Food Related Risks: A Nutritionist's Perspective*

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This paper presents a nutritionist's perspective on a number of issues consistently raised when discussing food and biotechnology.

The nutritionist has not always been welcome at the table when the talk was about technology. In fact, any time nutritionists get into a discussion about technical changes in the composition of the food supply our advice has not been particularly helpful, due to the fact that technology must focus on a particular crop or food rather than the whole nutritional picture.

A direct antecedent of this meeting was the interest that was generated in the 1960s, when, at Purdue, Nelson and Mertz (a plant breeder and a biochemist) discovered a particular gene in maize associated with higher lysine content of the corn, called the Opaque two gene—opaque two corn, or high lysine corn. As lysine is the most limiting amino acid in corn protein for the growth of many animals, this was exceptionally exciting. This discovery introduced the possibility of raising pigs by feeding them little more than high lysine corn with minor vitamin and mineral supplements. In addition, preliminary testing in adults and children revealed that diets consisting primarily of Opaque corn retained nitrogen more efficiently. Amidst an exceptional amount of promise and hyperbole, this development was considered as potentially eliminating hunger and malnutrition in the world.

That finding led to the idea that crops could be manipulated to affect nutritional value. This idea caused great excitement and led to plant breeders and nutritionists sitting down together to discuss the available technological options with the goal of improving the

nutritional quality of the food supply. Later work demonstrated that the early promise would not come as quickly as was hoped. Work showed that the yields of some crop varieties incorporating the Opaque gene were low, the milling quality of the grain was changed, and its disease resistance was poor, clearly demonstrating that many other factors needed to be considered alongside nutritional content in order to create a successful crop.

About the same time, United States Agency for International Development (USAID) carried out three major field studies around the world in order to look at the effect of supplemental lysine in populations where either wheat, corn, or rice was the major staple cereal. These grains are a major source of calories in many populations around the world.

For example, a study was done in Morocco supplementing wheat with lysine. In Thailand, a study was done adding lysine to rice, and in Guatemala, lysine was added to corn. These studies were unable to show nutritional benefit from the improved lysine content in any of these populations.

Why did the laboratory control studies show such elaborate and important effects from supplementing grain proteins with lysine, whereas the field studies did not? This was due to several factors: human feeding studies are difficult to carry out, and results difficult to interpret. Human lysine requirements are probably quite low, particularly when compared to rapidly growing rats, pigs, and chickens, and therefore the extrapolation of these animal studies to human populations was probably unwarranted. More importantly, even though the maize, wheat, or rice was the predominant staple, people still eat a variety of foods which complement each other in nutritional quality.

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While the discovery of the Opaque two gene was certainly very important, the effects of any new development must be considered within the context of the entire diet, and not as a single food.

New varieties of "quality protein maize", (as opposed to Opaque two corn) now eliminate many of the problems seen in earlier varieties. Yields are up, and the milling quality and other agronomic characteristics have been improved. Once again these varieties are still associated with much hyperbole and promoted as potentially eliminating many of the world's nutritional problems.

People eat a variety of foods, even in situations where there is very specific and heavy dependence upon one source of food for calories. Thus diet quality is measured by the sum total of everything eaten, and is not generally based on a single crop or product. Cereal promotions based on the concept of one cereal providing all nutrients necessary continually set a nutritionist's teeth on edge.

Following this era of discovery in the 1960s, nutritionists began to collaborate with plant breeders. Nutritionists were asked, "What should targets be in changing the composition of food? What should be done?" Plant breeders were confident that they could select for specific characteristics desired, saying, "Look. You give us some characteristics to select for, and we'll give you those characteristics." However, it is nearly impossible to predict what targets should be set for a particular food in order to improve the nutritional quality of the diet and thus improve the health of the United States or some other part of the world. Again, the problem is that people do not eat nutrients. They eat food, and they do not eat a particular food, they eat a variety of foods. That continues to be the dilemma as nutritionists and technologists interested in a particular crop discuss what we could do to make foods better nutritionally.

In the United States today, concern about human nutrition does not, for the most part, focus on deficiency disease. Within this context, setting targets for given levels of nutrients is not helpful. Increasing the lysine content of corn, the thiamine in cereal grains, or vitamin C in oranges would not improve the health of the American population. However, levels of saturated fat and cholesterol, the consumption of some kinds of carbohydrates, and changes that occur in manufacturing of foods through the addition of sodium and other things of this nature are of prime concern.

As public health problems are examined, the major causes of death are still heart disease, cancer, and conditions associated with them such as stroke, diabetic complications, and the interaction of these conditions with obesity. Increasing evidence points towards modifying these conditions and their progress through diet. Thus diet, as it relates to these conditions, has important public health considerations.

The dietary guidelines for Americans, currently in its third edition, has just been submitted to the Health and Human Services (HSS) Secretary and the Director of the United States Department of Agriculture (USDA), who will publish new guidelines in October. The third edition has not changed significantly from the first and second edition, and it will read something like this:

The first guideline: *eat a variety of foods.*

A varied diet virtually insures sufficient amounts of the various nutrients required for good health. If you do not get some nutrients from one food, you will get them from others. There is all this complementarity of foods that we have learned about over the years.

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In addition, consuming a variety of foods has important food safety implications. Within a varied diet are specific foods which each contribute nutrients and in some cases toxins to the total diet. The variety insures that no one item provides a majority of total nutrition for better or worse. Therefore, consuming a variety of foods makes it less likely that you are going to have food safety problems (e.g., consume excess toxins or pesticides). Variety is always the first on the list. Eat a variety of foods.

The second guideline: *maintain healthy weight.* There have been some interesting problems in attempting to determine exactly what is a healthy weight, but nevertheless, that is the guideline.

Other guidelines include: *Choose a diet low in saturated fats and cholesterol. Choose a diet with plenty of vegetables and grain products. Use sugars in moderation. Use salt and sodium in moderation. If you drink alcoholic beverages, do so in moderation.*

A few years ago, because of the above kind of nutritional concerns of the American public, the Division of Nutritional Sciences at Cornell University was asked by the USDA to help set a research agenda for the Agricultural Research Service (ARS) to meet dietary guidelines.

Together with Hub Allaway, who used to direct the Federal Plant Soil & Nutritional Laboratory in Ithaca, three workshops were held. A group of plant scientists, a group of animal scientists and a group of food scientists were brought together (with some mixing of the three groups in the workshops) to identify feasible research objectives for meeting nutritional concerns. The thrust of the discussions was as follows:

The plant breeders said “What do you want? We'll create a plant for you—tell us how much thiamine you want, how much riboflavin, whatever. We can create that plant—with biotechnology we can create it faster than we used to when we had to use very long-term selection techniques.”

The animal scientists determined they could produce meat with less fat, and possibly lower fat milk, if only a marketing system existed that would pay the necessary premiums.

Food scientists also said "Tell us what you want. Using agricultural commodities as raw material, we can fabricate the needed food. We could do it—if the regulations on standards of identity and labeling were changed."

And the nutritionists got into the discussion. "Well, on the one hand, maybe; on the other hand...". I have exaggerated a little bit in terms of all the content, but the thrust of these workshops were along those lines. But nutritionists were not able to provide the recipe as well as would have been liked.

It became clear that a better understanding of basic plant biochemistry was needed to determine what was possible and what made sense in terms of agronomic and other characteristics. Looking to the future of modified plants and even animal compositions by means of genetic manipulation, our horizons are very broad, and the time scale is probably short in terms of how long it might take us to get there. As we look to biotechnology to create production systems for future raw materials incorporated into foods, it is not possible to comprehend the scope of what might be produced, or what consumers will accept. It is difficult to foretell what might happen on the basis of nutrition.

A particular food is only a small part of a varied diet, and few people consume a single food as a total diet. When new foods are created it is most appropriate to think about them as new versions of an "old" food, and to examine them within the context of what they would replace. Questions such as: What is the role of the new food in the diet? What proportions of the daily energy does the new food supply? and within that context, What features should this new food have?, are appropriate. For example, most nutritionists do not believe that new foods *need* to be super fortified with nutrients.

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Most likely, guidelines will be necessary to determine what foods new foods might replace. Do new foods have a similar micronutrient profile as foods they generally replace; and can the nutrients within these foods be utilized—are they available, and can they be ingested and metabolized by the people who are consuming them?

If dietary patterns remain the same, will the nutrient profile of the population change, and will that pose a nutritional risk? These are the kind of questions that will be asked by nutritionists as we look ahead to some of the biotechnological advances. For example, as materials such as olestra and other fat substitutes enter the market in foods where they replace ma-

jor dietary caloric sources, it will be important to consider how the nutrient profile within the overall dietary pattern is affected.

Changes in plant composition may be more valuable in animal feeding than for humans. The fact that tailored crops will be more available, and more useful for feeding to certain animals, is an very exciting prospect, and will continue to be important.

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The production of materials of alternate food composition through biotechnology is not cause for alarm. We, as consumers in this country, have a choice whether or not to consume a specific food. This freedom will be an important issue as we look ahead. We will need to look carefully at our regulatory laws to ensure they accommodate these technological advances while still protecting consumers.

It is critical to recognize that we eat a varied diet, and that changes, whether through biotechnology or by traditional means, must be viewed in the context of *entire food patterns,* and not in terms of *one* food. With that in mind, those dealing primarily with the nutritional aspects of food could actually be helpful to technologists as they plan food changes. We should take advantage of this great new world of foods that is coming.