DMX-7

Total Solution for better Grain & Feed Quality

a revolutionary moisture management program

DMX-7: A moisture management program for better grain & feed quality

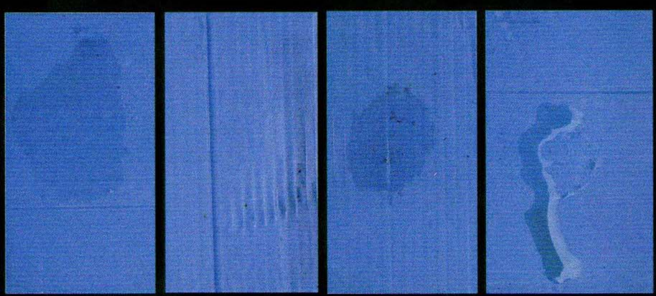
DMX-7 is a unique product that works two ways. First, DMX-7 contains propionic acid, which is the most effective mold inhibitor available. Propionic acid is a broad spectrum mold inhibitor but has a very limited residual effect due to its unstable volatile nature. DMX-7 is chemically engineered to lock in the effectiveness and advantages of propionic acid minus its unstable disadvantage. Secondly, DMX-7 contains deliquescents: chemical substance that physically bond to water molecules. These give the product a total control over free water molecules; an important attribute of moisture management in grain storage and feed processing. It is this unique moisture management property plus a very stable characteristic that makes DMX-7 stands out from all other products.

With such unique features, DMX-7 is able to offer you a moisture management program with complete flexibility even when required to store corn over very long period. "Mold control starts with Moisture Control"

DMX-7 is classified as a grain/feed conditioning mold inhabitor in a liquid form that can be used in 2 distinctive areas in a feedmill operation. First in grain storage, and secondly in the mixer to enhance feed processing, for a complete DMX-7 program. **In general, DMX-7 is not only a very good mold inhibitor, but also a moisture management tool for better grain and feed quality**. DMX-7 has been certified by FDA, EPA and Health Department of California for Food Production, for food use in the USA.

A quick testing method to show stability of a product.

Put an equal amount of each product on a non porous surface. Observe how the product will vaporise off over a short period of time.



Product X **Product Y** **Product Z** **DMX-7**

Photos taken after 2 weeks

Grain Degradation over a period of storage

Fresh Intake

4 months in silo (sample taken at silo bottom)

These pictures show the drastic difference in quality between the new arriving corn and corn that has been stored for 4 months in a flat bottom steel silo. Of significance is the obvious degradation in quality of the corn that has been stored over a period of 4 months.

1. Corn looks pale yellow
2. Discoloration of the germ area from grayish to dark - effects from live mold growth
3. Shriveled looking grain - moisture loss from uncontrolled grain respiration
4. Dry matter loss - caused by advance decay live mold contamination and shrink

A closer look into the silo reveals two things

1. Lots of grain weevils at an alarming infestation level
2. Rusted patches of wall sheets at the sweated areas.

These are all signs of a looming problem, so commonly seen in the region, but taken lightly by most. There is a science behind the explanations to these problems.

What actually starts the rot?

Maintaining grain in good condition in storage requires careful, routine inspection, good silo management practices, plus an effective program that can face up to the challenge of a tropical condition. Over the entire storage period, the very good grain will continuously degrade in quality and the speed that this happen is phenomenal in a tropical condition. Grains degrade 10 times faster in a tropical condition due to the very adverse weather condition of high heat, the hot scorching afternoon sun, the occasional burst of rain, and high humidity – all resulting in an occurrence of increased water activities in the grain mass. It only takes about 2-3 weeks for an onset of the many negative elements to start degrading the stored corn, and thereafter, worsening rapidly over time.

Water activity (Aw)

The single most important property of water in food systems is the water activity (aw) of food. The water activity of a food describes the degree to which the water is "bound" in the food and hence its availability to act as a solvent and participate in chemical/biochemical reactions and growth of microorganisms. It is an important property that can be used to predict the stability and safety of food with respect to microbial growth, rates of deteriorative reactions and chemical/physical properties.

Typical water activities, which are necessary for mold growth, range from 0.65 to 0.97; the water activity, and the propensity for mold growth increases with temperature. Shelled corn, for example, can be safely stored for one year at 14% moisture level and a temperature of 10 deg Celsius. However, the same corn stored at 30 deg Celsius will be substantially damaged by molds within 2 months. This is why it is so much easier to store grain in the cold regions but extremely challenging in tropical regions.

Moisture Migration

This is the spark that starts the fire. Moisture migration of free water liberating out of the corn is the primary cause of the whole problem. This is a naturally occurring phenomenon due to differences between day and night temperatures, a shift of differences in ambient temperature in a 12 hourly period day after day. Steel is a good conductor of heat - the silo external surface can get heated up to almost 60 deg Celsius in the afternoon and quickly cools down to about 22-25 deg Celsius depending on the night temperature. This will liberate bound water from within the grain to leach out as free water. Moisture will start moving if there is more then 5 deg Celsius difference in temperature. Movement of the liberated free water is further assisted by convective air current flow inside the silo. Free water in the grain mass will slowly migrate towards the cooler areas in a silo (shaded part of the internal wall opposite from the sun's direction and usually nearer to the lower half), is where you will normally see the sweated patches clinging to the silo wall; and always towards the silo concrete floor - which is why you will almost certainly notice spontaneous heating in the remaining corn at bottom of silo after gravity unloading. Concentration of free water in localized spots in the grain mass result in an increase in water activities (Aw). Increased Aw supports microbial and micro-flora activities, and this is the reason we see spontaneous heating in the grains. The heavily live mold contaminated caked layer sticking to the silo sidewall, if not scrapped away, will be the seeding of future problems in the next round of storage.

Grain Respiration

Grain will respire once it detects sufficient heat and moisture (whether bound or free). Many feedmills dread storing corn at or above 14% moisture. The hot pounding tropical sun (with its strong UV rays) during mid noon will drastically bring surface temperature of the upper part of the silo to a temperature level way above ambient temperature, much like how your car roof gets heated up from the hot afternoon sun. If unchecked, this surface heat can rapidly conduct into the grain mass. In cooler regions, aeration is used to blow cold ambient air in lowering grain mass temperature and suppressing insect development and micro-flora growth. On the contrary, a good aeration program (with a good knowledge and application of ambient temperature and humidity level) in the tropics or hotter regions can at best, help repel conducted heat in the grain mass and to equilibrate grain mass temperature or the elimination of temperature variance in the grain mass. However, even with a good aeration program, things can go terribly wrong if moisture migration is not controlled. If free water continues looming in the grain mass, which up to a point, when serious enough - with increased water activities and spontaneous heating, will cause the grain in and around the localized moisture areas to respire just as readily. Once grain respires, much of the bound water in the grain is liberated as free water. If left unchecked, can quickly spiral into a complex moisture related activities, resulting in increased water activities (Aw), spontaneous heating from microorganisms metabolism in the grain mass - causing grain to respire, shrink and shrivel, commonly referred to as shrinkage or weight loss.

Shrinkage

Shrinkage is physically noticeable and contributes to the financial losses in grain storage. Feed mills managers often take this as a physical weight loss due to moisture loss, and accept it as a common problem beyond their control. Besides weight loss, shrinkage causes irreversible changes to starch molecules (especially to the linear amylose structure) and protein matrixes that encapsulate individual starch granules within the endosperm of the corn kernel. Moisture loss causes starch retro-gradation, which limits digestibility and nutrient availability to the animal. This is an important factor why animal fed fresher high moisture corn performs better than older drier corn. Shrinkage of corn (moisture loss) also has a negative impact on feed pelleting, since less moisture is being relayed to the compounded meal - resulting in poorer steam conditioning and cooking, and hence a low degree of starch gelatinization – and pellet quality compromised.

Bio-deterioration

Bio-deterioration is due to the activity of inherent enzymes present in the seed. The extent of deterioration depends upon the level of enzyme activity, which in turn is determined by moisture (free water) and temperature. Enhanced bio-deterioration results in an enhanced loss (or denaturing) of nutrients and contamination with anti-nutritional factors. Nutritional impairment in degraded corn during storage will be of great consequence to the health, nutrition and performance of the animals, while directly hurting the profitability of an organization.

Insect Infestations

Insect infestation is a greater problem in regions where the relative humidity is high, but temperature has the greatest influence on insect multiplication. At temperatures of about 32° C, the rate of multiplication is such that a monthly compounded exponential increase of fifty times the original number is theoretically possible. Growth of insect pests and molds also raises both temperature and moisture; and thereby accelerates the activity of the enzymes, which would otherwise remain at a low level if conditions of storage were favorable. Insect infestation is rampant whenever there is heavy sweating, in areas where corn sticks to the silo wall in patches. Instinctively, insects will naturally gather around a conducive-environment (moist, heated, rich food source for young lavas) to breed and incubate their eggs.

Granary Weevils congregates in the caked and badly molded corn

The chewing damage and activities caused by granary weevils brings about increased respiration in the corn mass and this, associated with the metabolic activity of the pests themselves, promotes an evolution of heat (spontaneous heating) and moisture, which in turn provide favorable living conditions for molds and subsequently, at very high moisture levels, for bacterial growth.

Corrosion

Corrosion of galvanized steel silos is due primarily to moisture ingress and the consequent degradation of the sweated corn fermenting and producing a complex mixture of chemicals amongst which were formic and acetic acids, both of which are extremely aggressive and damaging towards galvanized coatings and steel. Worst and best case scenarios for continued exposure to damp corn predict that the total useful service life of the silos can be reduced by half if the corrosion is left unchecked or proper remedial maintenance to the corroded surface is not look into. Many 9-10 years silos failed because of corrosion and neglect.

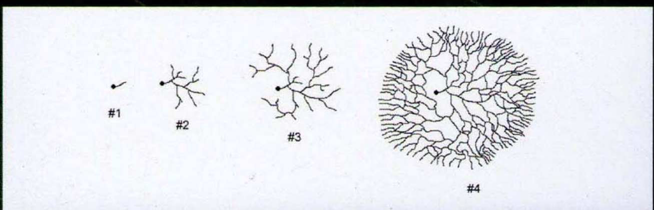
3 years old silo -
Heavy corrosion due to constant sweating

4 years old silo -
Condition (no sweating, no corrosion)
- where corn has been treated with an effective program

Challenges involved in maintaining overall grain quality

The greatest culprit to grain quality in tropical grain storage, whether in bags or in silos, is live field mold that attaches to the corn in post harvest handling. Moisture migration of free water leaching out of the corn is the primary cause of the problem. Secondary actions from grain respiration further compound to the problem. Both actions produce a flood of free water, increasing water activities (Aw). Available free water is the life trigger that live mold and mold spores is waiting for, to further colonize the grain mass. Molds require moisture and organic nutrients to thrive. Its network of fine mycelium (vegetative part of fungi that helps it absorb nutrient from the environment - much like the rooting system of a plant) secrete digestive cellular enzymes (cellulases) to degrade otherwise insoluble organic substrate into its soluble subunits, which they then absorb and use as sources of energy. This explains why, from the original creamy color of fresh corn, we see an eventual progression of shady grayish darkening of degraded corn till the germ area and almost the entire corn is finally black in color.

We can practically use the darkening of germ area as an indicator of how serious a mold problem we have with the stored corn. When live mold thrives, nutrient and energy value will slowly diminish and there is always a possible increase of harmful toxin, depending on the severity of the problem and fungi type.



Mycelium Growth - a single spore germinates and produces a short initial hypha, growing and expending into a web of mycelium. This is a fundamental charac-teristic of all macro fungi or micro fungi.

In order to feed, the mycelium releases enzymes into the surrounding and these enzymes break down complex organic polymers into simpler compounds (generally various sorts of sugars) which are then absorbed through the hyphal cell walls.

This is the reason we see a darkening of degrading corn, especialy in the nutrient pack germ area, over storage - a clear sign of mold contamination.

Corn free from mold contamination, maintaining the germ's creamy appearance. The germ's nutrient profile is kept intact

Corn with the typical mold contamination generally accepted as okay and used by feedmillers. Note the damaged germ and live mold load. This is where the damage goes into broiler feed

If storage is above 4 weeks, it is relevant that we understand the various challenges from moisture migration, grain respiration (more aggressive in a tropical storage condition), and the ensuing water activities (Aw - level of free water challenges) that is the cause of all sorts of micro-organismal activities (both microbial & micro-flora), and the subsequent spontaneous heating in the grain mass.

Mold control starts with moisture control.

Molds consume nutrients and oxygen and produce carbon dioxide, water and heat. Water and heat causes the humidity of air surrounding nearby kernels to increase above 65% to 70% and results in further mold growth. In a typical field scenario, the "normal mold inhibitors" of organic origin, despite it's proven prowess in laboratory testing against live mold challenge, has no chemical ability to control free water molecules. These products are also unstable and volatile (vaporizing off in 3-14 days depending on products). The challenge for the need to stay efficacious over lengthy storage period - is the reason you don't see result from these products in maintaining overall grain quality over long period storage.

With an effective chemical program (ability to manage moisture with an extremely long residual value), we will see:

- No Sweating, No Caking, and No Corrosion damage to silo wall
- No spontaneous heating - especially at bottom of flat bottom silo as moisture tends to migrate toward the silo floor over a period of time resulting in microbial & micro-floral activities causing the grain to heat up
- A reduction in the initial life mold count of grain at point of intake (usually by 2 or 3 folds) - live mold will eventually die off if there is no heat & free water available to sustain it
- Minimize shrinkage - by keeping grain respiration to a minimum. Shown to reduce the usual shrinkage by about 70%. Corn (a key macro ingredient in feed formula) that has a high moisture content can obviously carry over its available moisture to the compounded meal - is an important parameter in feed pelleting
- Over a period of extended use in a silo complex - can greatly reduce insect infestation by 80%
- A better overall grain quality. A cleaner and higher nutrient profile - important for animal performance at farm level

DMX-7 treated corn - 8 months (sample taken at bottom of silo - Thailand)

Brand X treated corn - 5 months (sample taken at silo bottom - Vietnam)

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