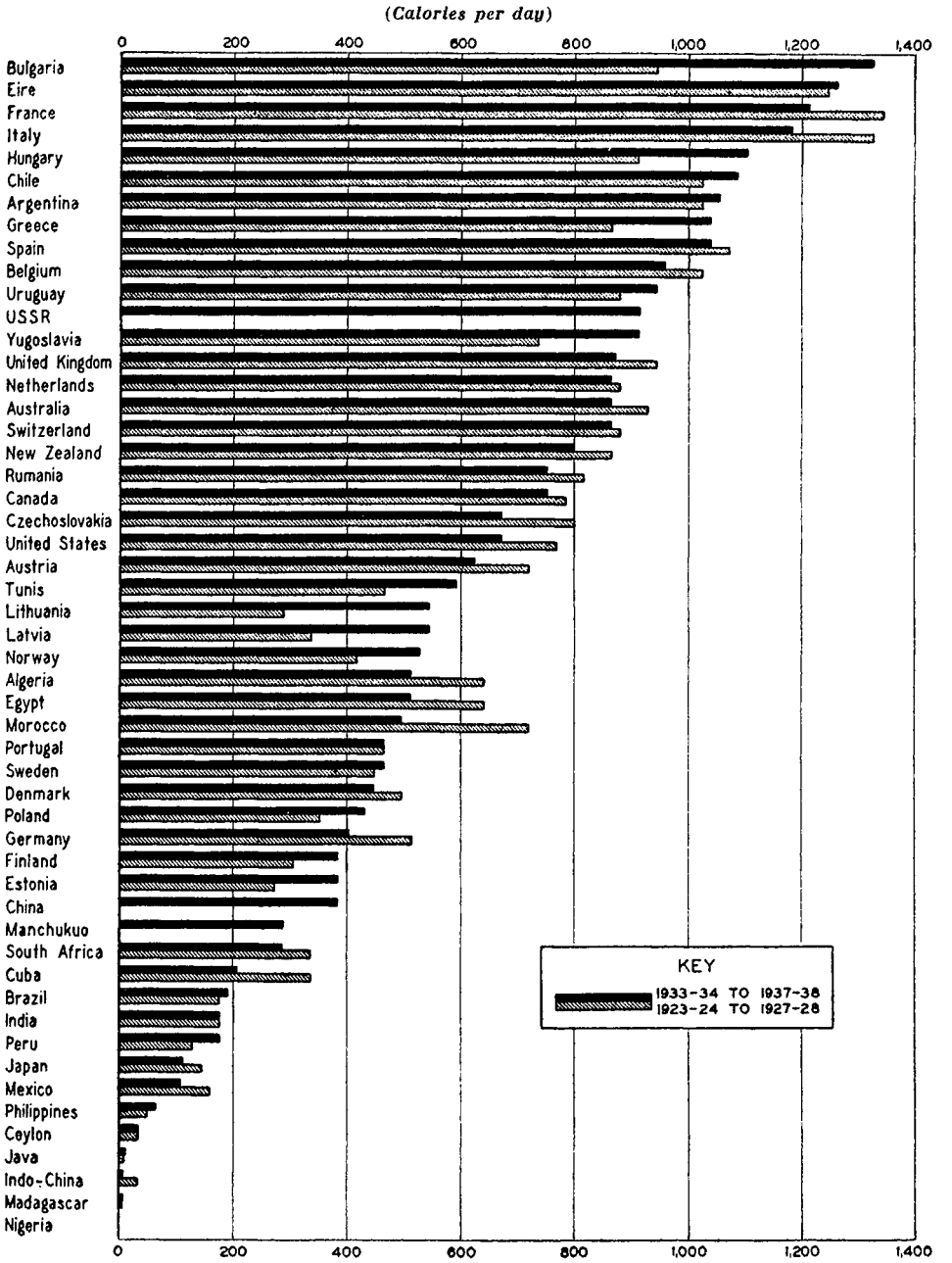
General Survey

The available facts regarding change in daily per capita wheat-calorie disappearance between the two specified periods are summarized in Chart 6. Levels of disappearance in the period 1933–38 are shown by black bars, and levels in the earlier period 1923–28 by hatched bars. The order of arrangement is according to levels in the later period, as also in Chart 1 (p. 40).

For three countries—the USSR, China, and Manchukuo—we have no statistical evidence of change in the level of daily per capita wheat-calorie disappearance.[26] For four other countries—Portugal, India, Ceylon, and Nigeria—the statistical data indicate that no change has occurred. But in all the other 45 countries, change of larger or smaller magnitude, in one direction or the other, is suggested. The largest increase was in Bulgaria, where daily per capita wheat-flour disappearance increased 3.8 ounces (384 calories). The largest reduction, amounting to 2.2 ounces or 224 calories, was in Morocco.

[26] Since wheat production in the USSR has risen much more than rye production in the past decade or more, and probably faster than population, it may reasonably be inferred that per capita wheat-flour disappearance has increased. Not even the probable direction of change is clear for China and Manchukuo on the basis of such meager statistical evidence as is available and seems trustworthy.

CHART 6.—AVERAGE LEVELS OF PER CAPITA DISAPPEARANCE OF WHEAT FLOUR IN 52 COUNTRIES, 1923–28 AND 1933–38*



* See Table I.

Viewed in relation to general levels of total food-calorie disappearance per capita, as suggested by data per adult male in Chart 3 (p. 51), only the larger changes in wheat-flour disappearance would suggest rather prominent alterations in national diets. Thus the approximate level of food-calorie disappearance in Bulgaria, for all that is known to the contrary, may have ranged between 2,500 and 2,900 calories per capita per day in both periods; and 384 calories of wheat flour would represent some 13–15 per cent of total food calories. The insertion into a national diet of a new foodstuff, or more of an old foodstuff,

providing as much as 13–15 per cent of the total food calories might well involve a change in diet readily perceptible to the population and possibly of significance to its nutrition. On the other hand, the effects of enlarging or reducing the disappearance of wheat by the amount of only 1 or 2 per cent of total calorie disappearance could hardly be perceived by the affected population, and might carry practically no nutritional significance. One per cent of total daily per capita food-calorie disappearance would be 20–30 calories, depending on the level of the total.

The smaller changes in daily per capita wheat-calorie disappearance, as shown in the chart, therefore seem too small to justify discussion. Moreover, the data are presumably too inaccurate to justify the belief that indicated small changes represent facts rather than statistical errors.[27] Accordingly, we somewhat arbitrarily exclude from further consideration all indicated changes of less than 40 wheat calories per capita per day. This excludes from discussion the changes in thirteen countries, of which six showed increases ranging up to 32 calories while seven showed reductions ranging up to 32 calories. There remain thirty-two countries in which the indicated changes appear sufficiently large to warrant analysis.

Before this discussion is begun, it should be emphasized that Chart 6 fails to suggest, at least with reference to the decade between 1925 and 1935, any prominent tendency toward equalization of national levels of per capita wheat-calorie disappearance. The extreme range from nation to nation was barely narrower in 1933–38 than in 1923–28, and it is easily seen that reductions and increases occurred alike from high, from intermediate, and from low levels between 1923–28 and 1933–38. The point need not be labored, because a decade is a short time for long-term dietary influences to make their effects apparent. Over a longer period in the future, at least if one could assume rising levels of general prosperity, a tendency toward equalization might appear more clearly (p. 42).

The following tabulation summarizes the larger changes that appear to have taken place[28] between 1923–28 and 1933–38 in wheat-calorie disappearance per capita per day:

ESTIMATED CHANGES IN DAILY PER CAPITA DISAPPEARANCE OF WHEAT FLOUR IN 32 COUNTRIES BETWEEN 1923–28 AND 1933–38*

Increases		Reductions	
Country	Calories	Country	Calories
Bulgaria	384	Morocco	224
Lithuania	256	Italy	144
Latvia	208	Algeria	128
Hungary	192	Egypt	128
Yugoslavia	176	Czechoslovakia	128
Greece	176	France	128
Tunis	128	Cuba	128
Norway	112	Germany	109
Estonia	112	Austria	96
Finland	80	United States	96
Poland	80	United Kingdom	72
Uruguay	65	Australia	64
Chile	64	New Zealand	64
Peru	48	Belgium	64
		Rumania	64
		Mexico	61
		Denmark	48
		South Africa	48

* Basic data from Appendix Table I.

Geographically, the increases apparently exceeding 40 calories per capita per day were mostly in northern and eastern Europe and South America. Reductions occurred mostly in western and central Europe, northern Africa, North and Central America, and Australasia. There were no changes as large as 40 calories per capita per day in Asia.

Three principal separate but interrelated questions may be asked in analysis of these substantial changes, both upward and downward. (1) Do changes represent improvement or deterioration of diets? (2) What foodstuffs may have displaced wheat or been displaced by wheat, if displacement occurred? (3) What may have been the principal causes of change

[27] Errors may arise from many sources—estimates of crops, of stocks, of trade, of seed and feed use, and of flour yield from wheat ground.

[28] Some of these changes may well be purely statistical in part, because of changes in official methods of estimating wheat crops and for other reasons. Our method of converting wheat to flour at a constant extraction rate for each country where we have no flour-production statistics might, for example, result in statistical overstatement of an increase in per capita disappearance of flour if in fact the extraction rate of mills had been lowered, or in understatement of increase if the extraction rate had risen.

in the quantity of wheat-flour disappearance per capita per day? The additional problem of explaining why some increases or reductions were larger than others is not examined.

CHANGES OF BRITISH-AMERICAN TYPE

It was stated earlier that explanation of changes in per capita disappearance of wheat flour between 1923–28 and 1933–38 must consist largely of conjecture unless quantitative information is available concerning concurrent changes (*a*) in total calorie disappearance, (*b*) in disappearance of calories derived respectively from all cereals and potatoes, and other foods as a group, and (*c*) in disappearance of nonwheat components of the cereal-potato fraction of national diets. Such information is scanty. It can, however, be obtained in a form more or less useful for the United States, Great Britain, Germany, and Hungary.[29]

The American study suggests (1) a small reduction in total food-calorie disappearance per capita, (2) small reductions in both cereal-potato and non–cereal-potato calories, and (3) a small increase in the *proportion* of total calories derived from non–cereal-potato sources, with a small reduction in the proportion derived from cereals and potatoes. On the assumption that decline of total food calories was in reflection of reduced outlay of physical labor, these changes mean improvement in the composition of the diet. This is the more apparent because the change in non–cereal-potato calories came not in sugars, fats ex-butter, or meats, but in vegetables, fruits, and dairy products.[30] The contribution of expensive protective foodstuffs rose relatively, and the contribution of the cheap starchy foodstuffs fell both relatively and absolutely.

The absolute and relative decline in calories derived from cereals and potatoes fell mainly upon wheat, perhaps because wheat was the dominant foodstuff of the cereal-potato family before the decline took place.

The British study, on the other hand, suggests a slight rise in total food-calorie disappearance per capita. Practically all of this increase occurred in the non–cereal-potato fraction of the diet; but here increase came not only in fruits, vegetables, and dairy products but in lesser degree in sugar and meats as well. There was decline in the fraction of the diet contributed by cereals and potatoes; and this decline fell mainly on wheat probably because here also wheat was the dominant foodstuff of the cereal-potato family before the decline took place.[31]

Thus in both Great Britain and the United States the decade between approximately 1925 and 1935 witnessed improvement in composition of the national diets. Wheat disappearance declined because wheat, the dominant cereal-potato foodstuff, was tending to be "squeezed out" by more expensive foods. This development must somehow have been associated with the relationships between food prices and consumers' incomes or between the prices of different foods, or with a level of consumers' real income continuing high in relation to most other countries and so giving scope for persistence of long-evident trend

[29] The American inquiry is by Cavin, *op. cit.* Mr. Cavin has kindly provided further details on an annual basis. The British study is by Orr, *op. cit.;* the German is by von der Decken, *op. cit.;* the Hungarian is by Ungarisches Institut für Wirtschaftsforschung, *op. cit.*

[30] Data in pounds per capita per year, partly as drawn from details furnished direct by the United States Department of Agriculture, are as follows:

Foodstuffs	1923–28	1933–38
Cereals and potatoes	225	196
Wheat flour	176	154
Other foodstuffs	1,475	1,493
Fruits and vegetables[a]	357	389
Dairy products[b]	802	807
Sugars	116	110
Meats and fats[c]	200	187

[a] Excluding potatoes. [b] As whole milk.
[c] Excluding butter; lean meat, including poultry and eggs.

[31] Pertinent data, in pounds per capita per year, from Orr's investigation (*op. cit.*, p. 18), are as follows:

Foodstuffs	1924–28	1934
Wheat flour and potatoes	392	407
Wheat flour[a]	198	197
Other foodstuffs	427	493
Fruits and vegetables[b]	169	213
Butter and cheese	25	35
Sugars	87	94
Meats and fats[c]	146	151

[a] Our own calculations indicate a larger reduction.
[b] Excluding potatoes.
[c] Excluding butter; "meat" and "margarine" only.

toward increased diversification and cost of diet, reasonably to be interpreted as improved human nutrition. The mechanism whereby composition of diet improved from a period of prosperity to a period of depression is by no means clear.

It seems reasonable to interpret similarly the indicated reductions in per capita wheat-flour disappearance in Australia, New Zealand, France,[32] and Belgium. In all of these countries (in addition to the United States and the United Kingdom), the dominant cereal-potato foodstuff has probably yielded ground because of pressure from more expensive foodstuffs in the non–cereal-potato group. The reduction of per capita wheat-flour disappearance represents improvement in composition of the diet.

Changes of German Type

Von der Decken's data bearing on changes in the German diet from 1924 to 1936 suggest that, as in Great Britain, the salient features were slight increase in total food calories per capita per day, absolute and relative increase in calories derived from non–cereal-potato foodstuffs, and absolute and relative decline in calories derived from the family of cereals and potatoes and in calories derived from wheat. Improvement in composition of the diet is indicated in Germany also.[33]

[32] Of France, however, it must be said that indicated reduction of per capita wheat-flour disappearance between 1923–28 and 1933–38 may in part represent statistical error. French crop statistics, upon which our estimates of wheat-flour disappearance rest heavily, have been appraised on a lower basis since 1936 than was true in earlier years.

[33] Pertinent data from von der Decken's study (*op. cit.*, pp. 22–23), in pounds per capita per year, are as follows:

Foodstuffs	1924–26	1934–35
Wheat, rye, potatoes	683	647
Wheat flour	119	110
Rye flour	127	119
Other foodstuffs	1,102	1,248
Fruits and vegetables[a]	201	209
Dairy products[b]	711	809
Sugars	42	48
Meats and fats[c]	148	182

[a] Excluding potatoes.
[b] Including butter.
[c] Excluding butter.

[34] See Bennett, *op. cit.*, pp. 382–83.

But in Germany, the pressure toward enlarged use of non–cereal-potato foodstuffs fell less directly upon wheat than in countries of British-American type. In Germany wheat was a less important constituent of the cereal-potato fraction of the diet than rye, but (in calories) a more important constituent than potatoes. Rye declined less in consumption than either wheat or potatoes, although under these circumstances one might reasonably suppose that the cheaper cereal, rye, and potatoes as well, would have lost more ground than the dearer cereal, wheat. Indeed, it would not be unreasonable to suppose—unless there is a large degree of preference for rye—that per capita wheat disappearance might even rise, with the decline in cereal-potato disappearance falling mainly upon rye and potatoes. In fact, however, wheat seems to have lost more ground. This may be explained mainly by the drive toward self-sufficiency during the decade following 1928, in which governmental measures discouraged domestic disappearance of wheat especially as against rye. Wheat was imported while rye was frequently exported. Wheat was therefore easier to "protect" against international and domestic price decline, and was in fact kept dear.

Other countries where dietary developments probably resembled those in Germany are Denmark, Austria, and Czechoslovakia. In these countries per capita wheat-flour disappearance declined between 1923–28 and 1933–38, while composition of the diet probably improved. Here also the pressure to expand non–cereal-potato foodstuffs while contracting cereal-potato foodstuffs might, in the absence of strong protectionist measures applied to wheat, have fallen less or not at all upon wheat, and more upon the competing bread grain, rye, or on potatoes. In Denmark, however, it seems possible that wheat-protectionist measures may have contributed less strongly to decline of wheat-flour disappearance, and that the decline was more of the British-American type.[34]

Income status and composition of diet (see table, p. 61) appear to be much the same in Norway and Finland as in Germany, Austria, Czechoslovakia, and Denmark. Yet per capita disappearance of wheat flour rose between

1923–28 and 1933–38 in Norway and Finland while it fell in the other four countries. Evidence is lacking as to change in composition of the Norwegian and Finnish diets; but it would seem reasonable to suppose that here, as in Germany, calories derived from cereals and potatoes declined while calories derived from non–cereal-potato foodstuffs increased. If so, one may hazard the guess that pressure to expand the non–cereal-potato fraction of the diet at the expense of the cereal-potato fraction fell on rye and/or potatoes—presumably on rye—and not on wheat, the disappearance of which increased. Why this should have occurred in spite of the protectionist measures applied to wheat in Norway and Finland is not clear. Conceivably, consumers' incomes were better maintained than in the other four countries, permitting displacement of rye and potatoes by wheat. Or perhaps protectionist measures affected wheat less extremely than in the other four countries.

Perhaps Italy also reflects dietary developments of the German type. Wheat-flour disappearance per capita declined substantially between 1923–28 and 1933–38; and vigorous protection of wheat accompanied by heavy curtailment of wheat imports occurred in Italy as in Germany. But specific quantitative evidence is lacking with regard either to change in total food-calorie disappearance, or to change in the cereal-potato and the non–cereal-potato fractions of the diet.

If total food calories and non–cereal-potato calories increased in Italy as in Germany, the inference might be that Italian cereal-potato calories yielded to pressure toward dietary improvement, with wheat yielding more than corn because of special protection of wheat. If on the other hand total food calories remained unchanged, non–cereal-potato calories declined, and cereal-potato calories increased, then there may have been deterioration of Italian diet, with increase of per capita corn disappearance more than offsetting decline of wheat disappearance. The latter interpretation seems the more credible. It reflects a development not suggested either in the European countries thus far considered, or in others in eastern Europe about to be considered.

Changes of Hungarian Type

The Hungarian investigation bearing on change in the national diet is less detailed than those pertaining to the United States, Great Britain, and Germany. It suggests (1) a large (perhaps incredibly large) increase in per capita disappearance of all food calories, and (2) an increase in both the cereal-potato and non–cereal-potato calories of the diet, with appreciably larger increase in the cereal-potato calories.[35] If this in fact occurred, there was clearly improvement of diet in the quantitative sense; and it seems credible that such improvement occurred. Shortage of food calories was certainly prevalent just after the World War, and may well have extended into the period 1923–28. At least up to 1927 or 1928 there was general and marked recovery of agriculture, which could hardly have failed to bring with it an increasingly ample supply of food calories for domestic use. On the other hand, the proportion of food calories derived from cereals and potatoes seems to have increased. This would suggest deterioration in quality of diet if the diet had earlier been adequate in the quantitative sense; but since it probably was not, the general dietary development in Hungary presumably represents improvement both quantitatively and qualitatively.

Thus in Hungary there was room for expansion of food-calorie disappearance generally, and for expansion both of cereal-potato and of non–cereal-potato calories. In the cereal-potato fraction of the diet, the increase seems to have come almost wholly in wheat, while calories derived from rye apparently declined. This presumably reflects consumer preference, aided by a larger degree of governmental encouragement of domestic production of wheat than of rye and perhaps also by

[35] According to the Ungarisches Institut für Wirtschaftsforschung, (*op. cit.*, p. 37), food-calorie "consumption" increased 13 per cent between the periods 1925–26 to 1927–29 and 1935–36 to 1937–38; and of this increase in food calories, over 70 per cent was in carbohydrate calories, of which wheat, rye, and potatoes furnished about 78 per cent both in 1928–29 and 1937–38. In the years 1928–29, 1932–33, and 1937–38, wheat furnished respectively 29, 33, and 36 per cent of all calories; rye, 15, 15, and 11 per cent; and potatoes 10, 8, and 10 per cent (data for other years are not given).

slow-moving improvement of the competitive position of wheat in Hungarian agriculture.

Much the same general dietary changes perhaps occurred almost throughout eastern Europe: enlargement of total food-calorie disappearance per capita, mainly in the cereal-potato fraction of the diet and more in wheat than in the other food grains and potatoes of that fraction. The increases of wheat-calorie disappearance in Lithuania, Latvia, Estonia, Poland, Yugoslavia, Bulgaria, and Greece (see tabulation, p. 66) all seem explicable in terms of Hungarian developments.[36] In the last three of these countries, the cereal displaced by wheat—if absolute rather than relative displacement occurred—was presumably corn rather than rye (see table, p. 61).

Rumania seems exceptional among these eastern European countries, for here wheat-calorie disappearance declined. Yet one may suppose that the broader changes in diet were similar to those in Hungary, at least to the extent of increase in total food calories per capita and in calories from cereals and potatoes.[37] Whether or not non–cereal-potato calories also increased is conjectural. In any event, corn disappearance seems to have increased substantially while wheat disappearance declined slightly. Possibly this reflects no fundamental trend, but merely the accident of exceptional predominance of relatively low yields per acre of wheat in the later period. Perhaps, on the other hand, the competitive position of corn in Rumanian agriculture has improved. This is suggested by official statistics of acreage changes from 1923–27 to 1933–37, which show that total acreage of food cereals (wheat, corn, rye) and potatoes increased some 20 per cent, and that over three-fourths of the increase was in acreage of corn and only one-eighth in acreage of wheat. In all other eastern European countries, increase of wheat acreage constituted a much larger fraction of the increase in acreage of food grains and potatoes—nowhere less than a third, as in Poland.

Other Changes

Of the 32 countries in which estimated changes in per capita wheat-flour disappearance between 1923–28 and 1933–38 seemed to suggest alterations of diet large enough to be significant, 10 remain to be considered. The estimated changes in calories per capita derived from wheat in these countries, all non-European, were as follows:

Increases		Reductions	
Country	Calories	Country	Calories
Tunis	128	Morocco	224
Uruguay	65	Algeria	128
Chile	64	Egypt	128
Peru	48	Cuba	128
		Mexico	61
		South Africa	48

For none of these countries do we have statistical evidence concerning probable change in per capita disappearance of total food calories, cereal-potato calories, or non–cereal-potato calories. Yet one point may be made: none of these countries was so deeply engaged in the first World War that general agricultural recovery accompanied by substantial rise in per capita disappearance of total food calories, as in eastern Europe, can reasonably be supposed to have occurred. Moreover, all are predominantly agricultural countries and most have suffered economically in greater or lesser

[36] It must be said, however, that the statistical evidence concerning even wheat-flour disappearance rests upon a rather shaky foundation in several of these countries. The wheat-production statistics basic in estimates of wheat-flour disappearance, and indeed general statistics of agricultural output, show remarkably large increases between 1923–27 and 1933–37. Acreages of the principal cereal crops combined increased 15 per cent or more. Increase of cereal-potato acreage in Greece is indicated as 60 per cent, an incredibly high figure that throws doubt upon our calculations of change in per capita wheat-flour disappearance in Greece.

[37] See Roman Cressin, "Notă Asupra Consumului Probabil de Grâu, Secară şi Porumb în România, în Anii 1921–1938," *Conjunctura Economiei Româneşti* (Bucarest), November–December 1939, pp. 14–15. Annual average domestic utilization of wheat, rye, and corn (seed deducted, but including feed use that is fairly important for corn) is given as follows, in kilograms per capita of grain:

Grain	1923–28	1933–38
Wheat	115	105
Rye	9	13
Corn	315	339
Total	439	457

degree from the relatively lower purchasing power of their agricultural exports in recent years than in the years preceding 1929. It therefore seems unlikely that increase in the non–cereal-potato fraction of the diet can have been appreciable in any country of this group.

Reasonably satisfactory explanations can be found for declines of per capita wheat-flour disappearance in four countries that have normally been net importers of wheat — Egypt, Cuba, Mexico, and South Africa. Here the depressed economic and stringent financial position broadly characteristic of 1933–38 led to effective restraints upon wheat imports, and resulting decline of imports not fully offset by enlargement of domestic output. Consumers were presumably impelled to displace wheat flour with cheaper cereal products—in Egypt, probably rice and possibly corn; in Mexico and South Africa, corn. What substitutions may have occurred in Cuba seem even more conjectural, in the absence of information concerning domestic production of grains and potatoes.

Developments in Morocco and Algeria also seem comprehensible. Wheat disappearance declined while disappearance of barley and in lesser degree rice (in Morocco, perhaps corn more than rice) appears to have increased. The wheat-protectionist policy of France apparently provided a remunerative market for the wheat exports of these two grain-exporting countries, and so much so that farmers there found financial advantage in expanding wheat exports more rapidly than wheat production while contracting wheat consumption and substituting the cheaper cereals for wheat. French policy in the 1930's also involved absorption of rice surpluses of French Indo-China by other French colonies and the mother country.

Since Tunis also had access to the protected French wheat market, one would expect to find dietary changes there similar to those in Algeria and Morocco. Yet in Tunis the disappearance of wheat flour increased. Moreover, so far as we can judge, disappearance of barley, the principal dietary competitor of wheat, increased also. This suggests the possibility of substantial increase in per capita disappearance of total food calories and of cereal-potato calories generally, as in eastern Europe. The facts remain unclear. But yields per acre of wheat and barley in Tunis averaged so low in the period 1923–28 that there may then have been an exceptional degree of food shortage. Fluctuations in total food calories and cereal-potato calories may reasonably be supposed to occur in response to changes in domestic cereal production in countries of low levels of living. If 1923–28 was in fact a period of low cereal yield per acre and low per capita food disappearance, a higher level of wheat calories, cereal-potato calories, and total food calories per capita in 1933–38 would be credible.

The indicated increases of per capita wheat-flour disappearance in Uruguay, Chile, and Peru are small, and rest on somewhat insecure evidence. Our impression is that the changes, if real, may reflect accidental successions of crop yields rather than persistent change in composition of diets. But we know so little about food habits and trends in these countries that no explanation of the apparent increase in per capita wheat-flour disappearance can be more than conjectural.

Effects of War

Major disturbances of economic life such as accompany and follow warfare on a large scale must be expected to alter the position of wheat flour in national diets, temporarily or indefinitely, in large degree or in small. War disrupts both trade and domestic agriculture, and forces adaptations of national diets.

During the World War of 1914–18, total utilization of wheat grain in a "world" composed of Europe ex-Russia, northern Africa, and the five major overseas exporting countries fell in 1917–18, the war year of greatest shortage, to a level some 17 per cent below the prewar peak in 1913–14. In the overseas exporting countries, remote from the scene of warfare, the corresponding decline was much smaller; but decline occurred, largely in reflection of extreme shortage in the importing area of the world without abundance in the exporting area. The decline of wheat utilization in Europe and northern Africa together between 1913–14 and 1917–18 was nearly 25 per cent. It was still greater in the European

countries most deeply involved in warfare and shut off from overseas imports of wheat; in Germany and Austria-Hungary together, the decline may have reached nearly 50 per cent.[38] Under stress of shortage, wheat utilization probably always declines more than utilization of wheat flour, partly because shortage curtails feed use of wheat but partly because extraction rates are raised so as to yield more flour per unit of wheat. Nevertheless decline of per capita wheat-flour utilization must have been heavy in many countries. In most of these there was reversion to higher levels after the war, though often not to prewar status; and recovery was most uneven in degree and in timing.

The history of dietary changes between 1913–14 and 1928–29, including the changes in the position of wheat flour, has never been set forth adequately and may never be. The historical background for appraising probable changes in the dietary position of wheat during and after the present war is therefore meager and unsatisfactory. Without foreknowledge of the character and duration of the present war, the basis for appraisal is more slender still. Presumably, however, changes in the per capita level of wheat-flour disappearance will be less prominent in the overseas exporting countries than in Europe. There, reductions of large magnitude have already occurred in the war years 1939–40 and 1940–41 as compared with immediately preceding years,[39] though no shortage as severe as that of 1917–18 has yet emerged. Further changes may be expected whether the war ends soon or continues long; but their probable extent and geographical location seem highly conjectural at present.

[38] Based on discussion in M. K. Bennett, "Wheat and War, 1914–18 and Now," WHEAT STUDIES, November 1939, XVI, 76.

[39] See "Review" and "Survey and Outlook" numbers of WHEAT STUDIES since 1940.

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APPENDIX TABLE

TABLE I.—APPROXIMATE COMPOSITION OF NATIONAL DIETS OF 52 COUNTRIES, TYPICALLY 1933–38*

Country	Wheat-flour disappearance[a]† (*calories per day*)			Cereal-potato calories as percentage of total[b]		Calories per adult male per day (1933–38)[c]			Population (*millions, 1935*)[d]		
	Per capita		Per adult male	Indicated	Probable range	All foods	Cereals and potatoes	Other foods	Persons	Adult-male equivalent	
	1933–38	1923–28	1933–38							(*millions*)	(*per cent*)
Bulgaria	1,328	944	1,768	70, 77	70–80	3,800	2,850	950	6.2	4.7	75.1
Eire	1,264	1,248	1,621	57	50–60	3,800	2,090	1,710	3.0	2.3	78.0
France	1,216	1,344	1,537	61	50–60	3,800	2,090	1,710	41.9	33.1	79.1
Italy	1,184	1,328	1,544	65	60–70	3,600	2,340	1,260	42.3	32.4	76.7
Hungary	1,104	912	1,425	51, 57	50–60	3,800	2,090	1,710	8.9	6.9	77.7
Chile	1,088	1,024	1,455	61	60–70	3,800	2,470	1,330	4.5	3.4	74.8
Argentina	1,056	1,024	1,399	50	50–60	3,800	2,090	1,710	12.4	9.4	75.5
Greece	1,040	864	1,363	..	60–70[e]	3,600	2,340	1,260	6.8	5.2	76.3
Spain	1,040	1,072	1,354	..	60–70[e]	3,600	2,340	1,260	24.8	19.0	76.8
Belgium	960	1,024	1,194	52, 57	50–60	3,800	2,090	1,710	8.3	6.7	80.4
Uruguay	945	880	1,260	..	50–60[e]	3,600	2,340	1,260	2.0	1.5	75.0[e]
USSR	916	...	1,233	85	80–90	3,800	3,230	570	173.0	128.5	74.3
Yugoslavia	912	736	1,224	..	70–80[e]	3,800	2,850	950	15.0	11.2	74.5
United Kingdom	872	944	1,093	36	30–40	4,000	1,400	2,600	47.0	37.5	79.8
Netherlands	864	880	1,118	48	40–50	3,800	1,710	2,090	8.5	6.6	77.3
Australia	864	928	1,094	32, 37	30–40	4,000	1,400	2,600	6.8	5.4	79.0
Switzerland	864	880	1,087	36	30–40	3,800	1,330	2,470	4.2	3.3	79.5
New Zealand	800	864	1,005	30, 31	30–40	4,000	1,400	2,600	1.6	1.3	79.6
Rumania	752	816	1,009	85	80–90	3,800	3,230	570	19.2	14.3	74.5
Canada	752	784	969	34	30–40	4,000	1,400	2,600	11.0	8.5	77.6
Czechoslovakia	672	800	860	51	50–60	3,800	2,090	1,710	15.2	11.9	78.1
United States	672	768	857	34	30–40	4,000	1,400	2,600	128.0	100.4	78.4
Austria	624	720	779	39	40–50	3,800	1,710	2,090	6.8	5.4	80.1
Tunis	592	464	800	..	70–80[e]	3,600	2,700	900	2.6	1.9	74.0[e]
Lithuania	544	288	704	..	60–70[e]	3,800	2,470	1,330	2.5	1.9	77.3
Latvia	544	336	689	..	50–60[e]	3,800	2,090	1,710	2.0	1.6	78.9
Norway	528	416	673	41	40–50	3,800	1,710	2,090	2.9	2.3	78.4
Algeria	512	640	692	69	70–80	3,600	2,700	900	7.2	5.3	74.0[e]
Egypt	512	640	692	75	70–80	3,600	2,700	900	15.5	11.5	74.0
Morocco	496	720	670	..	70–80[e]	3,600	2,700	900	6.3	4.7	74.0[e]
Portugal	464	464	608	..	60–70[e]	3,600	2,340	1,260	7.2	5.5	76.3
Sweden	464	448	581	33	30–40	3,800	1,330	2,470	6.3	5.0	79.8
Denmark	448	496	564	40, 42	40–50	3,800	1,710	2,090	3.7	2.9	79.5
Poland	432	352	573	70, 73	70–80	3,800	2,850	950	33.8	25.5	75.4
Germany	403	512	504	46, 46	40–50	3,800	1,710	2,090	67.1	53.7	80.0
Finland	384	304	493	45	40–50	3,800	1,710	2,090	3.6	2.8	77.9
Estonia	384	272	482	58	50–60	3,800	2,090	1,710	1.1	.9	79.6
China	365	...	493	87	80–90	3,200	2,720	480	415.0	307.1	74.0[e]
Manchukuo	288	...	389	..	80–90[e]	3,200	2,720	480	35.0	25.9	74.0[e]
South Africa	288	336	389	..	60–70[e]	3,800	2,470	1,330	9.5	7.0	74.0[e]
Cuba	208	336	281	..	60–70[e]	3,600	2,340	1,260	4.3	3.2	73.9
Brazil	192	176	263	..	60–70[e]	3,600	2,340	1,260	41.6	30.4	73.1
India	176	176	238	80	80–90	3,200	2,720	480	370.5	274.2	74.0
Peru	176	128	235	..	60–70[e]	3,600	2,340	1,260	6.9	5.2	75.0[e]
Japan	112	144	150	79	70–80	3,200	2,400	800	69.5	52.0	74.8
Mexico	109	160	152	60	60–70	3,600	2,340	1,260	18.8	13.5	71.6
Philippines	64	48	89	85	80–90	2,800	2,380	420	13.3	9.6	72.0
Ceylon	32	32	43	..	80–90	2,800	2,380	420	5.7	4.3	74.8
Java	11	8	15	82	80–90	2,800	2,380	420	44.9	33.5	74.5[e]
French Indo-China	8	32	11	..	80–90[e]	2,800	2,380	420	22.9	16.9	74.0[e]
Madagascar	8	6	11	..	80–90[e]	3,200	2,720	480	3.8	2.8	74.0[e]
Nigeria	+0	+0	+0	..	80–90[e]	3,800	3,230	570	19.1	14.1	74.0[e]

* All estimates expressed in calories refer to physiologically available "large" calories (footnote 6, p. 43), and to disappearance rather than to consumption or ingestion (see text, p. 45).

† See footnotes *a–e* on pp. 74–75.

[a] Wheat-flour disappearance per capita per day is estimated variously for different countries in 5 groups:

1. Estimates for 11 countries (Argentina, United Kingdom, Netherlands, Australia, New Zealand, Canada, United States, Sweden, Denmark, Germany, and South Africa) are based upon official statistics of wheat flour milled domestically in the five crop years 1933–38 or 1923–28, plus net flour imports in the case of net-importing countries, or minus net flour imports in the case of net-exporting countries. Fairly reliable estimates presumably result from the use of such basic data.

2. Estimates for seven tropical countries where little or no wheat is produced or milled domestically (Cuba, Philippines, Ceylon, Java, French Indo-China, Madagascar, and Nigeria) are based on net imports of wheat flour in the specified period. Such data, averaged for a five-year period, presumably yield reliable results.

3. Estimates for 26 countries (Bulgaria, Eire, France, Italy, Hungary, Greece, Spain, Belgium, Yugoslavia, Switzerland, Rumania, Czechoslovakia, Austria, Tunis, Lithuania, Latvia, Norway, Algeria, Egypt, Morocco, Portugal, Poland, Finland, Estonia, India, and Japan) are based fundamentally upon official estimates of domestic wheat (not flour) production, plus or minus net imports or net exports of wheat and flour expressed as wheat. In addition, however, we take account, through our own set of estimates, of (*a*) additions to or deductions from stocks of wheat and flour during the specified period; (*b*) quantities of wheat used for seed domestically, which are deducted from production plus imports or production minus exports; (*c*) quantities of wheat probably used for feed, roughly estimated and deducted as with seed; and (*d*) probable rate of extraction of flour from wheat in the milling process.

For a net-importing country, the full formula is thus typically: domestic wheat production plus net imports of wheat and flour as wheat; plus initial stocks and minus final stocks of wheat and flour as wheat; minus domestic seed use of wheat; minus domestic feed use of wheat. The totals, expressed in million bushels of wheat, are next converted to flour at assumed rates of extraction, which range in different countries from 71 to 85 per cent. The estimated annual average totals of flour disappearance in 60-pound units are then converted to pounds, divided by population to reach annual per capita estimates, divided by 365 to reach daily per capita estimates, and finally converted to calories at the rate of 1,600 calories per pound of flour.

4. Estimates for six other countries (Chile, Uruguay, Manchukuo, Brazil, Peru, and Mexico) rest on the same formula as was used for the 26 countries listed above, except that initial and final stocks are ignored. The basis for appraising feed use and flour-extraction rates in these six countries is most insecure. Consequently, the resulting estimates of per capita flour disappearance are probably less reliable for these six countries than for any others.

5. Estimates for the USSR and China are based upon surveys of food consumption in households, as reported in USSR Central Statistical Administration, *Statistical Handbook of USSR for 1928* [translated title] (Moscow, 1929) and J. L. Buck, *Land Utilization in China: Statistics* (Nanking, 1937). The Russian survey covered more than 30,000 families; the Chinese, nearly 3,000. Data for both countries do not apply strictly to the period 1933–38.

Data in column 3, wheat-flour disappearance per adult male per day, were calculated from the per capita data in column 1 by dividing by the percentage of adult-male equivalent to total population in column 11.

[b] Estimates of cereal-potato calories in national diets in column 4, as explained in the text (pp. 53–55), are as derived from statistical investigations of the composition of national diets, or of diets of groups of families within nations.

Data relating to family budgets and permitting the calculation of approximate ratios were found particularly in International Labour Office, *Workers' Nutrition and Social Policy* (Studies and Reports, Ser. B, No. 23, Geneva, 1936) and "An International Survey of Recent Family Living Studies: II. Food Expenditure and Consumption Habits," *International Labour Review* (International Labour Office, Geneva), June 1939, XXXIX, 814–46. The first source yielded ratios for Norway, Sweden, Finland, Austria, Czechoslovakia, Poland, Bulgaria, Mexico, and Brazil; the second, for Denmark, Estonia, Germany, Belgium, Netherlands, Switzerland, and Hungary. Pertinent family-budget statistics for other countries were found in the following sources: Chile—Carlo Dragoni and Et. Burnet, "L'alimentation populaire au Chili. Première enquête générale de 1935," *Revista Chilena de Higiene y Medicina Preventiva* (Santiago), October–December 1938, I, 407–611; Philippines—H. C. Lava, *Levels of Living in the Ilocos Region, Philippines* (unpublished Ph.D. thesis, Stanford University, Calif., 1939); China—Buck, *op. cit.; Statistical Handbook of USSR for 1928;* Australia—Australia, *Final Report of the Advisory Council on Nutrition Together with Appendices* (1938); New Zealand—Lillian B. Storms and E. Neige Todhunter, "The Adequacy of Some New Zealand Dietaries," *Journal of Home Economics* (Baltimore), November 1928, XX, 817–24.

Ratios derived from global analyses of national food intake were found in the following sources: United Kingdom—J. B. Orr, *Food, Health and Income* (London, 1936); France—Commission scientifique interalliée du ravitaillement, *Rapport général. Les ressources et les besoins alimentaires des pays alliés. Annexes au premier rapport* (Paris, October 1918), pp. 7–16; Germany—Hans von der Decken, *Entwicklung der Selbstversorgung Deutschlands mit landwirtschaftlichen Erzeugnissen (Berichte über Landwirtschaft,* N.F., Sonderheft 138, Berlin, 1938); Italy—*Proceedings of the International Congress for Studies on Population* (Rome, 1934), II; Belgium—Fernand Baudhuin, "L'alimentation de la Belgique. Les données du problème en cas de blocus," *Bulletin de l'Institut de recherches économiques* (Université catholique de Louvain, École des sciences politiques et sociales, Louvain), August 1939, X, 375–88; Hungary—Ungarisches Institut für Wirtschaftsforschung, "Angaben über Volksernährung," in *Daten über die Entwicklung der Ungarischen Volkswirtschaft, 1924/25–1937/38* (Sonderheft 15, Budapest, 1938), pp. 34–38, 48; United States—J. P. Cavin, "Consumption of Agricultural Products," *Agricultural Situation* (U.S. Dept. Agr., Bur. Agr. Econ.), January 1939, XXIII, 13–15; India—"India's Food Problem," *Economist* (London), Dec. 26, 1936, pp. 627–28; Japan—E. C. Grey, *The Food of Japan* (League of Nations, Health Organisation, C.H. 681, Geneva, May 1928); Java—A. M. P. A. Scheltema, *The Food Consumption of the Native Inhabitants of Java and Madura* (National Council for the Netherlands and the Netherlands Indies of the Institute of Pacific Relations, Batavia, 1936). In addition to these published studies, the writer had available statistical calculations concerning the food of Bulgaria (by Pavel Egoroff), Canada (by W. R. Stott), and Australia (by W. S. Richards).

Approximate ratios for Eire, Denmark, Poland, Rumania, Argentina, and New Zealand were calculated by accounting as carefully as possible for calories per capita derived from cereals and potatoes, and taking these as percentages of assumed levels of total food calories per capita.

Ratios pertaining to Algeria and Egypt are as derived from a tabulation by Edith Hawley, *Economics of Food Consumption* (New York, 1932), p. 123, and represent percentages of 3,000 calories per man per day supplied by cereals and potatoes.

The ratios used in this study, as explained on pp. 53–55 of the text, are the ranges in column 5.

[c] Total disappearance of food calories per adult male per day (column 6) are roughly approximated by methods described in the text (pp. 45–47).

Calories from cereals and potatoes per adult male per day (column 7) are calculated by applying to estimates of total calories in column 6 the mid-points of ranges (column 5) indicating probable proportion of cereal-potato calories to total food calories.

Calories from other foods (column 8) are derived by subtraction of estimated cereal-potato calories from estimated total calories.

The margin of error is presumably substantial in all estimates of total calories, cereal-potato calories, and other-food calories.

[a] Data on total population (column 9) are as given for 1935 in League of Nations, Economic Intelligence Service, *Statistical Year-Book, 1936/37*, 1937. II. A. 7 (Geneva, 1937). Estimates of adult-male equivalent (column 10) are derived by application of the percentages in column 11 to total populations in column 9.

The ratios of adult-male-equivalent populations to total populations were calculated on the bases (*a*) of age and sex distribution of total populations as given in the *Statistical Year-Book, 1936/37*, and (*b*) of approximate average food-calorie requirements of each age and sex group, when the adult-male requirement is taken as one unit. A sample calculation for the United States in 1930 is as follows:

Age group (*years*)	Actual population (*thousands*)		Food-requirement factor (*units*)		Actual population × factor (*thousand adult-male equivalents*)	
	Male	Female	Male	Female	Male	Female
0– 4....	5,806	5,638	.28		1,626	1,579
5– 9....	6,281	6,227	.52		3,318	3,238
10–14....	6,069	5,936	.78		4,734	4,630
15–59....	38,561	37,676	1.00	.80	38,561	30,141
Over 60....	5,320	5,161	.80		4,256	4,129
Total....	62,137	60,638			52,495	43,717

Multiplication of actual population in each age group by the food-requirement factor yields the adult-male equivalent of each age group. The sum of adult-male equivalents (52,495 + 43,717 = 96,212) taken as a percentage of the total population (62,137 + 60,638 = 122,775) yields the ratio 78.4, as for the United States in column 11.

[c] These estimates lack a specific statistical basis, and were reached by analogy with countries geographically contiguous and similar in economic and demographic characteristics to countries for which statistical information was available.

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