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THE NATION'S PROTEIN SUPPLY

Prepared by the
Committee on Milk, Meat and Legumes
W. C. ROSE, *Chairman*
D. B. JONES, W. J. MORSE, R. C. POLLOCK

August, 1942

REPORT
of the
FOOD AND NUTRITION BOARD
of the
NATIONAL RESEARCH COUNCIL
2101 Constitution Avenue
WASHINGTON, D. C.

THE NATION'S PROTEIN SUPPLY

For several months the Committee on Milk, Meat, and Legumes has been giving consideration to the available supply of protein suitable for use in human nutrition, and presents herewith a report of its findings.

It is generally recognized that most of the protein of the diet is derived from grains, meats, dairy products, poultry and eggs. However, if one is to undertake an evaluation, in terms of public nutrition, of the figures representing current production, *accurate* information concerning the contribution of different food groups to the average protein intake becomes imperative. Fortunately, data of this nature are recorded in the literature.

The role of foods as sources of protein is illustrated by the results of the detailed statistical study of the American dietary conducted a number of years ago by Raymond Pearl.¹ The average contribution of each group for the years 1911-12 to 1916-17 is reproduced in Table I. The figures are said to have been corrected for *inedible* refuse, and for losses due to storage, spoilage, and transportation.

It will be noted that, for the period in question, 36 per cent of the protein was obtained from grains, and 53.5 per cent from meats, dairy products, poultry and eggs. If one adds the contribution of legumes, which according to Pearl (p. 404) amounted to 1.9 per cent of the total, it becomes evident that 55.4 per cent of the protein consumed during the six-year period originated in the food groups with which this Committee is concerned. It is also evident that more than 91 per cent of the dietary

TABLE I

Consumption of Protein in Human Foods in the United States Arranged by Groups in Order of Magnitude

Group	Average for the Six Years, 1911-12 to 1916-17		
	Absolute consumption of protein (lbs.)	Percentage consumption	Cumulated per cent
Grains.....	2,902,088,700	36.01	36.01
Meats.....	2,125,877,985	26.38	62.39
Dairy products.....	1,642,248,720	20.38	82.77
Poultry and eggs.....	542,822,490	6.74	89.51
Vegetables.....	472,760,820	5.87	95.38
Fish.....	187,098,660	2.32	97.70
Oils and nuts.....	127,534,995	1.58	99.28
Fruits.....	55,047,825	0.69	99.97
Oleomargarine.....	1,847,790	0.02	99.99
Sugars.....	1,003,275	0.01	100.00
Total.....	8,058,331,260	100.00	

protein was derived from the first four groups in Pearl's table, plus legumes. The contribution of vegetables, fish, nuts, etc., was relatively small and almost negligible.

Other investigations have led to similar conclusions regarding the sources of protein. In Table II are reproduced the findings of Sherman ² in studies of the distribution of nutrients in 224 dietaries, and of Stiebeling and Phipard ³ in like analyses of the food intakes of employed wage earners and clerical workers in cities. Certain of the figures of Pearl are reproduced for comparative purposes.

TABLE II

Contribution of Dietary Protein by Different Food Groups

	<i>Pearl</i> Protein %	<i>Sherman</i> Protein %	<i>Stiebeling</i> Protein %	
Meats	26.38	35.34	31.8	(including poultry and
Dairy products .	20.38	11.87	17.7	fish)
Poultry and eggs	6.74	4.64	7.5	(eggs only)
Legumes	1.91	1.91*	3.0	(including nuts)
	<hr/>	<hr/>	<hr/>	
	55.41	53.76	60.0	
Grains	36.01	37.25	28.2	
	<hr/>	<hr/>	<hr/>	
	91.42	91.01	88.2	

* Not listed by Sherman; figure is that of Pearl.

It should be noted that the figure for meats in the Stiebeling and Phipard data includes poultry and fish, and that the figure for legumes includes nuts. If one corrects for the contribution of fish (2.32 per cent) and nuts (1.28 per cent) as found by Pearl, the total for the remaining high-protein foods becomes 54.5 per cent. This is in close agreement with the observations of the other two investigators. Thus, for the purposes of this report, it may be assumed with considerable assurance that 54 per cent of the protein in the average American diet is derived from meats, dairy products, poultry, eggs, and legumes, and that approximately one-third is obtained from grains. The latter figure is further substantiated by the fact that the average daily per capita consumption of flour is said to be 6.5 ounces, or 185 grams. This contains 20 to 23 grams of protein, which represents 30 per cent or more of the 70 grams generally regarded as a satisfactory intake for an adult man. In view of the surplus of grains in the United States at the present time, no reason exists for anticipating that these commodities will in the immediate future contribute *less* protein to the diet, and thereby throw a greater burden upon other foods. Therefore, the estimates outlined below are based upon the assumption that the intake of grain products will remain essentially constant.

In Tables III to VIII inclusive are presented the figures representing the calculated production of protein in the form of meats, eggs, milk,

poultry and legumes (exclusive of soybeans and peanuts) in continental United States during the year 1940.* Data for 1941 are not yet available, but are undoubtedly higher.

TABLE III
Meat Production—1940

	Pounds	Average Protein %*	Total Protein lbs.
Beef.....	7,216,000,000	12.25	883,960,000
Veal.....	961,000,000	12.25	117,722,500
Lamb and mutton.....	878,000,000	12.25	107,555,000
Pork (excl. lard).....	9,920,000,000	9	892,800,000
Edible by-products.....	692,000,000	17.8	123,176,000
Total protein content.....			2,125,213,500

* The protein percentages are based upon results obtained in actual meat packing practice. For beef, veal, lamb and mutton they may be calculated by assuming that 64.5% of the meat is "lean," of which 19% is protein.

TABLE IV
Egg Production—1940

	Number
Farm production only.....	38,879,000,000
Used for farm hatching.....	470,000,000
Available.....	38,409,000,000*
Average protein content—6 gm.	
Total protein content, lbs.—507,920,000	

* Obviously, this figure does not include the eggs produced by the small flocks in the yards of the urban residents. Data of this nature appear not to be available.

TABLE V
*Milk Production—1939***

	Pounds
On farms.....	108,558,000,000
Not on farms.....	2,826,000,000†
Total.....	111,384,000,000
Fed to calves.....	3,021,000,000
Available.....	108,363,000,000
Average protein content, %—3.2	
Total available protein, lbs.—3,467,616,000	

** Preliminary.

† Assumed to be same as 1930.

TABLE VI

Poultry Production—1940

Chickens produced on farms*.....	607,801,000
Average weight $\left(\frac{\text{Price per head} = 53.4 \text{ cents}}{\text{Price per lb.} = 13.3 \text{ cents}}\right)$, lbs.....	4.0
Total chicken production on farms, lbs.....	2,431,204,000
Edible part (estimated at 54%), lbs.....	1,312,850,000
Average protein content, %.....	21
Total available protein, lbs.....	275,698,000
Turkeys produced on farms*.....	33,052,000
Average weight $\left(\frac{\text{Price per head} = 2.33 \text{ dollars}}{\text{Price per lb.} = 15.4 \text{ cents}}\right)$, lbs.....	15
Total turkey production on farms, lbs.....	495,780,000
Edible part (estimated at 60%), lbs.....	297,468,000
Average protein content, %.....	20
Total available protein, lbs.....	59,493,000
Total protein from chickens and turkeys, lbs.—335,191,000	

* Chickens or turkeys sold, plus consumed in household of producers, plus or minus change in inventory.

TABLE VII

Production of Beans, Dry, Edible—1940

	Pounds*
Pea.....	427,600,000
Great Northern.....	176,800,000
Small White (California).....	65,100,000
White Marrow.....	10,100,000
Yelloweye.....	8,200,000
White Kidney.....	4,600,000
Red Kidney.....	63,700,000
Small Red.....	37,100,000
Cranberry.....	27,900,000
Pink.....	87,500,000
Pinto.....	296,100,000
Blackeye (California).....	115,400,000
Lima (California).....	129,000,000
Baby Lima (California).....	83,600,000
<hr/>	
Total (excluding seed beans).....	1,532,700,000
Average protein content, %—20	
Total protein, lbs.—306,540,000	

* Preliminary.

TABLE VIII
Production of Green Peas—1940

Unshelled for Market (excluding those not marketed), lbs.....	254,220,000	
Protein content, %.....	2.5	
Total protein, lbs.....		6,355,000
Shelled for processing, lbs.....	612,240,000	
Protein content, %.....	6.5	
Total protein, lbs.....		39,795,000
Total.....		46,150,000

Except in the case of milk, all of the protein listed in the preceding tables appears to be used as human food, or to be available for such use. Thus, the values for meat protein have been corrected for skeletal structures and "trimmings," and represent dressed products as delivered to the retailer. In like manner, the values for the protein of eggs, poultry, and legumes represent the *edible* parts only.

With milk the situation is not so simple. Obviously, large quantities of this food are used in the manufacture of butter, and much of the resulting skim milk (or buttermilk in the case of farm-churned butter) is fed to live stock, or even discarded (see page 8). Insofar as dry skim milk is produced, an excellent source of protein is made available. However, only part of this enters the human diet, and part is used as a component of animal feeds. Furthermore, a considerable portion of the skim milk is diverted to the preparation of commercial casein. During 1939 the dried casein manufactured in this country exceeded forty million pounds, or was equivalent to the protein content of more than one billion pounds of fluid milk.

Instead of attempting to correct the total available supply of milk protein by inaccurate estimates of the quantities which are employed for non-dietary purposes, a more trustworthy procedure seemed to be to limit consideration (1) to those products which appear to be manufactured exclusively as foods for man, and (2) to milk consumed in the fluid state. Such data are presented in Table IX. It is to be noted that the figures in the second column are expressed in terms of milk equivalents. However, not all of the protein represented by the milk equivalents is present in the finished products. This is made clear by the footnotes to Table IX.

TABLE IX

Estimated Supply of Milk Protein Suitable for Human Use—1939

	Milk Equivalent* Pounds	Protein** Pounds
As fluid milk and cream.....	45,500,000,000	1,092,000,000†
As manufactured products:		
Cheese.....	7,030,000,000	161,690,000††
Evaporated milk.....	5,012,000,000	160,384,000
Sweetened condensed milk.....	198,000,000	6,336,000
Dried whole milk.....	192,000,000	6,144,000
Malted milk.....	52,000,000	1,664,000
Ice cream.....	3,636,000,000	47,962,000‡
Defatted dry milk solids.....	2,992,000,000	95,744,000††
Defatted condensed milk.....	1,158,000,000	37,056,000
Defatted milk cheese.....	981,000,000	22,563,000††
Defatted milk drinks (cultured and chocolate).....	2,000,000,000	64,000,000
Total protein.....		1,695,543,000

* The milk equivalents are taken from the "Statistical Flow-Sheet of Milk, 1939," issued by the Bureau of Dairy Industry, U. S. Department of Agriculture, Washington. The Committee is deeply indebted to Mr. Roud McCann, Director of the American Dry Milk Institute, Inc., Chicago, for invaluable assistance and advice in assembling the data in this table.

** Unless otherwise stated, the values in this column are based upon the assumption that whole milk contains 3.2 per cent of protein. Probably 3.4 per cent represents a closer approach to the true protein content. The lower figure was used in order to allow for the inevitable mechanical and operating losses in the dairy industry.

† In arriving at this figure it was assumed that 25 per cent of the milk is used in the production of cream, or is otherwise lost as a source of protein for the human diet.

†† Cheese whey is said to contain an average protein content of 0.885 per cent (*cf.* Associates of L. A. Rogers, "Fundamentals of Dairy Science," 1935, Reinhold Publishing Corporation, New York). Thus, in calculating the protein in the form of cheese the milk equivalent was assumed to contain 3.2 minus 0.9 or 2.3 per cent of protein.

‡ This figure is based on ice cream with an overrun of 100 per cent, weighing 4.5 pounds to the gallon, and containing 3.5 per cent of protein. According to "Agricultural Statistics, 1941" the ice cream production during 1939 amounted to 304,522,000 gallons. Inasmuch as part of the protein in ice cream is derived from dry and condensed milk, some duplication may exist between this figure and others in the table. Significant duplication appears unlikely in view of the conservative protein percentage employed in the calculations, the allowance for losses in fluid milk and cream, and the fact that so-called "ice milk," of which more than 13 million gallons were manufactured in 1939, has not been included as a source of protein.

†† This represents the protein which entered the human diet in the form of defatted dry milk solids, or was available for this purpose. It does not include the dry skim milk manufactured for animal feeds.

Tables III, IV, and VI to IX inclusive are summarized in Table X.

TABLE X

Summary of Estimated Available Protein

	Pounds*
Meats.....	2,125,000,000
Eggs.....	507,000,000
Milk.....	1,695,000,000
Poultry.....	335,000,000
Beans.....	306,000,000
Peas.....	46,000,000
Total.....	5,014,000,000

* Figures have been rounded downward.

The latter shows that the 1940 production of protein (1939 value in the case of milk) in the foods specified exceeded 5,000,000,000 pounds.

Attention was next directed to the per capita protein requirement. In order to arrive at this value, the "Recommended Daily Allowances"⁵ of protein for different age and sex groups, as proposed by the Food and Nutrition Board, were correlated with the corresponding age and sex groups of the entire population as estimated by the Bureau of the Census. The calculation showed that to meet the standards of the Board the average daily per capita *intake* of protein should be 66 gm. But provision also must be made for *edible* wastage. The extent to which this occurs is debatable. Pearl¹ assumed an edible wastage of 5 per cent. In order to be conservative, the Committee has arbitrarily assigned 10 per cent for this purpose. Thus, it is presupposed that an allotment of 73 gm. of protein per capita daily would be sufficient to insure the actual ingestion of 66 gm. Of this 73 gm., 54 per cent, or approximately 40 gm., ordinarily would be derived from meats, milk, eggs and legumes (cf. Table II). This would amount to 32 pounds per capita annually. On this basis, the protein represented by the estimates in Table X is sufficient to meet the needs of more than 156,000,000 people. Even if one makes the improbable assumption that each individual in the military forces requires an intake of 150 gm. of protein daily, plus 15 gm. for edible wastage, and that 60 per cent of this should be derived from the high-protein foods, sufficient protein would have been available in 1940 to have fed an army of 7,000,000 and a civilian population of 139,000,000 individuals.

It is apparent that the American people are in no immediate danger of experiencing a deficiency in the protein supply. It is equally evident that should this country be called upon to export a very considerable proportion of its high-protein foods, a protein shortage might occur unless in the meantime appropriate measures are taken to prevent it. In order to meet this contingency, governmental agencies are encouraging an increased production of the food groups with which this study is concerned. The production goals for 1942 are listed in Table XI. They show an expected increase in protein of 17 per cent over the 1940 figure. If these goals are attained, the resulting protein will be adequate for 183,000,000 people. The present estimated population of the United States is 134,000,000. Thus, it appears that sufficient high-protein foods could be exported during the current year to meet the requirements of at least 45,000,000 people without creating a shortage of protein in this country. In terms of commodities, 1 billion pounds of beef, 1 billion pounds of pork, 1 billion dozen eggs, 500 million pounds of dry whole milk, and 500 million pounds of dry beans could be furnished to our allies, and still leave a larger supply of protein than was available in 1940. It should be emphasized, however, that *this optimistic outlook is predicated upon the assumption that the 1942 production goals will actually be reached.*

TABLE XI
*1942 Production Goals**

		Total Protein lbs.
Beef, lbs.	8,300,000,000	1,016,000,000
Veal, lbs.	1,050,000,000	128,000,000
Lamb and mutton, lbs.....	950,000,000	116,000,000
Pork (excl. lard), lbs.....	11,125,000,000	1,001,000,000
Edible by-products, lbs.....	770,000,000	137,000,000
Eggs, no.	49,900,000,000	658,000,000
Milk, lbs.	125,000,000,000	1,960,000,000**
Chickens, lbs.	2,576,000,000†	292,000,000
Turkeys, lbs.	536,000,000†	64,000,000
Beans, dry, edible, lbs.....	2,145,000,000††	429,000,000
Green peas, lbs.....	918,000,000‡	66,000,000
Total, lbs.		5,867,000,000

* Except for the meats, the figures in this table are based upon revised goals of the U. S. Department of Agriculture announced by Secretary Claude R. Wickard in an official press release under date of January 16, 1942. The production figures for meats were furnished by the National Live Stock and Meat Board, Chicago.

** This value is based upon the assumption that approximately 49 per cent of the milk protein will find its way into the human diet as appears to have been the case in 1940.

† Gross weight, assuming the same average weight of the birds as in 1940.

†† 140 per cent of the 1940 production.

‡ The goal was established for the *processed* peas only. This is 150 per cent of the 1940 production, and is represented by the figure in the second column. The protein estimate assumes the same production of *non-processed* peas as in 1940.

While a protein shortage certainly is not imminent, this fact does not exclude the possibility that it may occur at the expiration of the war. Then the United States and Great Britain may be called upon to feed a large part of continental Europe. The demand for high-protein foods, of the sort to which we and the British are accustomed, may exceed the production facilities of the two countries, particularly during the critical period of economic readjustment immediately following the cessation of hostilities. In order to anticipate this eventuality attention should be given to the following measures.

(1) The conservation of the skim milk resources of the country, and the introduction of dry skim milk as a household article of food. Doubtless the attainment of such an objective would involve the institution of an educational program, and certainly would necessitate the packaging of the product in a form and size suitable for distribution by the grocer. The skim milk supply represents an extraordinarily abundant source of high quality protein, which at the present time is largely being squandered. The "Statistical Flow-Sheet" issued by the Bureau of Dairy Industry shows that less than 8 per cent of the skim milk produced during 1939 was converted into the dry state. An additional 9.5 per cent was processed and marketed in other forms. *More than 82 per cent remained on the farms and was used as animal feed.* This condition is chiefly responsible for the fact that less than half of the available milk protein finds its way into the human diet (*cf.* Tables V and IX).

Much of this protein should be salvaged. The Committee does not underestimate the difficulties involved in the collection of skim milk from small producers. Furthermore, it recognizes that some of this product is unfit for human consumption, and might better be used as cattle feed. Indeed, the use of liberal quantities for the latter purpose is highly desirable, and may even be necessary. Despite these obvious facts, one can scarcely condone the lavish waste of nutritious materials now occurring annually in the dairy industry. The full significance of this incredible situation is appreciated when one realizes that the milk protein remaining on the farms each year is equivalent to the protein content of 20 million beef steers.⁶

(2) The more extensive use of fish insofar as this is practicable while coastal waters are the scene of submarine warfare. According to Pearl,¹ fish accounted for only 2.3 per cent of the protein consumption during the years 1911-12 to 1916-17. This figure could be enlarged by appropriate propaganda should the necessity arise for conserving protein of other sources.

(3) The use of soybean products. It is generally recognized that the soybean is exceptionally rich in protein of high nutritive quality. Soybean flour and grits can be used advantageously in a large number of dishes. Their addition to soups, baked goods, and cereals not only improves the quality, but in most instances enhances the taste and texture. Admixture of soy grits with meat in the manufacture of sausage is said to diminish the shrinkage due to the loss of fat in cooking. This is not without significance in connection with the possible necessity of conserving dietary fat. Already, several very acceptable products containing meat and soybean flour or grits, in varying proportions, are being manufactured experimentally, or for shipment abroad.

(4) The use of peanut protein. A satisfactory peanut flour, rich in protein of good quality, is now being manufactured on a small scale, and could be produced in much larger amounts. Its addition to many articles of food is entirely feasible.

Other sources of protein are available in abundance, or could be rendered so should the need arise. Among these may be mentioned cotton-seed meal, yeast, and the germs of grains. In this connection it is of interest to note that a flour derived from defatted corn germ is now being manufactured for human dietary use. It contains in excess of 20 per cent of protein, is economical, and is said to possess excellent keeping properties.

Further information concerning the nutritive qualities of certain of these proteins, and the practicability of including them in the diet of man, will be furnished at a later date should circumstances seem to require it.

REFERENCES AND NOTES

¹Pearl, Raymond, "Studies in Human Biology," 1924, pp. 383-421, Williams and Wilkins Company, Baltimore.

²Sherman, H. C., "The Chemistry of Food and Nutrition," Sixth Edition, 1941, p. 510, Macmillan Company, New York.

³Stiebeling, H. K., and Phipard, E. F., U. S. Department of Agriculture, Circular No. 507, 1939.

⁴Except in the case of the edible by-products of meat, the production values for the commodities listed in Tables III to VIII are taken from "Agricultural Statistics, 1941," U. S. Department of Agriculture, Washington. The figure representing the production of edible by-products (Table III) was furnished by the National Live Stock and Meat Board, Chicago. All data are for 1940 except in the case of milk, in which they are for 1939. The protein percentages are based upon the best information the Committee has been able to find, and are believed to be conservative.

⁵It should be emphasized that these "Allowances" are not nutritional minima. On the contrary, each furnishes a liberal surplus over and above the quantity necessary for maintenance, and provides for considerable safety in the selection of foods to meet individual taste and purchasing power.

⁶This comparison was brought to the attention of the Committee by Mr. Roud McCann, Director of the American Dry Milk Institute, who attributes it to Dr. Ouida D. Abbott of the Department of Home Economics, University of Florida.

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