Condition Monitoring of Farm Machinery, a Maintenance Strategy for a Sustainable Livestock Production: A Review

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Abstract. The agricultural industry is crucial to the development of the national economy. Inadequate agricultural equipment maintenance could result to a huge economic impact, especially during the harvest period. Thus, this study highlighted on the importance of condition monitoring of agricultural machinery/equipment for enhanced agricultural productions. The study established that adequate condition monitoring of agricultural machineries provides reliability data that will help in the implementation of the integrity of maintenance strategies. Additionally, adequate health monitoring of the advanced machineries will help in improving the efficiency of the machines as well as improving the overall agricultural productivity. This study provides great insight to farmers on the way to monitor and maintain the health of their agricultural machineries.

Keyword: Maintenance, Condition monitoring, Agricultural production

1 Introduction

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Of all these tasks, an essential part is capacity planning which ensures that all operations meet the set current target as well as the future demand, thus, highlighting that cost effectiveness should be the watch word of the farm operation manager. Thus, adequate capacity planning helps in improving agricultural operation efficiency and reducing the cost of maintenance. Currently, agricultural operations in the developed and developing countries are gradually being replaced with intelligent machines and autonomous vehicles which help in reducing the hard labour as well as improving the efficiency of operations. The presence of innovative sensing and several technologies for actuation integrated with advanced information and communication technologies gave the potential for the current advancement in agricultural operation. However, for this to work effectively, there is a need to adequately reconsider the conventional method of agricultural machinery maintenance. Thus, maintenance activity planning and methods must meet with the current methods and features. Particularly, in the case of planning of route and scheduling of task. In fact, for sustainable agricultural production, there is a need to advanced maintenance of agricultural machinery. According to studies, maintenance scheduling is basic for machinery in the operation of wind farms. It has impact on the cost of the equipment, revenue from the market and logistics plans required by the maintenance personnel. In some operations, cost of maintenance contributes a lot to the running cost of the wind farms. Thus, to avoid or probably reduce this, operators in the wind farms are constantly in search of maintenance strategies that will improve the effectiveness of maintenance policies using real-time data obtained from sensors. Condition monitoring techniques has the capacity to identify the degradation of agricultural equipment and give an estimate of the conditions of the equipment. Thus, operators are alerted when the machinery condition gets to the toxic level. Despite the importance of farm machineries, operation and maintenance policies rely heavily on several decisions in practice. For instance, maintenance policies used in wind farms involved the combinations of several corrective strategies that take proactive steps to initiate maintenance action upon the failure observation as well as policies which are time-based for the performance of maintenance activities. Furthermore, in the case of wind farms, opportunistic maintenance which involve the grouping of several maintenance actions for the purpose of reducing downtime are always used. Within the context of opportunistic maintenance, corrective and preventive maintenance could be scheduled as maintenance tasks for other components especially for turbines. In most wind farms, opportunistic maintenance is classified into the use of optimization models to obtain different operation and maintenance. The other approach utilizes structured policies to make procedures for maintenance decisions. Both approaches have what is known as multiple threshold values that contains operational parameters and ages which helps in the estimation of optimal times to start the first and other subsequent maintenance actions. However, some of the problems of these policies is that sensor data is not used and usually assume data failure of identical components follow the same distribution. But in in the actual fact, every component has varying degree of degradation and failure occur from several factors such as manufacturing defects, operational loading especially and environmental factor especially in areas where this equipment operates in harsh climatic conditions.

2 Condition Monitoring and Fault Diagnoses of Agricultural Machinery
by boulders and posts from old fences. Such a problem is difficult to identify by the operators. Thus, deploying a deep learning model for the condition monitoring of the machine by the operators will help in solving such problems.

According to a study by Xiang et al., to measure the information regarding health conditions of agricultural machinery, a global navigation satellite system can be used. This includes the data receiving module, data processing and the user interface screen module. The functions also include the understanding of the operation area, such as the real-time working path as well as calculations of the total field area, area completed and speed are also calculated. The developed system was done in the Android environment using the Android's Canvas class which has the capacity to draw the area of farmland, the actual work area as well as the area for turning by the vehicle. The result showed that the developed system improved the efficiency of agricultural operations and reduced the maintenance cost of the equipment.

According to a study by, it was established that a major problem with the availability of machine components is the guarantee which is in high demand by customers, however, the manufacturers are not willing to provide guarantee availability owing to the increasing cost due to the risk of uncertainties which occur from the operational data as well as inadequate machine conditions. Based on this, there is a need for condition monitoring of agricultural equipment for effective operation and performance of the agricultural industry. In this case, relevant parts that are always in service and their failure mechanism are developed to be able to implement the preventive maintenance approach. Furthermore, several food processing industries have introduced process control which have actually improved the agricultural technology. It was established in the study of Craessaerts et al. that different processes using agricultural machinery are usually performed manually with human operators, however, major part of operation can now be handled via the action of machines. More so, even at the level of supervision, operators are shouldered with the responsibility of observing the process to detect any malfunctions in the sensors which may have adverse effect on the action of the controller such like severe damages. Going forward, the supervision is becoming tedious due to the increase in the workload and the complexity of the machine. Thus, causing the erroneous effect of the human effort on the machine controls, in addition to this, it contributes to economic, environmental and safety effects. Similarly, operating using inadequate data could result in improper control actions there will be no optimal operation of the system. Thus, condition monitoring for machinery is key and highly economical in the agricultural industry.

According to, there are risks and dangers during the harvesting of grains. Thus, there is a need for proper monitoring of the operations to help in reducing the possibility of exposing equipment to severe failures. In most cases, heat sources are created which could lead to explosion of dust. According to, the development in the trends of agriculture has led to some level of energy demand which has called for a more intelligent equipment for the agro-industrial operations. Thus, unmanned farm is taking the ground of the agricultural operations. All these involved energy consumptions especially when the entire operation is replaced with electric farm. For instance, water pumping in irrigation farming has been improved using asynchronous motor. Also, for fishery purpose, heat exchanger as well as accumulator are combined to eliminate the problem of excessive energy consumption. Thus, condition monitoring of these equipment will help in reducing the cost of production as well as improving the overall productivity of the agricultural operations.

However, having a well-constructed maintenance network is needed for a reliable operation of agricultural equipment/machinery. Based on this proposed a layout for varying maintenance operations to increase the productivity of agricultural machineries. The construction of the maintenance network was done using integrated analytic and balanced score card as service provider technique which aided in the construction of the maintenance network. The determinants considered include the process capability, knowledge of the asset, service satisfaction and cost as well.
capability and that this method led to improvement in the reliability of the service provider during the layout construction of the maintenance network. According to Wu et al. [28], the performance operations of agricultural equipment is usually done via cross-regional social services especially in China. Thus, data collation is then very important for the implementation of dynamic monitoring for effective agricultural operations. This system involves the integration of the agricultural operations with big data analytics which could help in decision making and overall improvement in the agricultural machineries as well as agricultural production. Figure 1 showed the entire layout of the system with the inclusion of the Global Navigation Satellite System terminals and the internet of things framework for the agricultural machinery as well as big data for the national agricultural machinery operation.

Figure 1: Framework of Agricultural Machinery Operations with monitoring analysis

Source: [28]
The operation of modern agricultural machineries is diverse and complex. There is a need for adequate decision making by the operators of these machineries for effective operation. Thus, high effort is required in processing the information and application of these machineries.

Hence, the need for adequate condition monitoring of the machineries. Also, failure analysis of agricultural machineries is very important due to the continuous development and improvement in the agricultural mechanization. Provision of adequate agricultural machinery failure analysis would help in cost and wastage of time. This is possible via data collation of agricultural machinery via internet of things, charts and models. Thus, the cause of failure and maintenance activities required becomes very easy to obtain using these tools.

Thus, developed a novel an agricultural management platform for the analysis of failure and maintenance of agricultural machineries. It has the capacity to access about one-hundred million data points and can detect fault and maintenance solutions. Figure 2 showed the entire architecture of the model diagram.

According to a study by Zhou et al., it was established that it is possible for farmers to upload the breakdown information of the agricultural machinery into an internet platform and maintenance order is initiated. The platform has the capacity to evaluate the maintenance activities of each of the machines and then eventually arrange the maintenance procedure. Thus, the library of maintenance is then deployed to solve the problem on-site.

Figure 2: Architecture model diagram

Source: [30]
According to a study by Zhou et al. [32], the collected data from the monitoring system include the location of the job, information of the job status, information regarding the fault detection of the agricultural machinery. All this job information is sent to the mobile network platform containing the data management via sensors so as to process and analyse the data. Thus, for effective operation of agricultural machinery, there is the need for it to meet the demand of the intelligent information system. Figure 3 showed strategy for managing maintenance.
Maintenance management strategy of Agricultural Machinery

3 Maintenance management strategy of Agricultural Machinery

Figure 3: Maintenance strategy process

Source: [32]

Agricultural machinery constitutes a major problem such as injury on the farm. Thus, there is a need for operators to understand the importance of safety practices during operation. Such safety practices can be considered to be presence of safety devices on the machinery and level of maintenance. These are regarded as the risk factors. In a study by [33], data source of about 2390 farms were collated and measures were created using factor analysis considering the safety practices. Also, the farm represent unit for all analyses and other associations were included using multiple Poisson regression models. However, higher risks were associated with the operation of the machinery. Also, the result indicates that prevention of injury is needed for the use of the devices on the machinery. Also, it was established that inadequate maintenance of the modern agricultural equipment could result in increased risk of failure. Thus, maintenance practices contribute immensely to the prevention of accident.

According to [34], it is possible to improve the optimization of facility location allocation problem using real-life machinery maintenance service platform which is designed to get adequate and reliable response to failing agricultural machinery during the period of harvest. This was considered by considering a farming season which was divided into varying time periods to be able to determine the location of temporary maintenance stations as well as understanding the facilities required for the maintenance services. The problem was modelled using a combined integer program which is capable of minimizing the entire service mileage.
For adequate safety and stability of agricultural production, there is a need to maintain prompt response to malfunctioning agricultural machinery through an effective maintenance platform. This could be achieved by clustering different agricultural production areas into a specific maintenance service region and allocating facilities for adequate maintenance in each region. Also, the service region can be formulated as a multi-objective mixed integer which also has the capacity to minimize the overall mileage between the maintenance facilities and points of demand as established in the previous study. Furthermore, optimized contiguity was deployed in enforcing the single service area as connected geographically. This implies that it is possible to carry out maintenance between several regions without leaving that particular location [35].

In a study by [36], it was established that one of the major problems of agricultural machinery industry lies in the electrification and maintenance network during operations. These problems have contributed to increase in the cost of production as well as safety problems. Thus, adequate maintenance of machines as well as the machine architectures will help in efficient production as well as increase in the overall productivity. Also, modernization such as digitization of agricultural machineries will help in improving adequate maintenance [37-40].

4 Conclusion

Agricultural production has become an important and crucial to the nation’s economy. Adequate maintenance of agricultural machineries/equipment may not be considered practical. However, inadequate maintenance will cause several failures in the detection of the equipment deterioration mechanism. Thus, this study has been able to establish a balance between the maintenance operations and the equipment performance during agricultural operation as well. Thus, adequate maintenance practices have been established in this study to ensure equipment reliability and availability as well as improving the agricultural production.

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