World Nutritional Determinants

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Optimum Nutrition through Better Planning of World Agriculture

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In this paper I will discuss four parameters related to improving worldwide nutrition: (1) the role of calories and nutrients; (2) the role of food choices in the development of degenerative diseases; (3) the limits of agriculture in providing calories and essential nutrients, and (4) the role of government in better planning of world agriculture.

[1] I would like to thank Ms. *Donna Stowe* for her secretarial and editorial assistance.

I. The Role of Calories and Nutrients

Conception of the Need for Calories

Although human milk is the first source of calories to which almost everyone is exposed, other sources are soon utilized in the diet of the individual. In the developed countries, a wide array of food items, from cereals to canned and frozen foods, are readily available to provide calories in optimum amounts. In many of the developing countries the mother is forced to use whatever is available to provide supplementary calories and hopefully enough essential nutrients to sustain life. The lack of success in the developing countries is shown by comparison of vital statistics among countries (table I). Health professionals in developing countries have lowered these infant mortality rates. However, it has been estimated that one quarter of the human population goes to bed hungry every night [*Crittenden,* 1982]. In a world in which all countries are becoming increasingly aware of the basic needs of their citizens, far too few governments assign sufficient resources for providing an adequate diet or for making available means for population control. The latter is highly important and basic to a solution. My discussion in this article, however, shall be limited to nutrition and food production. What can be done within the framework of present day knowledge of nutrition?

Health professionals, it seems to me, have failed to educate the population in both the developed and the developing countries to the need for calories to sustain life. Our enzyme systems operate at 98 °F, well above room temperature, and therefore need heat from an outside source. The major sources of heat are provided by calories from fats, sugars, and cereals. These calories are essential to sustaining life. For individuals in developed countries to avoid calories by spending billions of dollars on noncaloric drinks and low calorie food items, often of no nutritional significance, is a poor use of funds and resources. At present, 70% of the $3 billion per year's worth of saccharin produced in the world is going into soft drinks [*O'Sullivan,* 1983]. Because saccharin is carcinogenic and its use is banned in some developed countries, substitutes are being developed. For example, it is anticipated that the sales of aspartame, a sweetener prepared from α-phenylalanine, will increase from $14 million in 1981 to $500 million by 1986. The current price for α-phenylalanine is $27/lb. It would seem more economical to use sugar at 25c/lb and realize that the calories supplied by sugar do not need to be supplanted by more expensive calories from low-nutrition snack foods.

Table I. Chances per 1,000 live births of death from infective and parasitic diseases in 1974–1978 [WHO Health Statistics Annual, 1980]

	♂	♀		♂	♀
Developed countries			*Developing countries*		
Australia	5.6	5.2	Costa Rica	35.4	31.8
Canada	5.9	5.2	El Salvador	109.8	92.9
Denmark	4.9	3.9	Mauritius	43.0	41.0
United Kingdom	4.8	3.7	Singapore	56.7	26.4
USA	7.8	7.3	Cuba	20.5	14.6

If Americans and Europeans had a better understanding of the role of calories in the diet, they might manage them with less weight gain and have more money in their pockets for something more worthwhile than low calorie food and drink. Calories are feared because when we consume more than the number needed to keep our enzyme systems operating at 98 °F, the excess calories are converted to body fat and stored for future need. An excess of approximately 110 cal/day (less than one 12-oz bottle of soft drink) adds 12 lb of weight per year. Most people prefer to keep the slim look of youth and not add more weight. They therefore believe that drinking a noncaloric drink provides an answer to the weight problem. It would certainly be more healthful to drink milk or fruit juices, which ounce for ounce are less expensive and more nutritious, and reduce the fat and sugar content in the total diet by 110 cal/day [*Kummerow,* 1979a].

People of the developing countries also have a problem with calories but it is usually directly opposite to that of the developed countries: it is often a shortage of calories. Some do produce surplus calories in the form of sugars, vegetable oils and other agricultural products. These are often exported for foreign exchange to import cereal grains (table II), to pay off interest on international loans, or to buy armaments; but that is another story. The lack of purchasing power in large segments of the population in the developing countries does not allow for the purchase of sufficient cereal grains to provide the calories needed. Much of the malnutrition in developing countries, particularly marasmus, a wasting disease, has been blamed on a lack of protein, but calories are also crucial. As *McLaren* [1974] has pointed out: 'Marasmus results from grossly restricted intake of all nutrients and energy. Dietary factors, especially in marasmus, are of second-line order of importance, and in a multifactorial aetiology, poverty, ignorance,

Table II. Imports and exports (in 100 metric tons) for developing and developed countries in 1980

	Import	Export
Cereals		
Developing		
Central America	15,994	1,187
Developed		
USA	1,925	1,129,058
Sugar		
Developing		
Central America	8,286	81,605
South America	8,906	39,162
Developed		
USA	37,208	141
Canada	8,749	6,401
Coconut and Palm Oil		
Developing		
Oceania (Fiji, Papua-New Guinea)	–	801
Asia (Malaysia, Indonesia, Philippines)	4	36,206
Developed		
North America	6,584	187
Western Europe	12,237	1,602

Data from: 1980 Yearbook of International Trade Statistics [1981]; 1980 Food and Agriculture Organization Trade Yearbook [1981]; Food and Agriculture Organization Monthly Statistics Bulletin [1982].

bad housing, poor hygiene, and lack of family planning all conspire. Food-consumption data and dietary surveys incriminate [an] energy [deficit] rather than [a] protein deficit. Increasing the energy intake and not ... [the] protein [intake] has produced catch-up growth in undernourished children. Lack of nutriment ... with an energy gap rather than a protein gap is the crux of the matter; but how to match the intake of the child with its requirements remains a problem of puzzling complexity.'

Conception of the Need for Nutrients

McLaren [1974] in his article entitled 'The Great Protein Fiasco' stated, 'We still do not know, for instance, whether or not many of us are actually eating levels of protein that are harmfully high. The experts now

talk of the "safe level of protein intake" but have been unable to set its upper limit. The recommended dietary protein intake has been progressively lowered by the experts in recent years so that it is now about where it was nearly 70 years ago.' The Food and Nutrition Committee of the National Research Council (NRC) presently recommends 56 g of protein per day and has defined the optimum daily intake of vitamins and minerals for humans (table III).

The daily intake of protein, vitamins and minerals has also been defined by the NRC for pets, poultry, cattle and swine. It is relatively simple to follow these recommendations for animals with diets of cereals and legumes. Such diets have resulted in healthier animals and decreased market maturation time. For example, swine fed a diet of ground corn and soybean meal supplemented with minerals and synthetic vitamins reach maturity in 6 months instead of 2.5 years. A bred gilt will give birth to a piglet weighing 2–4 lb. Within 6 months this piglet fed the supplemented corn soybean diet weighs 220 lb.

Millions of human beings in the developing countries use ground corn and beans as their major source of calories and nutrients. They are shorter of stature than Americans and have a shorter life expectancy (table IV). A ton of commercial swine ration contains 1,725 lb of ground corn, 220 lb of soybean meal and 55 lb of a lysine vitamin mineral mix. This ration compares favorably with a diet meeting the NRC recommendations for man (table III). However, without the supplemental 55 lb of minerals and vitamin mix per 2,000 lb, the commercial ration does not provide the same rate of growth. Is it possible that the diet of millions of people eating a diet composed largely of ground corn and beans could be improved by simply adding a mineral vitamin supplement to the ground corn? Since 1944 in the southern states of the USA, ground corn (corn grits) has been supplemented with niacin, riboflavin and thiamine to prevent pellagra. Such a simple supplementation decreased the death rate from pellagra in the USA from 2,000 in 1941 to 12 in 1944 [Vital Statistics of the United States, 1941, 1944].

Interestingly, the commercial mineral vitamin mix used in swine rations differs somewhat in trace mineral composition from the mineral mix recommended by the NRC (table III). The commercial mix is designed for swine kept in confinement under crowded conditions which foster stress, competition for feed, and a tendency to 'eat like pigs'. The difference that a nutritionally complete diet might have on the behavior of people living under crowded conditions has yet to be studied. Certainly the nutri-

Table III. Recommended daily allowances (RDA) for man and swine compared

	RDA for man[1]	RDA for swine[2]	Actual commercial swine ration pre-mix[3]
Protein, g	56	67.5	
Minerals			
Calcium, mg	1,200	2,300	50,000
Phosphorus, mg	1,200	1,800	22,500
Sodium, mg	*[4]	250	37,500[5]
Chlorine, mg	*	330	
Potassium, mg	*	750	
Magnesium, mg	400	100	350
Iron, mg	18	38	450
Zinc, mg	15	25	45
Manganese, mg	*	1	
Copper, mg	*	1.5	
Iodine, mg	150	0.04	10
Selenium, mg	*	0.04	
Vitamins			
Vitamin A, μg β-carotene	6,000	2,200	27,272
Vitamin D, IU	400	55	6,818
Vitamin E, mg	10	2.8	18.75
Vitamin C, mg	60	*	
Vitamin K, mg	*	50	
Thiamin, mg	1.4	0.33	
Riboflavin, mg	1.7	0.75	4.55
Niacin, mg	18	5.5	34.09
Vitamin B_6, mg	2.0	0.38	
Folacin, μg	400	150	
Vitamin B_{12}, μg	3.0	5.5	0.036
Pantothenic acid, mg	*	3.3	11.36
Choline, mg	*	275	227.27
Biotin, mg	*	0.03	

[1] American males 15–18 years old weighing 66 kg.
[2] Swine weighing 1–5 kg live weight.
[3] Pre-mix added to the commercial corn-soybean ration.
[4] Not given.
[5] This number represents the total amount of sodium and potassium chloride.
Data from: National Academy of Sciences [1980]; Nutrient Requirements of Swine [1979].

Table IV. Life expectancies in developed versus developing countries: percent expectation of life at age 75

Developed countries		Developing countries	
North America		*South America*	
United States	10.4	Uruguay	9.1
Canada	10.3	Chili	8.8
Scandinavia		*Central America*	
Sweden	9.7	Bermuda	8
Norway	9.6	*Asia*	
Central Europe		Singapore	7.4
The Netherlands	9.7	*Africa*	
Switzerland	9.7	Mauritius	7
Asia		*Mediterranean*	
Japan	9.5	Malta	6.6
Israel	9.3		
Mediterranean			
Greece	9.5		
Spain	8.9		
Italy	8.6		
Yugoslavia	8.4		

tional well-being in over-populated countries of people on corn and bean diets could be improved by adding the proper mineral vitamin mix to the corn meal. Enriched food would be far more economical than weapons for the USA to supply.

The cereal based diets in some developing countries are also supplemented with beans as a protein source. In India, rice and wheat are supplemented with a large variety of beans, sometimes called pulses, and in China these cereals are supplemented with soybeans. In India and China, a small amount of animal protein is used to supplement the vegetable protein. In India, buffalo milk and in China, pork represent the main animal protein sources. The milk is so important in India that cows are considered sacred and are not slaughtered for meat. The Chinese consume only 13 g of protein and 142 cal as compared to 71 g of protein and 742 cal/capita from meat per day for Americans [*Eberstadt,* 1979]. The Chinese also consume only 76 cal of visible fat (margarine, shortening and frying oils) as compared to 576 cal of fat/capita/day for Americans or Northern Europeans. Americans