SESSION IV: THE WORLD FOOD PRIZE LAUREATES' RESPONSE
October 14, 2005 - 2:00 p.m. to 3:30 p.m.
Laureates Roundtable

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We have heard repeatedly during the symposium that developing countries must increasingly face the double burden of persistent chronic undernutrition and micronutrient deficiencies at the same time that they are dealing with the new impact of overweight and obesity in their countries on chronic disease. It has not been pointed out, however, that this relationship is made worse by the impact of fetal and infant malnutrition on chronic disease in later life. This was first demonstrated by David Barker and colleagues for populations born in England and Wales in the 1930s and '40s, in which the malnutrition had been quite borderline and inapparent.

Recent evidence, particularly from India, indicates that clinically evident fetal and infant malnutrition still characteristic of most developing countries makes populations much more susceptible to chronic disease in later life if they become overweight or obese. For this reason, it may be appropriate to begin to speak of a triple burden of disease for developing countries, especially those in transition, until the problems of fetal malnutrition and low birth weight are solved.

In the past, nutritionists have focused on the nutritional problems of individual, vulnerable groups, generally identified as pregnant and lactating women, infant and toddlers, school children and adolescents. Now we need to include adults of all ages, especially women of childbearing age who may enter pregnancy poorly nourished.

At the moment of conception most individuals have the genetic makeup, the genotype, for a long and healthy life. But from that point onward, there are environmental factors, in the very broad sense, that damage, this potential and result at each stage in a far different phenotype than at conception. Malnutrition and overnutrition are the most common and consistent factors responsible for this damage.

In pregnancy, folic acid deficiency early in pregnancy increases neural tube defects at birth. This is a permanent change in the phenotype. Iodine deficiency in pregnancy impairs fetal brain development, again a change that cannot be later reversed. Protein energy deficiency lowers growth rate with multiple other consequences that are evident later at school age and in adult life. Iron deficiency lowers infant iron stores at birth with consequences that we will be described next.

In infancy, when breastmilk is no longer sufficient as a sole source of food, there must be appropriate and timely complementary feeding. If not, there will be physical and mental stunting. Both iron deficiency and protein calorie malnutrition will result at this age without proper supplementation. There are extensive studies of this for protein calorie malnutrition, but it is not yet sufficiently recognized that exclusive breastfeeding, as now recommended, provides only about half the amount of iron that is required, and the other half must come from the stores at birth.

The stores at birth for a child of normal birth weight, born of a well-nourished mother, still run out about six months of age. If the mother is malnourished, they may run out at four months of age, and if the child is of low birth weight, which may be anywhere from 10 to 40% of children in developing countries, then they will run out at two months. If the required iron is not provided to the infant in some manner when iron stores present at birth are exhausted, there will be damage to the developing brain, even if the child is exclusively breastfed. The mechanisms include fewer dopamine neuro-transmitters and slower conductivity in cranial nerves due to reduced mylenation.

The preschool age is again a vulnerable period in which protein energy malnutrition indicated by stunting will be reflected in permanent reductions in physical and cognitive development. A child who is deficient in vitamin D during this period may bear the effects of rickets throughout life. Iron deficiency anemia also affects cognition in this age group.

These common sources of damage to the phenotype continue through school age and adolescence with some of the same deficiencies. Low calcium intakes coupled with low vitamin D will predispose to adult osteoporosis.

We have been hearing about the problem of chronic diseases during the adult years throughout the meeting. These are exacerbated by the poor lifestyles, poor diets and reduced physical activity that are leading to overweight and obesity.

For the elderly there is now increased evidence that much of their cognitive loss and physical disability is unnecessary. It can be prevented by proper diet, correcting the B vitamin deficiencies and by physical activity and strength training. Moreover, some of the increase in malignancies and infections at older ages can be reduced by good dietary habits.

This still doesn't take into sufficient account the women of childbearing age. I started consideration of the life cycle with conception, but the problems start earlier. Women must enter pregnancy with a good iron status because supplementation during pregnancy is simply too late to bring about a full correction. They also need to have an adequate folic acid status, because the damage from folic acid deficiency comes too early in pregnancy to be seen in the clinic or be corrected by supplementation.

So what are the implications of the holistic approach to malnutrition in human populations for health and agricultural practitioners and policymakers? There are many different biological needs that our food supply must satisfy, and these can only be met by a varied diet. Cereal or root-crop staples can go far towards meeting the need for energy, but protein needs can be a limiting factor for persons who are overly dependent on a cereal or root as a staple. For individuals who can consume small amounts of animal protein or legume protein, this is not likely to be a problem.

Unfortunately, as Dr. Bouis pointed out on Tuesday, legume yields have not increased with population growth. In fact, their availability has decreased at a time when cereal yields have been increasing remarkably. As a result, the increased cost of legumes has put them beyond the purchasing power of those most in need and who traditionally for generations have depended on the complementation between the protein in cereals and the protein in legumes to arrive at an adequate quality combination.

It is for this reason that cereal protein quality is important. And this means, for example, that quality protein maze, or QPM, for which Villegas and Vasal received the 2000 World Food Prize, is such an important achievement that every effort should be made to apply it to maize for the widest possible range of environments and uses. Nitrogen balance studies in Guatemala and MIT, for which I was responsible, confirmed that the nitrogen retention with QPM at requirement levels is the same as it is for milk. In human diets, QPM can go far toward replacing more costly animal or legume protein, and in the diets of non-ruminants, it can reduce the need for more expensive protein supplements, such as oil seed meals or fish meal.

Ordinary maize is deficient in both lysine and tryptophan, and QPM is a source of high-quality protein because it has nearly an ideal amino acid pattern because it is increased in both lysine and tryptophan. Wheat protein quality is poor only because it is deficient in lysine. Many metabolic studies in humans, demonstrate that the addition of lysine alone to wheat flour would have a similar effect. But this would be much too expensive to benefit the poor. The development of a quality protein wheat – shall we call it a QPW? – would be a major contribution to the nutrition of populations depending on wheat as a staple.

Since thus far it has not been possible to improve the quality of wheat protein by conventional breeding, it is a prime target for genetic engineering. There is less advantage for doing this for rice because its protein quality is better than that of maze or wheat. For all of the reasons that Dr. Gupta told us about at lunch, increased availability of fish protein, particularly when accessible to the poor, would be ideal for improving the protein quality of cereal based diets...

As has been mentioned repeatedly throughout this symposium, micronutrient deficiencies are widespread and serious constraints on human and social development in developing countries and some sectors of the populations in industrialized countries.

Fortunately, vitamins and minerals can be provided cheaply and effectively to older children and adults by fortification of appropriate staple foods. Therefore, the B-vitamins and minerals need not be priority targets for plant breeders. However, fortification with synthetic vitamin A would increase the cost of the fortificant mix tenfold. So the best solution for meeting the vitamin A requirements of older children and adults is the availability and consumption of foods with substantial vitamin A activity. Red palm oil is a particularly helpful and rich source of provitamin A carotinoids that is widely available in most tropical developing countries.

The introduction of foreign genes to produce golden rice with vitamin A activity from beta-carotene is certainly a step in the right direction. And the report at this meeting of new cultivars that could in theory meet the full vitamin A requirement of children and adults in quantities normally consumed would be useful if people can be brought to accept deeply orange rice. This will be difficult. In the Philippines they did not accept rice fortified with occasional kernels colored yellow due to the riboflavin in the micronutrient encapsulated kernel. They simply picked out the fortified yellowish kernels.

However, a similar approach to increasing the vitamin A activities of sweet potatoes, bananas and other crops whose yellow or orange color is already well accepted would be of greater immediate nutritional significance. Moreover, most plant foods would be good sources of iron if it were not for the poor bioavailability of iron when it is bound to phytates. As mentioned in this symposium, cultivars with a lower phytate content could make a useful contribution to alleviating this most widespread and damaging micronutrient deficiency in the world today, that of iron.

In the 21st Century, genetic engineering offers greater opportunities for improving the nutritional value of foods and their contributions to a healthy diet than ever before in human history. Ultimately improvements from genetic engineering will go beyond the essential nutrients now recognized and include a variety of phytochemicals with antioxidant and anticancer activities. However, before this can happen, there must be a far better analysis of needs and prioritizing of targets for plant breeders than is now available or indeed possible. Nevertheless, the potential for producing a whole range of new foods that supplement and further advance the gains of the original Green Revolution is breathtaking.

I believe that we have come this week to some additional insights into global hunger. It is clear that we need to be concerned for the nutritional characteristics as well as the agronomic characteristics of agricultural products. We cannot simply focus on overt hunger as it has been traditionally perceived, but must also must be aware of the even greater damage from hidden hunger. We must recognize that more and more of the world's developing countries will be facing the problems of nutritional excesses before they have solved the problem of nutritional deficiencies. I suggested that this will be a <u>triple</u> burden of nutritional disease for developing countries because fetal and infant malnutrition will have increased susceptibility of future generations to the effects of dietary excesses and more sedentary life styles.

So there are obviously multiple challenges - to agriculturists to produce more nutritious crops, - to nutritionists to define better nutritional goals so that the breeders are not wasting their time – to fisheries researchers to meet the growing world demand for fish and - to the industry to produce processed foods that contribute to a healthy diet. There will not be any one solution. Multiple approaches will be required to produce the food supply that will assure adequate protein and micronutrients in the diets of everyone. The aim will continue to be food and nutrition security for all.