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Appraisal of Various Factors Responsible for Decline to Wheat Production

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One of the most crucial steps in the entire wheat production process is the harvesting of the wheat. China has a large and varied area dedicated to wheat cultivation. Also, there has always been a problem with harvest losses because of the wide variety of brands and the subpar performance of domestic combine harvesters. There will be less money for the farmers if there are any problems during harvest. Therefore, it is of utmost importance to select the appropriate loss reduction methods to effectively reduce wheat harvest losses in light of the actual situation of mechanized wheat harvesting and the losses occurring within various parts of the harvester. This study, guided by the issues of loss during mechanized harvesting, first identifies the primary losses in the operation of a wheat combine harvester, then introduces sensor monitoring technology for grain harvesting loss and intelligent control technology for the combine harvester, and finally analyses the application of these technologies in the service of loss reduction during mechanized wheat harvesting. Finally, we draw some conclusions and make some recommendations about this loss reduction technology for mechanized wheat harvesting so that it can be used as a benchmark elsewhere and contribute to the continued progress of modern agriculture.

Keywords: Wheat Yield, Production, Sensors, Controls

Introduction

The world's largest grain producer in China [1]. In 2021, a total of 140 million tonnes of wheat were produced from a total planting area of 25.6 million ha [2]. Harvesting wheat is a crucial step in the manufacturing process. A decrease in total grain output and quality during grain harvesting is referred to as "harvest loss," and it represents a direct loss of income for farmers [3]. The most common types of loss during the mechanical harvesting of wheat are header losses, threshing, separation losses, and cleaning losses [4]. Wheat suffers an overall loss rate of about 7% during harvest. Maximum grain loss occurred during the mechanical harvest of crops (2.5 percent), followed by loss due to bird feeding, rodents, insect pests, natural grain falling, etc. (2 percent), and nearly 0.41 percent due to transportation [5]. Recent years have seen an increase in the number of studies and reports that corroborate the growing severity of the problem of wheat loss during harvest [6]. As a result, we need to give serious consideration to the issue of grain harvest loss and take constructive steps to reduce it, as well as increase research on loss detection devices, to set the stage for more effective efforts to reduce such losses in the future.

An estimated 9 million metric tonnes of wheat per year are wasted in China. This is the equivalent of failing to harvest 1.3 million hectares of land. To a large extent, the loss of wheat results from both the growth period and mechanized harvest, with the latter accounting for the bulk of the total. It is of the utmost importance to figure out how to decrease the amount of grain that is lost during harvest. This paper begins with the most significant losses experienced during mechanized wheat harvesting and proceeds to detail the root causes of those losses by breaking down each component of the combine harvester's operation. It then turns its attention to the current state of sensor monitoring technology and intelligent control technology for the combined harvester, with a focus on how they affect grain harvest losses.

The efficiency of harvesting grain is greatly enhanced by the use of a combine harvester, which is capable of cutting, threshing, cleaning, and separating in a single pass. Learning the fundamentals of how a combine harvester operates is essential before making any modifications to cut down on waste. Straw that has been threshed and cleaned is expelled from the cylinder's opening. An inclined conveyor then transports the material to the threshing cylinder. Through the concave screen and into the shaking plate, any remaining grains, short stalks, or contaminants are removed before entering the cleaning system [7].

According to studies conducted by North Dakota State University, the combined header is responsible for more than half of all grain loss that occurs before the crop is processed. Main causes were sloppy mechanical adjustment made by hand and header vibration. Wheat grains are easily redirected when the reel is positioned too low, causing the machine to move in a forward direction. Wheat ears fall forward from cut wheat plants and can be easily broken from the root by a reel moving at too high a speed, leading to significant losses. Machine harvesting of mature wheat results in some grain loss due to poor adhesion between the grain and the wheat ear [8]. Wheat plants left on the header floor at the end of a field will be thrown out due to inertia if the header is raised too slowly [9]. One place to begin implementing solutions to the problem of wheat loss is by increasing the header's intelligence and enhancing the accuracy of the manual mechanical adjustment. Farmers typically buy domestic combine harvesters outright, and harvesting often begins before operators have received adequate training in the proper use of the machine. Losses in production can also be attributed to human error[10].

Related Studies.

A wheat combine harvester's threshing and separation system is a crucial component because it prevents the grain from being damaged or wasted while being crushed [11]. This is because unclean threshing, broken grains, and incomplete separation are unavoidable.

Therefore, more grain is crushed per unit of time. Because the grain enters tangentially and discharges axially, the straw is crushed, making separation more difficult, and some grain is lost due to crushing and entrainment when using the tangential + longitudinal axial flow cylinder for threshing. Since existing threshing cylinders are not completely free of grain loss, sophisticated sensor technology is required to monitor grain loss and make real-time adjustments to cylinder parameters in order to minimize threshing and separation losses. If the concave clearance is too big, materials flow more easily, but there's still more work to be done in the threshing process; if it's too little, blockages are more likely to form, and the machine as a whole will be less efficient [12].

A combined harvester's cleaning loss is a key performance indicator because it is one of the main reasons why harvested grains often go to waste. When a combine harvester is in use, some grain will be lost due to the cleaning process. There are a number of variables that affect the rate of cleaning loss, such as the method used, the amount fed, the parameters of the mechanism, etc.Both airflow and air and screen types dominate the market for cleaning equipment at the moment [13] [14]. In short, the use of real-time sensor technology to monitor cleaning loss, followed by automatic adjustment of the appropriate working parameters, is essential for achieving the best possible cleaning result.

Increased accuracy, reliability, and productivity during harvesting can help cut down on grain waste. Real-time sensor monitoring and data generation can improve combine harvester efficiency and yield useful information for harvest analysis and optimization. In terms of piezoelectric performance and sensing applications, polyvinylidene fluoride piezoelectric film stands out as a top pick [15]. Only 50 m thick, piezoelectric films are extremely thin [16]. A 0.1-millimeter-thick PET plastic film was applied to both the top and bottom surfaces for scratch protection [17]. By observing the piezoelectric effect, we can conclude that charges are generated when a grain strikes a POLYVINYLIDENE FLUORIDE piezoelectric film. In Figure 5, we see the steps taken to create the POLYVINYLIDENE FLUORIDE piezoelectric film sensor and track its loss.

Results and Discussions.

As a result of their low cost and reliable performance, academics have begun using POLYVINYLIDENE FLUORIDE piezoelectric film sensors to monitor grain loss. Locations on the combine at which sensors can be installed. POLYVINYLIDENE FLUORIDE piezoelectric film sensors are used in loss monitoring technology for combines due to their low cost and low technical barrier to entry [20]. Instability in the structure of the piezoelectric film sensor necessitates periodic correction, which slows the combine harvester's regular operational progress [21].

Researcher designed a monitoring device for combined harvester cleaning loss using piezoelectric ceramics as a sensing element, and field tests showed a monitoring error of 3.57 percent. Because of their high vibration transmission capacity, piezoelectric ceramic sensors have been put to use in monitoring grain loss. However, we are unable to obtain the spatial distribution characteristics of grain loss due to the piezoelectric ceramic sensors' unreliable measurement accuracy and uneven surface sensitivity distribution.

A combined harvester's smart technologies. Smart fault detection (1), autonomous driving and navigation (2), production measurement (3), threshing separation and cleaning control (4), online loss rate monitoring (5), header control (6), and feed detection (7) [25] [26]. New Holland's CR-series combines have a profiling header for automatic stubble height and feeding-amount control, avoiding ams caused by too much material being fed at once [27] [28]. To make adjusting the combined header's parameters quick and straightforward, Chen et al. designed a device that uses buttons instead of multiple levers. In addition, a microcontroller-based smart header control system was developed by the team, allowing for fine-grained control of the header's height. Researcher sensor type for a header profiling device with electrohydraulic control exhibited rapid system response, stable operation, and precise profiling [29][30]. A robust feedback linearization-based header height control strategy was proposed [31], which allows the header's pitch angle to be automatically adjusted in response to ground fluctuations. Researcher used a mechanical profiling mechanism in conjunction with ultrasonic array sensors to determine header height [32]. The limit hinge is linked to the profiling plate, which makes ground contact during operation. The angle sensor is coupled to the connecting rod, which is rotated by the ground profiling plate. The basic idea behind a mechanical header profiling mechanism is depicted in

Food Consumption

To calculate the feeding amount, take the mass of the combined body and divide it by the time it takes for that mass to move through the body [33]. Numerous studies on determining the optimal amount of feeding for a combine harvester have been conducted by experts from a wide variety of domestic and international academic institutions [34] [35] [36]. Scholars on the home front have contributed significantly to our understanding of feeding quantity monitoring [37].

Grain loss and crushing rate in a combine harvester are proportional to the efficiency of its threshing and separation system. The majority of lost grain occurs during the threshing and separation process due to dirty threshing brought on by broken stalks entrapping the grains. [37]. The conventional approach to detecting artificial grain loss is accurate but time-consuming and inefficient, and it can only be used with a subset of the experimental data collected through sampling; therefore, it cannot provide loss information in real-time data to the controllers. As a result, sensors enable continuous online tracking of grain loss.

Studies on grain loss sensors for combine harvesters started in the developed world in the 1960s, and today several manufacturers sell them. Most recently, a number of well-known producers of agricultural machinery have begun installing sensors in their combine harvesters that provide continuous, online data on the amount of grain that is lost. [40]. A researcher found that depict the combine harvester's threshing and separation loss tracking system.

The combine harvester's cleaning system is crucial because it helps harvesters get the cleanest grain possible with the least amount of waste [41]. Intelligent control systems implemented in grain cleaning devices have been shown to significantly cut down on cleaning losses and boost overall machine output [42] [43]. Loss-reduction technology has matured to the point where it can be studied and is already being implemented in models in other countries [44] [45] [46]. A TUCANO 550 combine harvester operating on a slope

Berner et al. initially implemented a control system for the cleaning system. Static pressure measurements taken during cleaning were used to determine the grain yield. By utilising a database model, we can determine the ideal fan speed to minimise the amount of screen loss and thus maximise predicted grain yields.

Discovering the causes of loss during combined harvester operation is a prerequisite for optimizing the use of loss monitoring tools. the paper's newly-introduced causes of grain harvest losses [47]. Loss of harvested grain is a key performance indicator for a combined harvester. [48][49]. The force and speed with which the grain hits the sensor plate will determine how much of a charge will be produced. Simply put, charge can't be measured directly, a charge amplifier can transform it into a voltage signal [50]. As shown in Figure 12, the sensor system is actively tracking the loss of grains.The typical error ranges for measuring grain loss and the locations on combines where the various types of grain loss monitoring sensors are typically mounted are detailed in Table 3.

Recommendations from the Technical Community for Reducing Wheat Shearing Losses When Employing Mechanized Methods Following are some suggested technical guidelines for harvesting wheat with machinery more effectively and with higher quality. There is a sizable market for used combine harvesters in China, despite the fact that the machines' components are often broken and significant amounts of grain are lost during harvest.

Conclusions

There hasn't been a lot of research done on the topic of monitoring grain loss at the combined header, so more investigation is needed. Therefore, it's crucial to convert the latest data from grain loss sensors into a precise absolute value for grain loss. The sensor system for tracking grain loss needs to have its monitoring speed and precision enhanced. The current resolution of the grain loss sensor is not very high. A greater investment in agricultural sensor R&D is needed to boost their performance and efficiency in time for the wheat harvest. Upgrade the sophisticated algorithm that controls the system.

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