Chapter 10
Reference on Rice Quality and Safety

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ABSTRACT
Over the last decade, there have been massive investments and research to improve rice yield per hectare. Alongside successful stories of improved rice yields are corresponding concerns stemming from pre- and post-harvest rice quality- and safety-related issues. Such concerns in rice production, handling, and storage systems present public health and economic problems. To consumers and producers, a serious concern is the potential growth of toxigenic fungi on rice during storage leading to contamination of the rice with mycotoxins. That withstanding, diminished functional, sensory, and nutritional attributes hugely impact the investment returns. The author understands that discourse on rice storage is incomplete without reflections on nutritional related losses. In rendering a strong chapter to meet a wider readership, the above issues are discussed with deliberate effort to highlight technological advances making headway in the rice industry; these are outlined in the introduction, at first, and then expounded on in subsequent sections.

INTRODUCTION
Rice (Oryza sativa L.) is one of the leading food crops in the world and the staple food for more than half the world’s population. The United Stated Department of Agriculture (USDA) has established rice grade as U.S. No. 1 through 6, in which sample grade is based on quality discount factors. These factors include weed seed, red rice, seed mixture, damaged kernels, chalky kernels, etc. It is generally considered a semiaquatic, annual grass plant. Environmental conditions, such as drought, high nighttime temperatures, low sunlight intensity, disease, inadequate or excessive nitrogen and draining water early in hot weather, all intensify stress on rice kernels. The susceptibility of kernels to develop chalk or other kernel-weakening features in response to stress differs somewhat among cultivars. Cultivars of
the two cultivated species, *O. sativa* L. and *O. glaberrima* Steud., can grow in a wide range of water-soil regimes, from deeply flooded land to dry, hilly slopes. Because of its long history of cultivation and selection under diverse environments, remarkable diversity exists in rice. The grain is grown in more than 100 countries on every continent except Antarctica, extending from 53° north to 40° south and from sea level to ranges of 2,500 m to 3,000 m above sea level. However, *O. glaberrima* is grown only on limited scale. The production practices for rice in various countries range from extremely primitive to highly mechanize.

Abnormally high nighttime air temperatures during kernel formation disrupt the starch formation process within the developing kernel. Thus, starch structure is altered and the general packing density of starch granules is reduced, creating chalky portions of kernels with associated changes in physico-chemical properties. Kernel smut disease anecdotally reduces milling yield and can sufficiently discolor rough rice to create quality reductions during parboiling. Field insects can also have detrimental effects on rice quality. Most notable is the stink bug, which bores into the kernel during development, resulting in a black spot on the kernel known as “peck.” Such kernels are typically removed after milling using color sorters.

The amount and timing of nitrogen fertilizer applied to rice during growth can impact milling yields. Greater nitrogen application rates at the beginning of kernel development are generally considered to increase head rice yield (HRY). One researcher surmises that a decline in HRY associated with reduced nitrogen application was a result of either decreased integrity of protein structural components of the rice kernel or of faster maturation and drying. Other data shows that topdressing nitrogen fertilizer at heading resulted in increased protein content for all cultivars tested and increased HRY for four of five cultivars evaluated, with the outlier being a cultivar with known high HRY potential.

Rice milling yield may be lower if rice is harvested at either very high or low moisture contents. At high moisture contents, many kernels can still be thin and immature and often break during the milling process. The ends of wet rice kernels grind off and become dust when they are processed. Rice may fissure if it dries in the field to below 15 percent moisture content and/or is rapidly rewetted (e.g., due to rainfall, heavy dew etc.). Rapid rewetting is a key cause for lowered head rice yields. Certain cultivars may be more susceptible to head rice yield reductions than others if rice drops below 15 percent moisture content (wet basis) and is rewetted in the field.

Laboratory milling systems are used throughout the rice industry to 1) estimate the milling yield that may be expected of rice lots when milled in large-scale milling systems and 2) produce milled rice samples from which visual, functional, sensory and nutritional assessments of the rice lot can be made. Laboratory-scale milling systems have long been used to estimate the milling performance that can be expected of a rice lot when milled in large, industrial scale systems. Laboratory systems comprise equipment that first removes the hull from the rough rice kernel, producing brown rice. Brown rice is typically milled to remove the germ and bran layers, leaving milled rice. The predominant measurements of rice milling yield are made using the endosperm, or milled rice kernel. The degree to which the bran layers are removed from brown rice, the degree of milling (DOM), plays a significant role in determining overall milling yield and functional quality of milled rice.

To achieve optimal milling yield and quality, long-grain rough rice is harvested at 19-21% moisture content wet basis (w.b.), and medium-grain at 23-25% moisture content. At such high harvest moisture contents, the grain is prone to heating which arises from respiration of the grain itself and associated microorganisms and pests; excessive respiration leads to rapid deterioration of the grain quality. Therefore, timely and proper drying of the grain from the relatively high harvest moisture contents to safe storage