World Bank (2011). World Bank, FAO, NRI Missing Food: The Case of Postharvest Grain Losses in Sub-Saharan Africa. Economic Sector Work Report No. 60371-AFR, 2011, World Bank, Washington, DC.

Green Ecological Grain Storage Technology and Quality Control in China

Yongan Xu, Lei Wei, Yang Cao, Peihuan He, Tianyu Shi, Dan Zheng, Xin Chen

Academy of State Grain Administration of China, Beijing 100037 China;
*Corresponding author: sty@chinagrain.org
DOI 10.5073/jka.2018.463.076

Abstract

Green ecological grain storage technologies (GEGSTs) are the means of controlling stored grain quality, and quality changes of stored grain are the basis of GEGSTs control. This paper introduces that GEGSTs are widely used in China, including monitoring and early warning of stored grain pest and mould, pest control by using food-grade materials, controlled atmosphere for pest control, ventilation for lowering and equalizing temperature, low and quasi-low temperature grain storage, treatment of hot spots, etc. And it introduces that grain processing enterprises' and market's request for grain quality, is called "quality control". It also clarifies that stored grain quality control is the purpose, and emphasizes that GEGSTs control is the process, so GEGSTs control should serve for quality control. Therefore, we propose that the technology application and the quality control of grain storage are equally important, and without the quality control, the technology application could be invalid, especially for sensitive areas in grain bulks. In the process of grain storage, special attention should be paid to quality changes in the sensitive areas, like real-time monitoring. Identify and utilize scientific and reasonable technology accordingly, including related technologies and equipment, to improve "overall" quality control level of stored grain bulks, and to gradually standardize them. By means of GEGSTs, positive ecological storage conditions are effectively utilized, which helps us achieve the purposes of safety, no pollution, high quality and nutrition during grain storage.

Key words: Storage Technologies, Grain consumption, Quality Control

Green ecological grain storage technologies (GEGSTs), based on the theory of grain bulk ecology, through the means of green ecological low-carbon, help us achieve the purpose of safety and quality control during grain storage. Grain storage technology control is a process, and grain storage quality control is the purpose, so grain storage technology control should serve for stored grain quality control. After harvest of grain, quality control in grain circulation involves three aspects, which are grain quality during consumption, warehousing and storage. Among them, stored grain quality is related to the warehousing quality and grain consumption quality, taking into account the two links of grain production and grain consumption. It is the key to do a good job in the convergence and coordination of these three aspects, to improve the technical level of grain storage management.

1. Green ecological grain storage technologies

GEGSTs are widely used in China, including pest control by using food-grade materials, ventilation for lowering and equalizing temperature, controlled atmosphere for pest control, low and quasi-low temperature grain storage, monitoring and early warning of stored grain pests and moulds, treatment of hot spots etc.

With the development of insect pheromones and different wavelength spectra to attract stored-grain pests, the density and insect situation of stored-grain pests in a granary could be monitored by using new trapping technology. Combined with the detection of grain condition, the population dynamics of stored-grain pests under different ecological conditions could be predicted, and thus the decision-making control technology was put forward. Integrated with grain storage information technology and other high-tech, a new core technology of comprehensive control of stored grain pests is formed.

Pest control technology by using food-grade materials is an upgrade of traditional inert-powder pest control technology with plant ash, diatomite and others. Insecticidal mechanisms of food-grade materials fall into the internode membrane of the insect body, which would lead to wear the

internode membrane during insects moving and adsorbing lubricating fluid and body fluids, thus resulting in pest death (Zidan Wu et al., 2011).

The gas composition in a sealed grain pile could be artificially changed, such as putting CO_2 and N_2 into the grain pile or reducing the oxygen concentration, so as to kill pests, inhibit the respiration and growth of the pests, prevent the occurrence of mold and delay the deterioration of stored grain quality. The main application technologies are related to natural hypoxia or artificial gas, which is essentially mechanical nitrogen-rich hypoxia process, to reduce oxygen in a granary.

Low temperature storage refers to the average grain temperature maintained at or below 15°C all year-round, and the partial maximum grain temperature is not higher than 20°C. Quasi-low temperature storage refers to the storage mode in which the average grain temperature is kept at and below 20°C all year-round, and the partial maximum grain temperature is not higher than 25°C. Grain warehousing temperature and moisture are the basis of low temperature and quasi-low temperature grain storage, which is generally divided into two cases: grain warehousing in high temperature seasons and grain warehousing in low temperature seasons. High temperature seasons are from May to October, and grain temperature is comparatively high when warehousing. In order to achieve low temperature and quasi-low temperature grain storage, cold ventilation technology must be employed, especially when the grain temperature is higher than 25°C. Once the granary is filled up, it is necessary to level off the grain surface, use horizontal ventilation technology to make outside air penetrate through the whole grain pile, or use uncovering-cloth ventilation technology for partial processing. These processes will help to not only eliminate the accumulated heat during grain warehousing, but also to eliminate the harmful gases released by the grain pile. Low temperature seasons are from November to March or April of the following year. During these times, grain temperature is low when warehousing ithe granary, so we just need to level grain surfaces.

2. Grain quality demand for grain consumption purposes

The quality demand of grain consumption varies according to the usage. The grain is eventually processed for humans, animals and industries in the market (Xiaohe Ma et al., 2008). Meeting the demand of the grain consumption market ensures grain storage rotation, higher prices for good quality, and good storage income and social benefits.

Human consumption (food grain) is the primary area of grain use, including mainly wheat and rice, and also maize and coarse cereals in small amounts. Food grain accounts for 50% of the annual grain consumption (Xiaohe Ma et al. 2008).

Requirements of the food grain are not only to eat enough, but also to eat well, to eat green, ecological and fresh food. In addition to providing products with good taste, color and smell, food grain processing must meet the standards of food hygiene, including prevention of heavy metals, mycotoxins, pesticide residues and other harmful substances in the product.

Grain provided for animals (fodder grain) is the second largest consumption area, supporting the development of the livestock and poultry industry and production of meat, eggs and milk. The fodder grain accounts for 33% of the annual grain consumption with consistent growth (Wei Jia et al., 2013).

In the process of development, the market demand for fodder grain quality is increasing and refining. Hygienical standards for feeds stipulate that the total number of mold in maize as well as wheat bran and rice bran is less than 40×10^3/g, and rules for maize with mold of $40\sim100\times10^3$/g is of limited use, and mold of more than 100×10^3/g is banned. Fodder corn standard stipulate that corn is divided into three levels, and the fatty acid value of the top-level corn is no more than 60 mg/100 g.

Grain provided for industries (industry grain), the third largest consumption area, accounts for 10% of the annual grain consumption, and the figure is predicted to be 13.9% in 2030. Industry grain is

used in a variety of products such as starch, modified starch, starch sugar, amino acid, organic acid, enzyme preparation, yeast and fuel ethanol, etc.

In recent years, some enterprises purchase and use poor quality grain in order to reduce the production cost of main raw materials, expecting to increase efficiency. But contrary to the expectation, low-quality grain leads to lower yield of main products, poor quality of by-products and poor market competitiveness.

3. Quality control requirements during takeover

Basic Requirements: "dry, full, clean"

Grain warehousing quality control is the source of grain circulation quality control. "Grain and Oil Storage Technical Specification" requires that quality of long-term stored grain should comply with the provisions of the Chinese national quality standards. Moisture content should not exceed the local safety moisture. Impurity content mixed with grain should not be greater than 1.0%, and when impurity content is higher, it should be cleaned out. At the same time, the stored grain quality indicators should comply with the "Stored Grain Quality Judgment Rules" and the relevant standards.

Quality Control Indicators

There are three main quality control indicators in the "Stored Grain Quality Judgment Rules", i.e., color and smell, fatty acid value, and taste score. Taste score, color and smell belong to sensory evaluation indexes determined in accordance with the conditions of the evaluation test by personnel with sensitive senses and identification ability usually in the laboratory environment. Fatty acid values are physical and chemical properties used for quantitative analyses.

Quality Control Key Points

The quality of newly stored grain is directly related to the appropriate storage degree, grain storage cycle and grain storage safety. On the basis of clearing impurities during warehousing to ensure "dry, full, clean", the fatty acid value of grain also needs to be strictly controlled.

A key link affecting fatty acid value changes is the process of grain drying. Because of the "labor problem", the number of post-harvest grain needing to be mechanically dried increases, and the number of natural air drying of grain systems decreases. The fatty acid value of mechanically dried grain is higher than that of naturally dried grain. The fatty acid value of newly harvested corn with natural drying is generally about 15 mg/100 g, and rarely exceeds 20 mg/100 g. The fatty acid value of mechanically dried corn reaches 29.7 mg/100 g ~ 45.3 mg/100 g, and among the samples with fatty acid values higher than 40 mg/100 g, there are more baked paste particles, more broken particles in the imperfect particles, and greater changes in the quality index in the mechanically dried corn than that with natural dryied (Chunlong Xia, 2008).

Technical Method of Quality Control

Before warehousing, we should pay more attention to controlling the fatty acid value. The lower the initial fatty acid value of grain is, the better. It is necessary for long-term storage of grain to take quasi-low temperature and low temperature control and other effective storage technology measures in order to control the rate of fatty acid increase and delay quality change; however, these measures will increase the cost of grain storage (Yurong Zhang et al., 2004).

In order to control the increase of fatty acid value, the drying process should be improved. In particular, the temperature of the drying air and the maximum temperature to which the corn is heated should be controlled to ensure the quality of the dried grain.

In addition, we should focus on developing grain drying technologies and devices that could be used and adopted easily by farmers. Farmers should be guided to carry out grain harvesting operations scientifically and reasonably, and do a good job at grain quality control.

4. Quality Control Requirements during Grain Storage

By taking advantage of good correlation between fatty acid and taste score, fatty acid value could be used as a sensitive indicator of daily monitoring of grain quality changes in order to monitor in a timely manner stored grain quality. We should pay special attention to parts of bulk grain, sensitive parts, and monitor in a timely manner, and to examine with reasonable scientific and technical measures, including related technologies and equipment, to improve "overall" quality control of stored grain.

5. Importance of Grain Quality Control

Guaranteeing grain quantity and quality are complementary. Guaranteeing grain quantity is relatively intuitive and tangible. However, maintaining quality, involving the biological and non-biological ecological environment of a grain bulk, is challenging. In order to control the physiology and biochemistry, molds, pests and other ecological factors of grain storage, it is necessary to strictly control grain quality during warehousing. At the same time, based on market oriented rules, we should strengthen the implememntation of proper grain storage technologies to achieve the requirementss of grain quality control, to meet the needs of grain consumption, and to ensure the high value of stored grain.

References

Zidan Wu, Yang Cao. Green ecological grain storage technologies ： China science and technology press, 2011.

Xiaohe Ma, Haitao LAN. Outstanding issues and policy recommendations on grain production capacity and food security in China. Reform. 2008, (9): 37 - 50.

Wei Jia, Fu Qin. Prediction of grain demand in China. Food and Nutrition in China. 2013,19 (11): 40 - 44.

Chunlong Xia. Discussion on quality index changes of dried corn. China High-Tech Enterprises, 2008 (14): 135 - 137.

Yurong Zhang, Wen Jiping, Zhou xianqing. Study on quality changes of maize under different storage temperatures. Grain Storage, 2003,32 (3): 7-9.

A new approach to acoustic insect detection in grain storage

Christina Mueller-Blenkle[1]*, Sascha Kirchner[2], Isabell Szallies[3], Cornel Adler[1]

[1]Julius Kühn Institut, Königin-Luise-Str.19, 14797 Berlin, Germany
[3]agrathaer GmbH, Eberswalder Straße 84, 15374 Müncheberg, Germany
*Corresponding author: christina.mueller@julius-kuehn.de
DOI 10.5073/jka.2018.463.077

Abstract

Insect pests in grain storages can cause severe financial losses. Infested grain needs to be treated and can be sold only with lower profit. Intense infestation can lead to contamination with mycotoxins and total loss of stock. Therefore, an early detection of insect storage pests is of great importance to farmers and storage keepers but is difficult to obtain in large amounts of grain.

Besides conventional detection methods such as insect traps and monitoring of temperature and relative humidity, acoustic monitoring can identify insect infestation. Insects in grain and other stored products produce sounds at a low level during movement and feeding activity. A new acoustic system was developed as part of the project "InsectTap" to increase the detectability of insect sounds. Highly sensitive microphones were installed inside a metal tube that increased the surface on which beetle signals could be detected. Additionally, the tube worked as a beetle trap recording all sounds from even one single beetle inside the trap.

The tube system was tested in 1 and 8 m^3 boxes filled with wheat. Infestation could be detected at a very early stage about 8 weeks before a temperature rise, or beetles at the grain surface indicated an infestation.

In the next step, this "Beetle Sound Tube"-System will be installed in different grain silos aiming for automatic early detection and specific identification of infestation. The information provided to the farmer or storage