A Review on Causes for Damaged Sorghum and Corn Grains

Sheetal B. Gawande¹, Dr. I. D. Patil²

¹Research Student, SSBT’s, COET, Bambhori, Jalgaon (MS), India
²Professor and Head, Department of Biotechnology, SSBT’s, COET, Bambhori, Jalgaon (MS), India

Abstract:
In this paper exhaustive review of literature is carried out for determination of main causes and type of sorghum and corn grains damages. It is found that the best possible remedy for damaged sorghum and corn grains is to utilize it for ethanol production. Since sorghum and corn grains is having highest potential ethanol production. Major causes of sorghum and corn grains damages are briefly discussed in this paper. It is revealed that grain gets damaged during harvesting, handling, and storage due to breakage. This cause reduction in grain size and protective shield of grains becomes weak. On these weak grains an insect infestation is able to reduce its chemical or nutritional value which is very important for its further utilization. The intensity of grain damage is difficult to quantify accurately but it can measured with the help of physical and chemical tests. Physical parameters of grains like length, width and Moisture content are discussed here.

Keywords
Breakage, Ethanol, Harvesting, Handling, shield

1. Introduction
The edible parts of plants and animals that are produced or harvested for human consumption but that are not ultimately consumed by people is called as food loss and waste. Food loss and damaged grain have many negative economic and environmental impacts. Based on weight the Food grain and Agriculture Organization of the United Nations (FAO) observed that in the world, Out of all food produced 32 percent food is lost or wasted in 2009. Approximately 24 percent of all produced food is waste or lost when converted to calories. Farmers’ incomes can be reduced economically because of waste investment in production of damaged food grain. Particularly food loss is defined as food that gets lost before it reaches the consumer or spills, spoils, incurs an abnormal reduction in quality such as bruising or wilting [1].

![Figure No1: Food Loss and Waste by Kcal](Source: WRI analysis based on FAO. 2011. Global food losses and food waste—extent, causes and prevention. Rome: UN FAO)
Food loss is because of agricultural process or technical limitation in storage, infrastructure, packaging, and marketing. Food waste is a food which is discarded either before or after it spoils though it has a good quality and fit for human consumption. Food loss and waste increase consumers’ expenses economically. The utilization of the waste food is need of the world to reduce the farmer’s loss. These damaged or waste food grains can be utilized for the effective production of ethanol using fermentation process. Nutritional qualities of grains are as given below

<table>
<thead>
<tr>
<th>Grain</th>
<th>Protein (g/kg)</th>
<th>Fat (g/kg)</th>
<th>Carbohydrate (g/kg)</th>
<th>Crude Fiber (g/kg)</th>
<th>Energy (Mcal/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>108</td>
<td>31</td>
<td>720</td>
<td>21</td>
<td>2.0</td>
</tr>
<tr>
<td>Wheat</td>
<td>125</td>
<td>17</td>
<td>720</td>
<td>18</td>
<td>2.1</td>
</tr>
<tr>
<td>Corn</td>
<td>92</td>
<td>45</td>
<td>716</td>
<td>27</td>
<td>2.1</td>
</tr>
</tbody>
</table>

The general Grain structure and composition of sorghum and corn are given below

Grain Damage: - agriculture based food grains like sorghum and corn grains are not suitable for to be used as food and if these grains are consumed by human being or animals, it will badly affect their health. Grain damage quality can be measure with the help of physical and chemical tests. Out of many common methods for determining grain damage some type of visible inspection can carried out with minimum amount of error. All factors that cause grain damage are difficult to recognize and measure them accurately.
Types of the sorghum and corn grains damage are discussed as follows:-

**Broken/Cracked Kernels**

A broken or cracked kernel is one of the most common forms of grain damage. This type of damage occurs during handling processes and moving grain anytime from one place to another. During further handling, deterioration of the grain more quickly through accelerated insect and fungal infestation and a faster propensity to breaking because of cracks in kernel. The increase in mechanical damage decreases the allowable of storage time.

![Kernels with zero to multiple stress cracks as placed from left to right.](image)

Figure No 3:

Stress cracks can form within the kernel, in addition to exterior cracks. Combination of thermal and mechanical handling processes like drying usually causes the stress cracks in the grain. Kernels can break more rapidly during further handling because of internal stress cracks which have greater breakage vulnerability. Percentage losses also turn into large quantities of useless grains by contaminating them with their droppings, webs and odors apart from damage due to insect pests. Quantitative as well as qualitative losses in grains take place significantly during storage [3].

**Fungal and Insect Infestation**

![Kernels which contain any mold on the exposed part of the kernel are considered damaged](image)

Figure No 4:

Dry matter losses may be because of Fungal and insect infestations make the grain less valuable. Grain damage as well as loss the actual weight of the grain result due to grain insect infestations. An insect infestation is able to reduce the chemical or nutritional value of the grain which is very important for the end use. Moisture, mechanical damage, storage temperature, and other factors can be trigger mold growth. Weight or quality losses because of insect during storage are not accurately measured though it is estimated around 35% of total production [4].

**Heat Damage**

Heat damage mostly arises from drying of grain. USDA recognized heat damage as a new type of damage though it is a sub type of damage including broken or cracked kernels. Heat damaged kernels may have seed coats which are peeling off or have a discolored, wrinkled, and blistered, be puffed and/or swollen. It is undesirable effects due to elevated temperatures used to eliminate moisture by drying process. Breakage/cracks, discoloration, and shrinkage are the most common signs of heat damage. Interior and exterior stress cracks on the kernels are caused because of temperature and moisture gradients in the grain during the drying process. Grain qualities problems arise due to cracks are listed in the two earlier grain damage types. Brown et al. explained that for multiple types of drying, the percentage of stress-cracked kernels increases as moisture content increases [5].

**Causes of damaged sorghum and corn grains:-**

1. **Damage during Harvest**

Grain damage between field and its end use is discussed in this article. Hence harvesting is first cause of grain damage itself. In some growing environment, Grain quality is might be majorly affected by harvest timing. Mechanical damage occurring during threshing process is a huge cause of grain damage. Threshing is a process of stripping the grain from the plant and can frequently cause cracks as well as other damage. Severe kernel damage during threshing can cause due to grain harvesting at too high moisture. An attempt to find methods to minimize grain damage without decreasing harvest productivity has been made by many researchers. Among the many harvest factors affecting the grain damage during the harvest some factors are uncontrollable by
operator like moisture content. The damage increases exponentially with the increase in rotor speed and it has a largest effect on grain damage. Actually decrease in forward speed or ground speed of machine, increases the grain damage [6]. If the gap of the concave is too narrow or as the length of the concave increases then grain damage also increases that implies its dependence on setting of concave [7].

**Damage during Handling**

Grain undergoes free fall during many handling processes. Usually grain is conveyed and dropped into storage devices such as semi or grain cart and it also undergoes free fall during unloading. Anytime free fall can be cause grain damage. The grain damage due to free fall is depends on many factors like height of travel, contact surfaces, discharge size, impact angle, and type of grain. The quantity of mechanical damage occurred during impact increases with the increase in drop height. The increase in number of handling process, increase the grain damage.

**Damaged due to insecticides:**

The insect damages are ranging from 5 – 30% of the world’s total agricultural production [8]. Before few weeks of crop harvest in the field, insects starts infestation frequently and could be Reach to the storage facility [9]. Weight or quality losses because of insect during storage are not accurately measured though it is estimated around 35% of total production [4]. Greenbugs are pear shape of aphids with approximately 1/16 inch long. small grains and sorghum damaged by Greenbugs in three ways: (1) Copious amounts of sap are extracted with their piercing-sucking mouthparts, thereby depriving the plant of water and nutrients; (2) A chemical is injected during the feeding process and this causes enzymatic destruction of cell walls which leads to chlorosis (reddening and yellowing) and eventually necrosis (browning) of leaf tissue; (3) Devastating viruses such as barley yellow dwarf virus in small grains and maize dwarf mosaic virus (MDMV) in sorghum may be transmitted, or the plants may be predisposed to other diseases like charcoal rot of sorghum. Greenbugs may infest and injure host crops at almost any stage of plant development from seedling stage to heading or later. Seedling plants are very susceptible to greenbug injury, which may result in plant loss, stunting and delayed maturity. Injurious infestations on larger plants cause stunting and reduced kernal size and quality.

**Determination of Physical Parameters of the Grain**

**Length and width:** The length and width of 10 randomly selected from each sorghum and corn variety were individually measured using a Vernier caliper.

**Moisture content:** Grain moisture content is expressed as a percentage of moisture based on wet weight (wet basis) or dry matter (dry basis). Wet basis moisture content is generally used. Dry basis is used primarily in research.

\[
M_w \text{ (wet basis)} = \frac{(w - d)}{w} \times 100
\]

\[
M_d \text{ (dry basis)} = \frac{(w - d)}{d} \times 100
\]

\[
w = \text{wet weight}
\]

\[
d = \text{dry weight}
\]

\[
M = \text{moisture content on a percent basis}
\]

**Assessment of Grain Damage**

A change in moisture content will also change in test weight of grain. The test weight is the weight per bushel based on volume. Since grain volume changes with a change in moisture content and since water and dry matter do not weigh the same, the test weight is changed. The grain damage was determined by using the formula:

\[
\% \text{ Grain Damage} = \frac{(\text{Initial Grain Weight} - \text{Final Grain Weight})}{\text{Initial Grain Weight}} \times 100
\]

**Utilization of damaged corn and Sorghum grain:**

Germination, or sprouting, is a common problem for grain when weather is moist during harvest or the environment is humid during storage. The most important issues in industrial ethanol production are yield, efficiency, and energy consumption. Laboratory results in terms of ethanol yield and ethanol fermentation efficiency from artificially germinated high-tannin sorghum suggest that huge potential energy savings exist in production of ethanol from germinated sorghum grain. Using germination-damaged sorghum for industrial ethanol production might benefit the producer and end user by expanding market uses of what has been historically considered a low-value commodity. Germination not only causes compositional changes in the sorghum grain but also initiates a series of biochemical and physiological changes. Intrinsic enzymes such as amylases, proteases, lipases, fiber-degrading
enzymes, and phytases are activated. Current fuel ethanol research and development deals with process engineering trends for improving biotechnological production of ethanol. This paper gives a overview of the current ethanol production processes from cereal grains and effect of sorghum grain sprouting on fermentation for sustainable fuel energy production. [10]

Conclusion:-
In this paper various causes of sorghum and corn grain damages are briefly discussed. Main causes of grain damages are mechanical damages during harvesting and handling grain size reduces due to breakage. Moisture content and due to insecticides deterioration of grain occurs heavily. Measurements of grain quality for determination of grain damage are also briefly discussed in this paper. After identification of sorghum and corn grain in damaged condition, that is these grains are not usable as food or feed. The next best option for its utilization is as fuel energy production.

Acknowledgment:
Authors are thankful to the SSBT’s, College of Engineering and Technology, Bambhori, Jalgaon for providing library facility. The authors would like to thank the staff and colleagues for useful discussions.

References:-
[1]. Installment 2 of "Creating a Sustainable Food Future" Reducing Food Loss and Waste brian lipinski, craig hanson, james lomax, lisa kitinjoa, richard waite and tim searcher. World resource Institute, Working Paper