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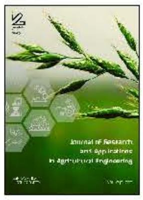

Use of the Telematics Systems to Technical Service of Tractors and Agricultural Machines

Krzysztof Krzyżaniak[a] (https://orcid.org/0000-0001-6658-6356)
Ireneusz Kowalik[a] * (https://orcid.org/0000-0003-1011-2551)

[a] Poznań University of Life Sciences, Faculty of Agronomy, Horticulture and Bioengineering, Department of Agronomy, Poznań, Poland

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The paper presents telematics systems functionality used by modern agricultural machines. Special attention has been paid to opportunity of used these systems in maintenance planning and remote diagnostic agricultural tractors and machines. Telematics systems are helpful to decrease operation costs and increase reliability of technical units in agricultural production.

Keywords
telematics systems
telemetry
technical service
precision farming

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1. Introduction

The rapidly developing digitization in the agricultural sector is becoming more and more popular among agricultural producers. Its main goal is to improve production efficiency while maintaining profitability [1, 6, 11]. Therefore, a number of precision farming technologies are introduced to improve the operation of machines. Such solutions include: automatic machine unit guidance systems, section control systems used during sowing and spraying, nitrogen fertilizer dose control systems based on the analysis of the field density and leaf colour, or systems regulating the operating parameters of machines for harvesting crops based on signals received from sensors. In addition, to steering and controlling the operation of machines, production planning is also a very important element. Therefore, for the purposes of optimizing work processes in machines, systems for collecting and processing large amounts of data are used. They can be used to create yield maps and analyses aimed at optimizing management processes [3, 12]. Due to the ever faster digitization of agriculture, modern tractors and agricultural machinery are increasingly factory-equipped with telemetry modules that record and send large amounts of data to the producers' servers [5]. The data is processed by the telematics system and enables to remote monitoring of the operation of a given technical means using a mobile application or an internet platform [7]. These types of solutions are offered directly by manufacturers of agricultural machinery with a global reach and by some companies dealing with precision farming systems (Fig. 1). Regardless of the manufacturer, the functionality of telematics systems is very similar and the main difference is the visual way of presenting data [3, 8]. The aim of the article is to present the currently used telematics systems in agricultural machines and to describe the possibilities of their use.

* Corresponding author: ireneusz.kowalik@up.poznan.pl

2. Material and methods

The characteristics of the latest telematics systems were made on the basis of specialist literature and materials that are not available in public circulation. These were company materials which introduced and at the same time use telematics systems in the technical means produced and offered on the market of agricultural machinery. In addition to literature data, information was also obtained during individual standardized interviews with users of such systems. The collected data and information provided the basis for the selection of content and a detailed analysis focused on the use of telematics systems for servicing machines.

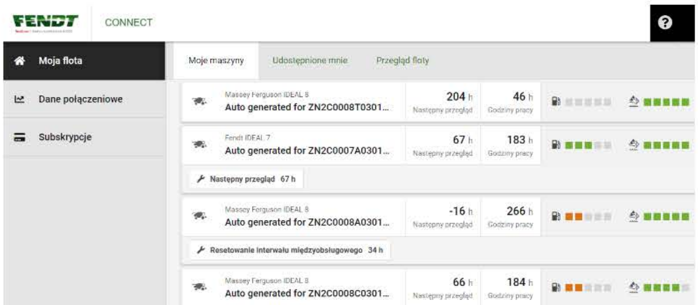

Fig. 1. View of fleet list on Fendt Connect website
(source: own study based on [15])

3. Telematics systems

A modern telematics system used in tractors and agricultural machines consists of a module connected to the CAN bus and a GSM antenna. The telemetry module records and collects data received from sensors installed in the machine in real time and then sends them to the server every 5 minutes. The recorded information includes engine operating parameters, working team work parameters, data on efficiency and fuel consumption, machine location with trace recording during the work performed and error messages [5, 14, 17]. Saving dozens of parameters is possible without additional installation between the sensors installed in a given technical measure thanks to the use of the CAN bus. A SIM card is inserted in the module, because the data transmission uses the cellular network with the GPRS function [3, 8, 12]. Most of the manufacturers of this type of solution use the universal EU-28 card operating throughout the European Union, and the fees related to data transmission are already included in the subscription. Thanks to this solution, there is no need to pay an additional subscription in the mobile telephone network. Depending on the purchased license, the user can use the basic or advanced version. In order to promote the computerization of agriculture, producers of agricultural technical means sell new tractors and self-propelled machines in the basic version with an annual or three-year free subscription to the telematics system. The duration of the free period depends on the brand and class of the machine. After the end of the subscription period, in order to continue using the system, it must be extended. The subscription costs depend on the version and range from a few to several thousand zlotys for an annual access [14, 15, 16, 17, 18, 19, 20]. In order to analyse the collected data, the user may use the internet platform or mobile application (Fig. 2). Having an advanced subscription, it is possible to create reports for a given period, which allows to carry out very detailed analyses and perform effective optimization of machine operating costs [3, 9, 10, 11, 12, 13, 17].

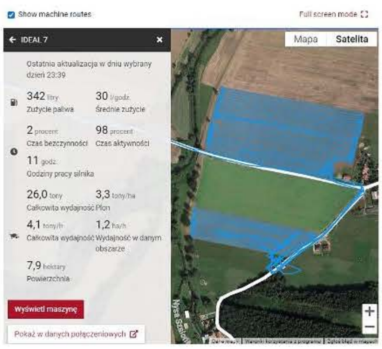

Fig. 2. Preview of work parameters and drive trails in AGCO Connect app
(source: own study based on [15])

To increase versatility and access to data for users of tractors and agricultural machinery from various manufacturers, Claas, John Deere and CNH have partnered to create the DataConnect system. It allows access to basic information recorded by telematics systems using a single manufacturer's platform. Thanks to the solution, it was possible in practice to monitor the operation of the machines of the above-mentioned manufacturers using an application dedicated by one of the brands or through the portal of the partner company 365FarmNet [12]. The system was launched in mid-2020. Currently, data transmission to the server takes place using the telematics system for Claas and John Deere machines, and for machines from the CNH concern using a USB memory stick or wired after connecting the terminal to a computer with access to the Internet (Fig. 3). Along with the development of the system, wireless data transmission to the DataConnect server will be introduced for all brands covered by the cooperation [14, 15].

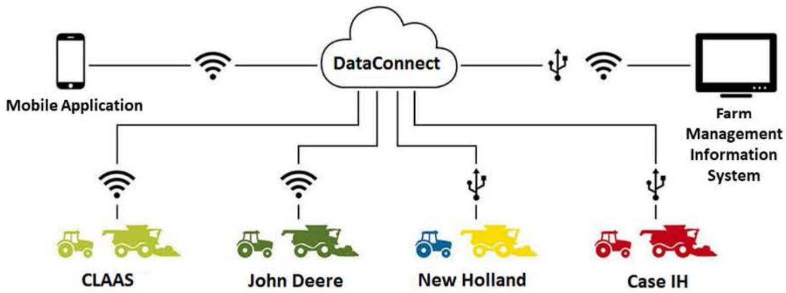

Fig. 3. Data transfer scheme for the DataConnect system
(source: own study based on [17])

4. Periodic inspections scheduling

A performing of periodic inspections in accordance with the schedule contained in the operator's manual is a very important aspect of the operation of tractors and self-propelled agricultural machines. Therefore, service bodies plan periodic technical inspections of tractors and self-propelled machines in consultation with the user. The date that does not conflict with the plan of performing agrotechnical treatments in a given farm is being establish [4, 13]. Therefore, the existing need to meet strictly defined agrotechnical deadlines when performing field works, brings with it the need to plan inspections in such a way that they are carried out in the periods recommended by manufacturers of technical measures and at the same time do not lead to disruptions in the work of service staff. In order to execute the reported orders in a timely manner, service departments more and more often apply the principle of advance planning. Such a procedure is very beneficial because it gives the opportunity to introduce better organization of work of individual brigades at service points. Therefore, authorized technical services increasingly use telematic systems used in tractors and agricultural machines, because they have free access to the collected data in the technical means they support (Fig. 4).

Periodic inspections and services of machines is a prevention that allows to increase the reliability and durability of the technical means used. Technical service in accordance with the recommendations is also one of the conditions required by manufacturers to maintain warranty continuity [2, 10].

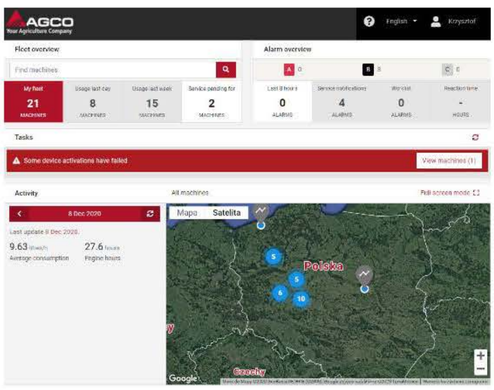

Fig. 4. Telematics website main screen used by authorized technical service of agricultural machines
(source: own study based on [15])

The available information includes, inter alia, the number of hours of engine operation in individual machines operated by a given service point. On its basis, the time to the next inspection is automatically calculated, taking into account the type and model of the machine, and therefore directly related, in accordance with the inspection interval provided for in the operator's manual. The information is displayed on the telemetry platform in the form of a list taking into account the entire fleet of machines, thanks to which the upcoming maintenance time and additionally set up a notification can be easily observed (Fig. 5). Remote monitoring of the current number of operating hours of the machine allows to plan a visit to the customer and to collect consumables needed to perform a given inspection. It is especially useful in situations where the farm has a large number of tractors and machines or in the case of a company providing maintenance services. The ability to locate the machines up-to-date with the simultaneous visualization of the stopping place on the map is an additional advantage. Such information is very beneficial as it helps to better organize the maintenance plan for the mechanics team and to optimize the most advantageous route and travel times.

Model	Alarm	Hours	Next inspection
T254 HiTech	B 2	2349 h	51 h
T254 Active	B 1	1776 h	24 h
T172 Versu	U 2	892 h	308 h
N134 Versu	C 1	1203 h	-3 h
T174eco Active	A 7	257 h	343 h
N114eco HiTech	B 2	421 h	179 h
N134 Active	A 1	416 h	184 h
T234 Direct	U 2	816 h	384 h

Fig. 5. Tractors list in telematics system including operating hours to next service and active alarms (source: own work based on [15])

5. Initial diagnostics

The advanced version of the telematics system, in addition to recording and collecting data during machine operation, also records and sends to the server any alarms with an error code. The option is especially useful for remote fault diagnosis by authorized service points. Alarms are divided into active and saved, thanks to which it is possible to determine whether a given problem occurs all the time or occurs only in the event of specific conditions occurring during the work. For most error codes, a detailed description is available with suggested diagnostics. Using the saved signals from individual sensors, the indications appearing in a given system at the time of the error and in any time interval can be analysed. The data can be presented in the form of numbers or graphs. It enables an initial diagnosis, preparation of the mechanic for specific tasks and, if necessary, ordering the necessary spare parts. The additional function of locating the machine is useful when the service technician travels directly to the workplace in the field.

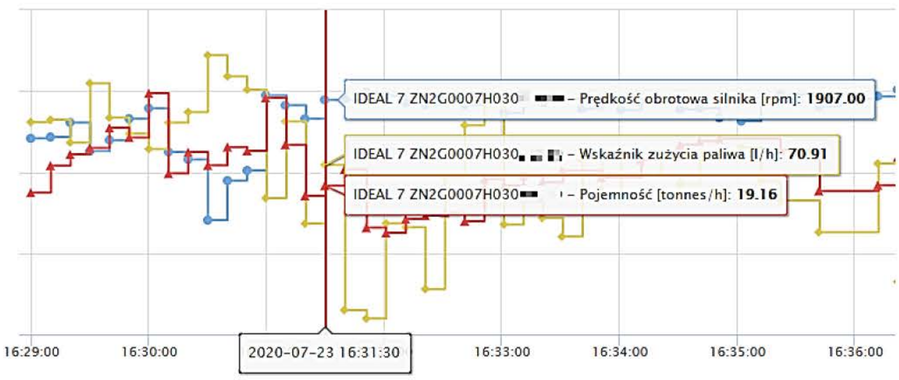

Fig. 6. Chart from AGCO Connect system for three work parameters of combine harvester (source: own work based on [15])

John Deere was the first company which have introduced an innovative "Remote Display Access" solution that uses GPRS functionality to remotely view the machine terminal to the market. Such a solution is useful not only in remote fault diagnosis, but also in order to increase the efficiency and quality of work in harvesting machines. By analysing the operating parameters, the product support specialist can change the settings of the operating parameters of the machine in order to improve the achieved parameters of the quality of work [15, 17]. According to the system, the operator is able to obtain support in a short time without the need for a specialist to come directly to the machine working in the field. It enables increasing the customer satisfaction with the use of the machine while reducing the cost of servicing. A similar solution began to be used in Deutz-Fahr tractors equipped with an iMonitor terminal [18].

6. Summary

The digitization of agriculture allows for higher production results with better cost optimization at the same time. Collecting a large amount of data enables creating detailed analyses and evaluating the profitability of individual treatments in the production process. Telematics systems used in tractors and agricultural machines, apart from the function of monitoring operational parameters and analysis of agricultural production processes, are increasingly used in technical service. Authorized service points, with the consent of customers, have access to the data of the supported technical means. The data make the maintenance planning process easier and better organized. Both the technical staff and the user of the tractor or machine are informed about the upcoming service time via the mobile application. Access to active and historical alarms occurring in the machine along with the analysis of parameters enables remote diagnostics. The telematics systems used in John Deere and Deutz-Fahr products also allow for remote direct control of the machine terminal. Manufacturers of agricultural tractors and machines, seeing the need for further computerization of agriculture, announce the continuous development of the solutions used so far. They also undertake more and more cooperation aimed at simplifying access to the collected data on tractors and agricultural machines of various brands, which can be used on one farm or service company.

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