Evaluation of harvesting driving modes from environmental point of view

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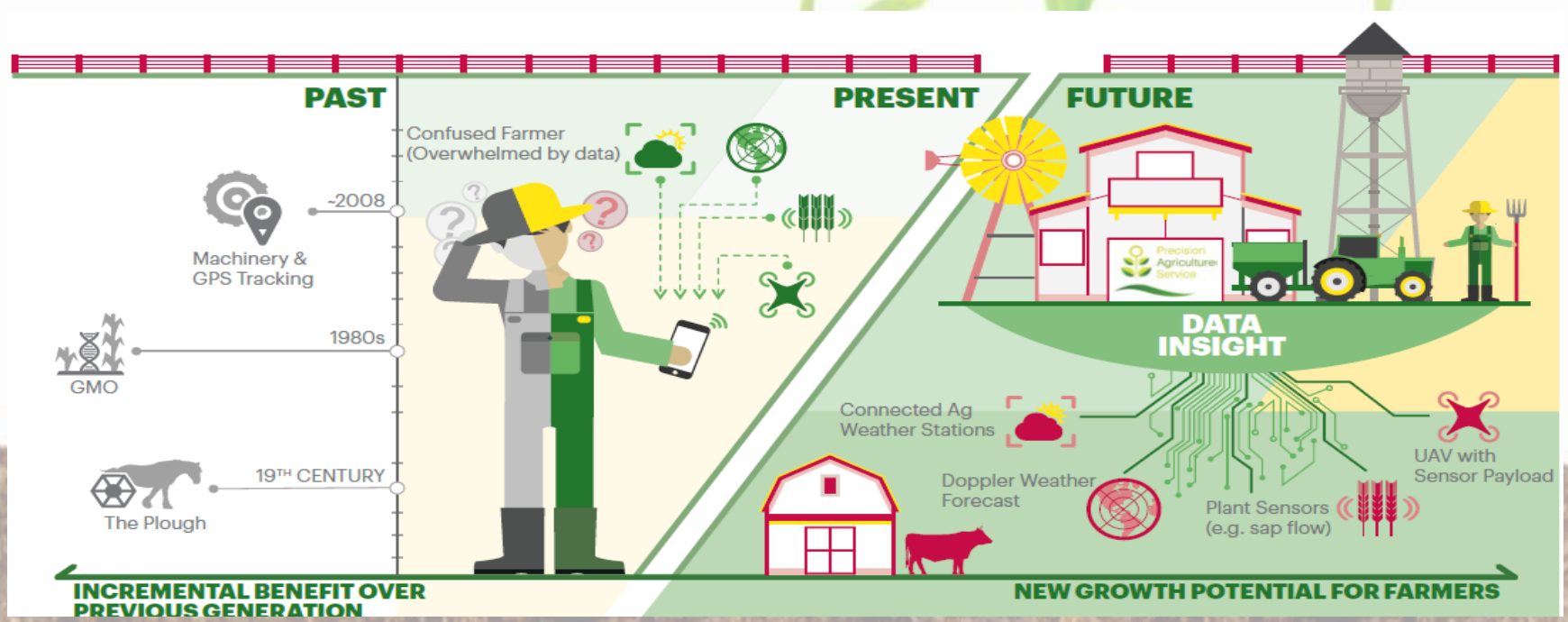
Introduction

Numerous automatic technological processes control systems that are implemented in the modern agriculture equipment. Automation facilitates technological processes and allows to increase the technical potential such as shorter time of the technological process, more efficient use of the fertilizer, plant protection products and saves fuel. Machinery performance data collected and stored via Telemetry platform can be sent to customer's computer for overview and decision- making for the following years. However, a significant quantity of data is not automatically processed by the Telemetry platform. Usually, the final decisions by customers are based on their experience. Farmers want to be sure that the equipment they use will not only depend on the technological process, but also reduce the negative impact on the environment.

Evolution of Digital Agriculture

The use of Telemetry system in Smart Ariculture is an innovative appoach which consists of implementation of the information system for more accurate and predictable Farm Management.



Source: Accenture digital – Digital Agriculture: Improving profitability, 2017

What automatic steering systems does?

Automatic systems.

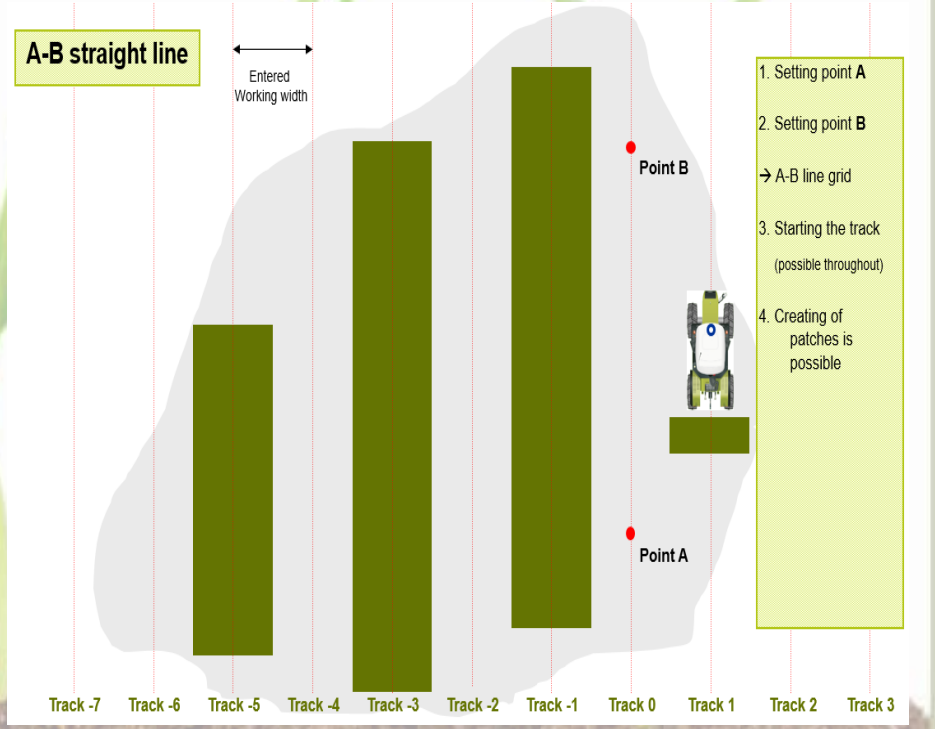
- Actively control the vehicle's steering hydraulics
- Range of correction signals covers all accuracy requirements
- Offer the highest level of convenience and accuracy
- Permanently installed on the machine

Source: PROFI - Naujos Claas Telematics duomenų perdavimo ir dokumentavimo galimybės , 2020

Materials and Methods

For the research analysis, four Claas combine harvesters Lexion 770 TT (Terra Trac) - with a crawler chassis - were selected.

Technical characteristics of Lexion 770 TT combine harvesters: OM502 LA engine power – 405 kW, threshing drum width – 1700 mm, 445 mm diameter rotors for post-threshing grain separation – 2 rotors, grain cleaning – 8 turbine fans, grain tank volume – 12.500 l, cutterbars model V1050 – effective cutting width 10.67 m



Materials and Methods

The analysis performed by implementing the LCA methodology to quantify the environmental impact of harvesting performed with two combine harvesters of the same models, one of which is the manually driven and the other by auto-steering mode. The environmental impact assessment was conducted by SimaPro 9.1 process modelling software.
The data on biomass cultivation, transportation, biofuels production and equipment were used from Ecoinvent v3 database. Based on CML-I calculation methodology was determined resulting impact of processes. The global warming and abiotic fossil fuels depletion are chosen as impact categories.

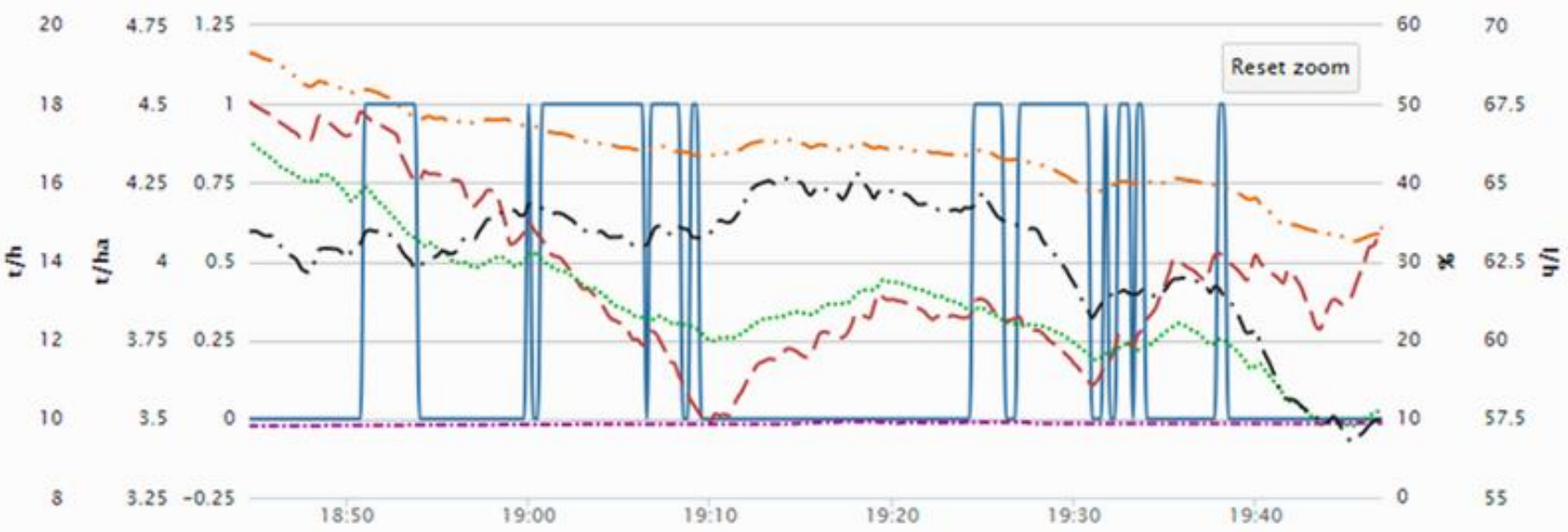
Indicator	Manual	Auto
Mass of harvester, kg	12800	12800
Rated power, kW	430	430
Lifetime, h	1300	1300
Amount of machinery, kg/FU	7.9	7.39
Fuel consumption per FU, kg/FU	20.05	18.16

Results and Discussions

Field diagrams when the combine is working with automatic steering and by the operator, manually

Combine harvester performance

Telemetry platform allows to get different type of graphics out of 24 selected parameters. The maximum 6 parameters can be selected for a one graphic follow up.



Harvest report data

Harvest report data can be chosen at preferred time range by day, week, month or even whole harvest season according the harvested crop. Beside it the work analysis in presents allows to check the load of the combine harvester.

Harvested crop: Canola Edible beans Oats Peas Wheat Barley		
Total	**Average**	**Maximum**
Engine hours	761:06 h	761:06 h
Total working hours	500:04 h	500:04 h
Area	1442.75 ha	1442.75 ha
Total distance traveled in field	2531.61 km	2531.61 km
Fuel consumption, field	21451.50 l	21451.50 l
Fuel consumption per area	14.87 l/ha	14.87 l/ha
Fuel consumption per working h	42.90 l/h	42.90 l/h
Fuel consumption, transport	1054.00 l	1054.00 l
Fuel consumption, total	22505.50 l	22505.50 l
Total distance traveled on the ro	954.47 km	954.47 km
Total distance traveled	3486.08 km	3486.08 km
Speed during harvesting	4.31 km/h	4.31 km/h
Total chopper hours	298:50 h	298:50 h

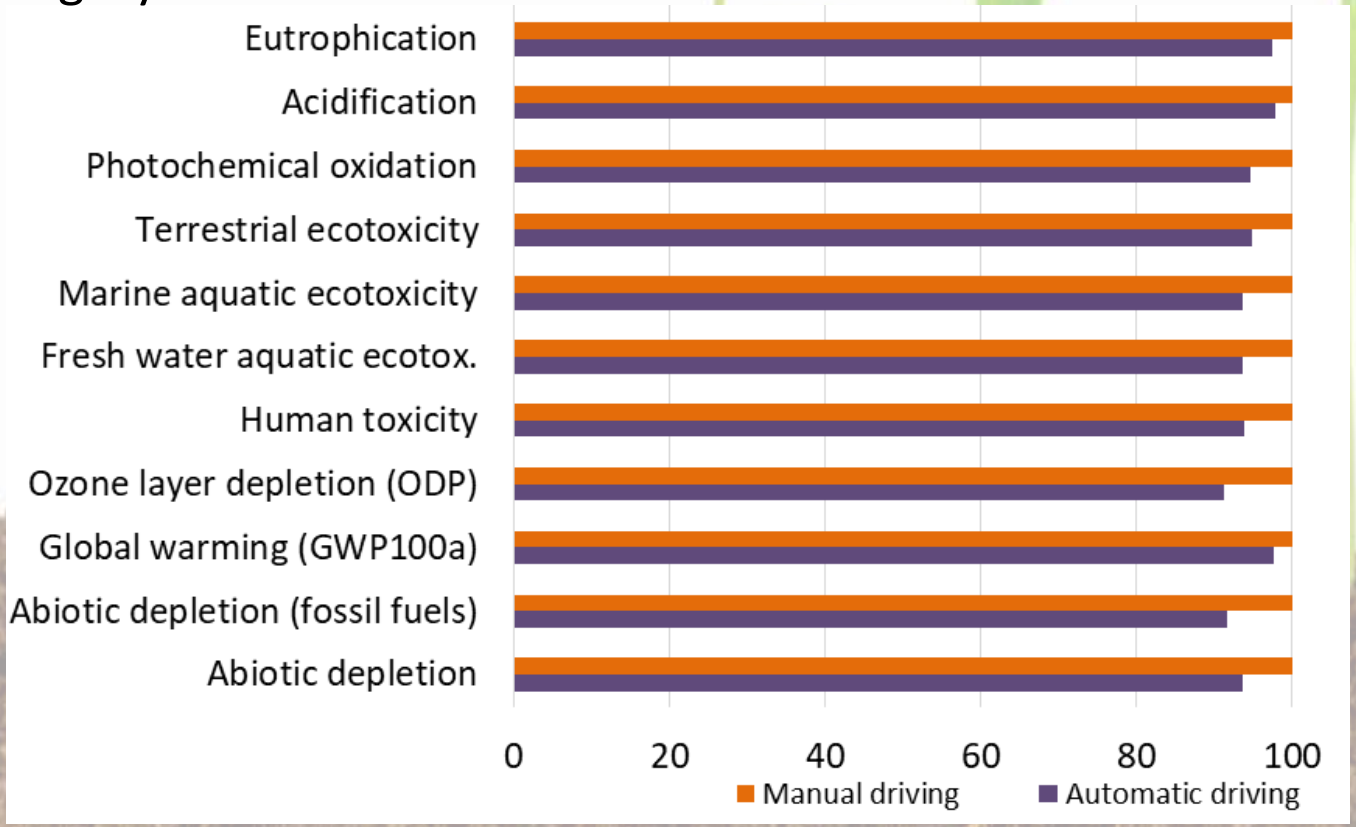
Working hour's distribution (Telematics)

Beside the harvest report data customer could also check the working hour's analysis. It allows evaluate the load of the combine harvester during the day or at set time range

Work hour analysis		
Unloading portion during travel	2.00%	2.00%
Unloading portion while idle	3.00%	3.00%
Turnaround time portion	8.00%	8.00%
Process time portion	58.00%	58.00%
Idle time portion	21.00%	21.00%
Travel time portion	7.00%	7.00%
Idle time with full grain tank portion	1.00%	1.00%

Damage assessment diagrams for two compared systems

The environmental impact assessment diagrams of two driving systems presented. The y-axis shows the impact categories and the percentage of 100 % impact for the process that generates the greatest impact within each category.



Conclusions

- Work hour distribution analysis provides information about the efficiency of the machine within a specific time range. Using harvest report it is possible to analyse combine harvester performance and create key performance indicator reports according to crop type.
- The LCA analysis has shown, that use of automatic steering mode global warming emission reduced by 4.79 % compared to manual steering mode. Accordingly, the diesel fuel consumption at automatic steering mode was reduced by 22.02 %.
- Summarizing, the analysis of the structure work process provides detailed information for the overall increase of the machine productivity and working process optimization. On another hand, it helps to manage the harmful impact on the environment.

Source: https://www.foodandfarmingtechnology.com/news/data-analytics/dataconnect-goes-live-enabling-greater-multi-brand-fleet-efficiency.html

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Thank You

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