PATH and the Ultra Rice™ Concept

PATH (Program for Appropriate Technology in Health) is an international, nonprofit, nongovernmental organization dedicated to improving health, especially the health of women and children. PATH identifies, develops, and applies appropriate and innovative solutions to public health problems in areas such as reproductive health, communicable disease prevention, and nutrition. Since 1996, PATH has worked to promote the Ultra Rice™ fortification technology. The purpose of this booklet is to introduce the Ultra Rice™ premix, a product that holds great promise for alleviating micronutrient deficiencies.

A Promising Solution for Alleviating Micronutrient Deficiencies
Ultra Rice™ premix is a micronutrient-fortified, manufactured rice product that was developed to address nutritional deficiencies in populations where rice is a staple food. The Ultra Rice™ premix is blended with local rice in ratios approximating 1:100. For example, one kilogram of Ultra Rice™ premix yields 1,000 fortified servings. When cooked, the taste and texture of the fortified rice blend are nearly identical to those of unfortified rice. Ultra Rice™ premix resembles natural milled rice grains in size and shape and does not break down during the typical washing and cooking stages of rice preparation.
The unique advantage of the Ultra Rice™ technology is its ability to protect micronutrients within the manufactured grain—a feature that is especially effective in areas where traditional preparation includes washing the rice prior to cooking. The Ultra Rice™ formula develops a structure that helps to shield sensitive micronutrients from ultraviolet light, oxidation, and leaching during food preparation.

The original Ultra Rice™ premix formula was designed as a vehicle for vitamin A. Other formulas, currently under development, will carry iron, zinc, thiamin, and folate. Additional nutrient combinations may be custom-designed to address specific dietary deficiencies in a targeted area.

The Role of Ultra Rice™ Technology in Alleviating Micronutrient Deficiencies

THE PROBLEM

Micronutrient deficiency is recognized as a serious threat to the health, development, and productivity of millions of people worldwide. A major cause of micronutrient deficiency is undernutrition, a condition present in much of the developing world. Undernutrition is the result of a prolonged, low level of food intake and/or poor absorption of the food consumed. Manifestations include wasting, stunting or underweight, reduced cognitive abilities, and low productivity. The Food and Agriculture Organization of the United Nations estimates that about 800 million people in the developing world are chronically hungry and undernourished (FAO, 1999). Two-thirds of these undernourished people live in Asia and the Pacific, which is home to 70 percent of the total population of the developing world. Women and children are especially vulnerable to micronutrient deficiencies because of their additional requirements for reproduction and growth, respectively (UNICEF, 1998). Severe micronutrient deficiencies can lead to blindness, impaired cognitive function, life-threatening infections, and, in millions of cases, death. Even mild to moderate deficiencies have serious health effects, increasing susceptibility to disease and increasing the likelihood of premature death.
Several options for alleviating micronutrient deficiencies exist. These include direct supplementation (e.g., tablets and capsules), food fortification, and dietary modification and diversification. However, nutritionists have realized there is no one “magic bullet” to eliminate micronutrient deficiencies, and in fact, various approaches are often combined to better cover at-risk populations.

Rice is the staple food for more than half of the world’s population. Worldwide, rice provides 23 percent of human energy intake and 16 percent of protein intake (International Rice Research Institute, 1997). Total consumption of rice continues to increase in close proximity to the areas with the highest incidence of micronutrient deficiencies.

**Common Micronutrient Deficiencies in the Developing World**

**Vitamin A deficiency (VAD):** Vitamin A deficiency is a major public health problem, especially among preschool children and pregnant women in low-income countries. At any one time, up to 230 million children are at risk of clinical/subclinical VAD, and over one million VAD-associated childhood deaths occur annually. In children, VAD is the leading cause of preventable severe visual impairment and blindness. An estimated 250,000 to 500,000 VAD children become blind every year, and about half of them die within a year of becoming blind. In addition, VAD significantly increases the risk of severe illness and death from common childhood infections, particularly diarrheal diseases and measles. In women, VAD may be an important factor contributing to poor pregnancy outcome and maternal mortality.

**Iron deficiency:** Iron deficiency is the most common nutritional deficiency in the world, affecting nearly 5 billion people. It is the primary cause of anemia, which affects nearly 2 billion people worldwide, or about a third of the world’s population. Overall, 39 percent of preschool children are anemic, and 52 percent of pregnant women are anemic. More than 90 percent of both groups live in developing countries. Iron deficiency has profound negative effects on human health and development. Decreased learning capacity and cognitive performance in the first few years of a child’s life are associated with iron deficiency anemia. In adults of both sexes, iron deficiency can lead to a reduction in physical and mental capacities, which can negatively impact work habits and, thus, economic development. In pregnant women, iron deficiency can lead to anemia that is associated with an increased risk of maternal morbidity and mortality.

**Zinc deficiency:** Zinc deficiency causes growth retardation, anorexia, diarrhea, immune deficiencies, skin and eye lesions, delayed sexual maturation, night blindness, and behavioral
correlation with population growth. By 2025, more than 5 billion of the world’s anticipated 10 billion people are expected to depend on rice as their principal food (IRRI, 1997).

Micronutrient deficiency is especially common where rice is the primary source of calories. In these areas sufficient nutrient-rich foods do not always accompany rice.

Milled rice is low in micronutrients because its nutrient-rich outside layer is removed during typical rice milling and polishing operations. This makes the grain better tasting and more visually appealing, but less nutritious. As a fortification vehicle, the Ultra Rice™ premix can replace micronutrients lost during the rice milling process and can help compensate for dietary insufficiencies. Fortifying a staple food such as rice has the added advantage of not requiring modifications to consumer purchasing or eating habits.

Changes. There are growing indications that zinc deficiency may be far more widespread than previously thought. There is evidence that zinc deficiency may cause intrauterine growth retardation and even neural tube defects in the fetus, as well as impaired immune function in the elderly.

Thiamin deficiency: The classic thiamin deficiency disease, beriberi, is characterized by loss of feeling in the hands and feet, muscle weakness, and potential paralysis. This deficiency disease, which can manifest itself within 12 weeks of deficient intake, can cause disability and death. Large segments of the world’s population continue to subsist on marginal or submarginal thiamin intakes.

Folate deficiency: Women of childbearing age can develop folate deficiency, which increases the risk of neural tube defects (such as spina bifida) early in pregnancy. Folate deficiency can also cause pernicious anemia.

The mission of PATH’s Ultra Rice™ program is to improve the nutritional status of vulnerable, rice-consuming populations by introducing, commercializing, and encouraging sustained availability of the Ultra Rice™ technology. Given the size of rice-eating populations worldwide, Ultra Rice™ technology could play a major role over the next decade in alleviating micronutrient deficiencies.

The Micronutrient Initiative of Canada, the Australian Agency for International Development, and the United States Agency for International Development (through the Opportunities for Micronutrient Interventions project) provided initial financial assistance for Ultra Rice™ activities. With support from the Bill and Melinda Gates Foundation, PATH is now working to:

- develop an iron-bearing and multiple-fortificant Ultra Rice™ premix formula, evaluating bioavailability and consumer acceptance;
- create commercially sustainable sources of appropriately fortified versions of Ultra Rice™ premix, and make these available to affected populations in developing countries; and
- demonstrate the effectiveness of Ultra Rice™ technology in alleviating micronutrient deficiencies in affected populations.

The Ultra Rice™ team is collaborating with nutrition experts, donors, and technical specialists to gain the advice and support of the international community for the advancement of this promising technology. PATH is committed to working closely with interested collaborators, including ministries of health, other government and regulatory agencies, private companies, and nongovernmental organizations, to identify opportunities for the introduction of Ultra Rice™ premix.
INTRODUCTION STRATEGY AND TECHNOLOGY TRANSFER

Introduction Strategy
To introduce Ultra Rice™ premix, PATH will focus on countries where:
- micronutrient deficiencies are documented,
- rice is a staple food,
- PATH can develop advocacy and in-country support for Ultra Rice™ premix as a micronutrient vehicle, and
- appropriate manufacturing technology is available.

A combination of various approaches will make the Ultra Rice™ program sustainable. Ultra Rice™ premix distribution systems may include government-sponsored nutritional programs, food aid programs, or private commercialization ventures. PATH recognizes the necessity to demonstrate a viable market before attracting commercial partners and subsequently transferring the manufacturing technology. PATH will provide technical assistance in product manufacturing, training, demand creation, and marketing.

PATH’s Role
PATH aims to make the Ultra Rice™ premix locally available by transferring Ultra Rice™ premix production from the development center in Washington State, U.S.A., to major rice-consuming countries around the world.

For more than 20 years, PATH has been involved in the research, development, technology transfer, and manufacture of health technologies in the developing world. PATH draws upon in-house skills in pharmaceuticals, food processing, quality control, and business development to determine the feasibility of technology transfer and the type of technical assistance required. This experience base will help PATH identify manufacturing partners for the local production of Ultra Rice™ premix. PATH intends to license the production rights for the premix to these selected partners. A formal licensing agreement between PATH and each local partner will help to ensure product quality and to encourage its distribution to at-risk populations. The transfer will also include a comprehensive set of standard operating procedures.
Manufacturing Partners’ Roles
Because Ultra Rice™ premix incorporates an extrusion step in its process, potential manufacturing partners would include local pasta or noodle makers, whose existing manufacturing technology should easily support Ultra Rice™ premix production. These manufacturing partners should also be able and willing to invest in additional production and quality-monitoring equipment, where necessary. A second production stage, the dry-blending of Ultra Rice™ premix with local rice to produce the consumable blend, may be completed by the Ultra Rice™ premix manufacturer, local rice millers, or rice packers.

ULTRA RICE™ PREMIX INITIATIVES UNDERWAY
Groups from several geographic areas have expressed interest in the Ultra Rice™ premix technology and are currently the focus of evaluation or initial introduction activities.

Brazil: In Pernambuco State, widespread vitamin A deficiency has been identified. To address this problem, PATH Canada, under contract from PATH, is working with government officials, nutritionists, and rice packers in the region to introduce vitamin A fortified Ultra Rice™ premix into local school lunch programs. PATH plans to extend this program into other areas of Brazil as well.

Indonesia: PATH is working with large employers to fortify rice provided to employees through on-site meal programs. Factory management intends to blend the Ultra Rice™ premix with local rice to serve to workers on a daily basis. Initial volumes are expected to amount to approximately 10,000 to 15,000 meals per day. PATH’s objective is to demonstrate a potential market so that interested local, commercial producers of the premix might be identified.

Philippines: After carefully evaluating other rice fortification methods, health officials have expressed strong interest in the Ultra Rice™ premix technology. PATH has had initial discussions with local authorities involved in rice fortification research. In November 1999, the Department of Health approved a fortification strategic plan, and there is keen interest in the development of an Ultra Rice™ formula with iron for testing and trials in the Philippines. The Philippine government is expected to fortify at least 10 percent of the rice distributed by the agency charged with rice market stabilization.

Serving the Ultra Rice™ blend in the Brazil study.
The Ultra Rice™ Production Technology

THE PREMIX

- The Ultra Rice™ premix is made from dough consisting of rice flour, selected micronutrients, binders, antioxidants, lipids, and other nutrient-protecting materials. No genetically modified materials are included.
- From the different forms of nutrient compounds available, PATH has chosen those which demonstrate the optimal nutritional, organoleptic (taste and odor), color, texture, and density characteristics, while maintaining affordable costs.
- No animal products (e.g., animal fats) are included in the ingredients. All incorporated components are included in the United States Food and Drug Administration’s GRAS list, a list of food additives that are “generally recognized as safe.”

THE PROCESS

- After the dough is formed, it is extruded through a special die, cut into rice-sized kernels, and dried. The final Ultra Rice™ premix resembles natural milled rice grains in size and shape.
- After production, the Ultra Rice™ premix is flushed with nitrogen to maintain shelf life, bagged, sealed, and stored in moisture-proof, opaque containers.

THE BLEND

- Close to the time of consumption, the storage container is opened, and the Ultra Rice™ premix is blended with local rice. It may either be cooked on the premises or repackaged for further distribution.

How Much Will the Ultra Rice™ Premix Cost?

Based on current U.S. manufacturing costs, Ultra Rice™ premix adds less than US$0.005 (half a cent) to a 100-gram serving of the fortified rice blend, a typical adult serving size. This figure, however, should be used only as a very rough approximation of cost. Local differences will affect the final price in any market.

Local cost components to consider include:

- whether production equipment is dedicated or shares production time (and overhead burden) with ongoing operations
- regional ingredient costs
- labor rates
- utility rates
- distribution costs
- proximity to market
- producer margin requirements
- volume of demand

PATH has production, costing, and marketing experience and will help investigate the economics of local production.
• The blend ratio (premix to natural rice) is approximately 1 to 100. Depending upon the precise potency level of the premix and the desired level of micronutrient fortification, this ratio may be varied within definable limits.

• Techniques and protocols for the dry-blending step are straightforward and the specifics best developed through direct consultation with the packer.

EQUIPMENT REQUIRED

• Most of the equipment used in the production of the Ultra Rice™ premix would be typical in a pasta or noodle factory and includes simple mixing and blending equipment, a de-aerator, an extruder, cutting blade, and dryer.

• Specialized equipment needed for premix production includes the extrusion die, an in-process moisture measuring device, and a rotating treatment drum.

• Subsequent dry-blending of the premix and rice may be accomplished on either a batch or a continuous basis. Metering, measuring, and assaying equipment for this step are not specialized.

References
Ultra Rice™ Premix Chronology

1980s Dr. James Cox and his son, Mr. Robert W. “Duffy” Cox, of Bon Dente International in Lynden, Washington, U.S.A., invent Ultra Rice™ premix to address the widespread prevalence of vitamin A deficiency in the developing world.

1994 Vitamin A fortified Ultra Rice™ premix is shown to be clinically effective in a study involving 83 Brazilian children and is shown to retain chemical stability after storage and cooking (Flores, 1994).

1996 With support from the Micronutrient Initiative of Canada, PATH implements a study on the feasibility of introduction of vitamin A fortified rice in Indonesia from 1994 to 1996. This study demonstrates the consumer acceptability of the Ultra Rice™ premix and the feasibility of selling through local markets.

1997 The Cox family generously donates to PATH the intellectual property associated with the Ultra Rice™ premix technology.

1998 The Micronutrient Initiative provides a second grant for PATH to investigate Ultra Rice™ premix characteristics such as shelf life, optimum dose, nutrient loss with cooking, and stability over time. The results of these and previous studies show that three important challenges for fortification technology—technical feasibility, clinical effectiveness, and consumer acceptance—have been overcome.

1998 PATH, with the support of Hoffmann-La Roche, determines that multiple fortification is feasible for future Ultra Rice™ premix formulations.

1999 PATH receives a grant from the Bill and Melinda Gates Foundation to support the development of additional fortified Ultra Rice™ premix formulas, technology transfer, and introduction activities.

2000 PATH begins developing a new Ultra Rice™ premix iron formulation and begins transferring the Ultra Rice™ premix technology to developing countries.
The Ultra Rice™ technology holds great promise for alleviating micronutrient deficiencies. PATH looks forward to collaborating with interested parties to make Ultra Rice™ premix more widely available around the world. For more information about the Ultra Rice™ program, please contact:

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