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PRODUCTION STRATEGIC SUCCESS FACTORS IN YIELD MONITORING TECHNOLOGIES

LASZLOP ÁDÁM egyetemi oktató
Pázmány Péter Katolikus Egyetem
adam.laszlop@yahoo.de

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ABSTRACT

Crop production is only profitable when all information is known about a specific crop. This information is turned into profitable yield through efficient management technologies and critical decision-making. Efficient management can only be done with the help of yield monitoring technologies, with the goal to optimize natural, human, and material resources while maximizing crop yield efficiency. Yield monitoring technologies works using sensors systems and ensure accuracy of yield. The sensor system detects every aspect of a potential yield in seconds and has also the ability to measure yield values from raw data. and set formulas. The final measurement (yield) is calculated and displayed on the dashboard of relevant technologies and acts to help decision-making and methodology.

Keywords: *Precision Agriculture (PA), Yield Monitor, Soil Moisture Sensor, Geographic Information System (GIS), Decision-Making*

ABSZTRAKT

A növénytermesztés csak akkor nyereséges, ha minden információ rendelkezésre áll az adott növényről. Ez az információ hatékony irányítási technológiával nyereséges hozammá alakul. A hatékony kezelés kritikus döntéshozatallal jár az adatok összeállításában. Hatékony gazdálkodás csak a hozamfigyelő technológia segítségével végezhető el. A hozamfigyelő technológia célja a természeti, emberi és anyagi erőforrások optimalizálása, a terméshozam hatékonyságának maximalizálása mellett. A pontosság a legfontosabb kritérium a hozamfigyelő technológiában. A hozamfigyelő technológia a szenzorrendszereken keresztül működik, amelyben minden fő kulcstényezőt érzékelő rendszer fed le. Az érzékelő rendszer másodpercek alatt észlel minden faktort, amely képes kielemezni a nyers adatok alapján annak értékét. A hozamfigyelő technológia minden eleme össze van kapcsolva, így nyers adatokat tényleges adatokká való átalakítása megadott képletek, utasítások alapján történek, és a végső mérés (hozam) kiszámításra kerül és megjelenik az irányítótáblán.

Introduction

In modern-day agriculture, advanced technologies have been introduced to increase productivity and profitability. One of the best technologies used for this purpose is yield monitoring. A yield monitor is a device that works with other sensors and is used for the calculation of crop yield. The yield monitor gives crop yield in both imperial (lbs/s) and SI (kg/s) measuring units (Shearer et al. 1999). A yield monitor can also be used to detect grain moisture and display a color-coded spatial map of a plot of land. It has a storage space by which all the data can be downloaded easily and when additional inputs are added, the monitor can also distinguish different fields and farms.

Yield monitoring technology is a part of precision agriculture (Reyns et al. 2002). In precision agriculture, inputs are applied only to that part of the field where they are required. These changes produce high yield with lower expenses and are a major success factor in crop production. The other major component of the yield monitoring system is the global positioning system (GPS), Geographic Information System (GIS), and crop sensors. A global positioning system is used for display and calculation of geolocation and time. The GPS uses a satellite radio navigation system (McDuffie 2017) operated by the US Space Force and a receiver. Through Geographic Information System (GIS) spatial and geographic data is analyzed (Clarke 1986). Three major crop sensors are also involved in yield monitoring technologies. These sensors measure soil moisture, cutting width, and photoelectric activity. The yield monitor has various types of small sensors as well that measure radiation, separate speed, ground speed, grain moisture, impact, and grain flow (Fulton et al. 2009).

The main purpose of this study is to determine production and strategic factors that influence success in the use of yield monitoring technologies.

Material & Methods

The experiment was performed to check the yield monitoring technology. For this purpose, many farms were visited. The data were collected in raw form and processed further for analysis. The data were recorded using pen & paper. An Android cell phone was used to take pictures. The comparison of field data and the companies' data was distinguished using a laptop. The data were recorded in March 2021. A simple methodology was used to examine yield monitoring technology.

i) Data Collection

The data collection was done by visiting farms, who have integrated yield monitoring technology into their process. All sensors were pre-installed at the farms and all farms fulfilled all conditions of modern-day precision agriculture.

ii) Data Processing

The data was collected in rough form. The only data processed were those that related to our research. As yield monitoring technology was our major focus, we collected all possible information about the farms' use of these technologies.

iii) Data Analysis

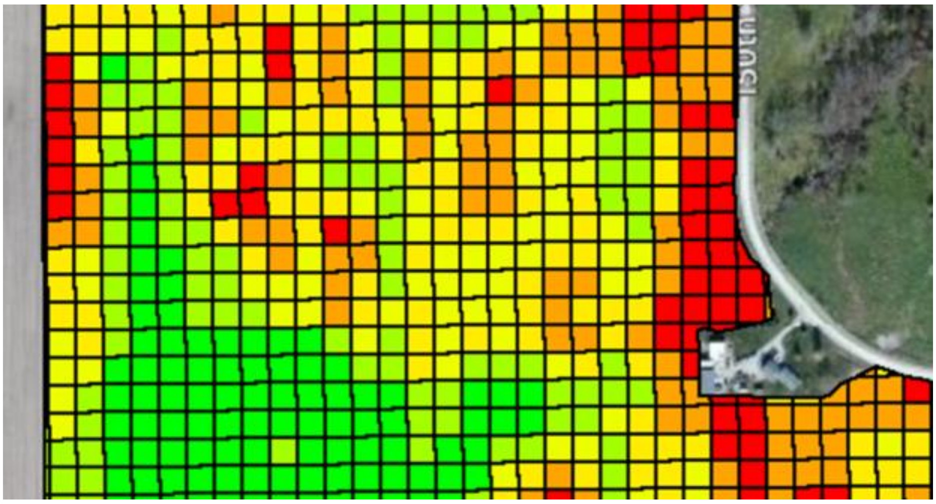
The analysis of all the processed data was done by the research techniques. For this purpose, different companies' websites were visited to collect publicly available yield monitoring data. The final analysis was done to compare the company data and farm data.

Result & Discussion

Mapping, sensing, and monitor type are the main production strategic factors that cause an increase in the efficiency of yield monitoring technologies. Mapping gives the geographical location through a GPS while sensing gives the exact crop requirement of the farm. Monitors convert raw data into highly modified data and display yield.

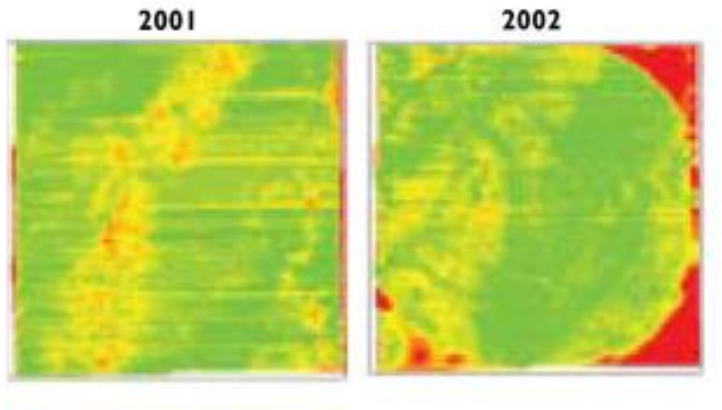
The variation of yield is temporal through the yield monitoring technology in different farms. The yield is also different in many areas due to soil production capacity. Several approaches measure the time of yield. The chosen technique calculates normalized yield, the ratio of actual yield to field yield, through yield monitoring technology. In the normalized yield, even yield can be measured from the grid cell. When the management techniques are different the yield of every farm became different in the same area. Here is a diagram showing the yield of a farm. The red color shows low yielding field areas while the green color shows high yielding areas. All other colors are showing normal yield areas.

The yield of a farm



Yield monitoring technology also creates increases in yield due to the accuracy of the system. Here is another picture of the same farm in 2001 and 2002. In 2001, the crops were growing with yield monitoring technology while in 2002, the same crops were growing without yield monitoring technology. This proved that yield of the year 2001 was higher than 2002 and speaks highly to the effectiveness of yield monitoring technology.

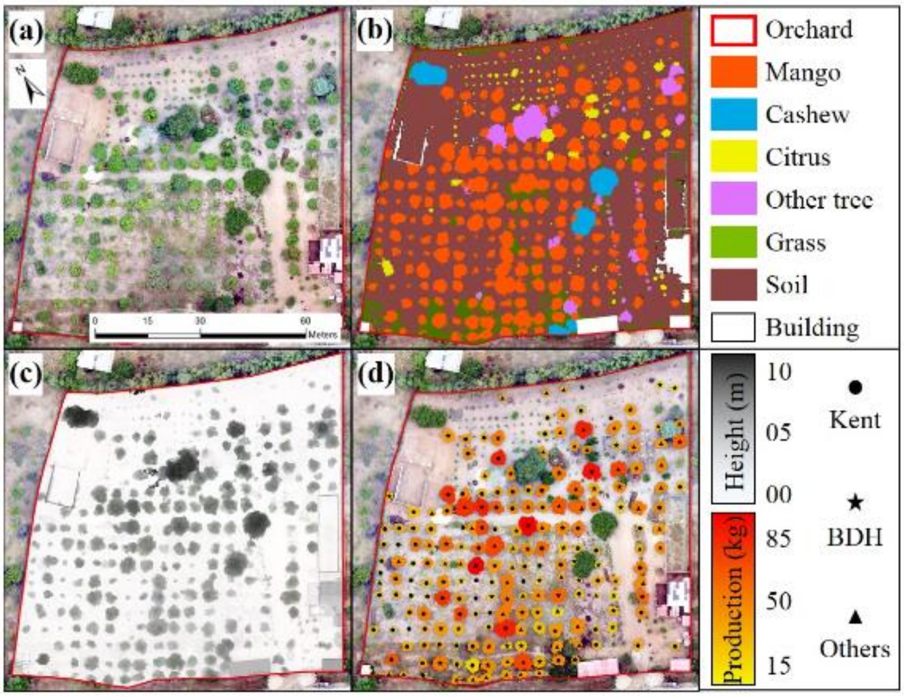
Growth comparison (with and without monitoring system)



Source: https://naurok.com.ua/geografichni-zadachi-ta-zavdannya-profesiynogo-zmistu-230148.html

Yield monitoring technology is not only limited to field crops. It can also be used for orchards and grasses. The accuracy will maintain the same for all fields and orchards. In orchards, it is mostly used for mango and citrus yield. Here is a picture of orchards and grasses showing their productivity with their height.

Orchard yield mapping outputs



Source: Sarron et.al. 2018

Mapping involves geo-referencing data through GPS technology (Reitz and Kutzbach 1996) while sensing involves sensors for accuracy.

The final observed result was that one of the major strategic factors in yield monitoring technology is mapping and sensing. The mapping and sensing in yield monitoring technology involves the following basic components:

i) GPS: Time and geolocation are measured by it.

ii) GIS: Analysis of geographical data is done by it.

iii) GPS Antenna: Satellite signals are received through it.

iv) Yield Monitor Display: Records and displays data.

v) Crop Growth Sensors: Determines the growth of crop and interconnected with the monitoring system.

vi) Soil Moisture Sensors: Determines the moisture content of the soil and helps in irrigation management.

vii) Nitrogen Sensors: Detect the exact amount of nitrogen content of the plant.

viii) Grain Flow Sensors: Grain volume is determined by it.

ix) Grain Moisture Sensors: Grain moisture is detected through it.

x) Grain Speed Sensors: Used in grain flow measurement.

xi) Position Sensors: During turns, it is used to distinguish measurements logged.

xii) Travel Speed Sensors: During logging, it is used to determine the distance of the combined harvester.

The exact harvest location is not possible to find with the help of sensors because the grain flow calculation through a combined harvester is a delayed process (Myers 2012). When real-time correction is applied, the harvest location is found accurately. The errors are removed by shifting the raw data for combining delay and point corresponding to the header up position are eliminated (Sudduth and Drummond 2007). The grain flow delay setting is combined and may be crop-specific. The typical value for the grain crops range from about 10 to 12 seconds. Few points are added and removed at the beginning and end of the combined harvester having yield monitoring technology (Lee et al. 2012). These are also known as start and end pass delays. The start pass delays occur when crop harvesting starts, but grain flow has not stabilized yet because the elevator is filling up gradually. End pass delays occur when the combine moves out of the crop and the grain flow becomes zero. At this stage, the elevator is completely emptied. The most appropriate setting can be achieved with the help of a consultant.

Raw data is shifted to correct for grain flow delay along with deletion of points that represent header status up. Start pass delays and end pass delays are primary data filtering procedures built into the software supplied with yield monitoring systems.

There are 4 monitor serups used in yield monitoring technologies (Johnson 1996), two American, and two European. American types include the mass flow monitor and the weight monitor while European types include the optical and nuclear monitors. According to Johnson, optical monitors are most commonly used.

Mass flow yield monitors have specific sensors that measure the force exerted on a plate by the grain coming off the top of the clean grain elevator. Some of the monitors also have potentiometers. The potentiometer has two-part brackets. Half of the bracket is bolted to combine the frame and the other half has a connection with the impact plate. Grain hardness causes the change in resistance of the potentiometer. This change is converted into an electronic signal which is used to calculate yield.

A load cell is connected to a metal arm in weight-type monitors. This metal arm supports the weight of either the hopper itself or the grain flowing through the clean grain cross auger. The grain in augur is directly linked to the force exerted on the load cell.

In an optical monitor, infrared light is used, and a detector is installed across the clean grain elevator. The infrared beam is blocked in the auger housing due to empty auger paddles. The actual weight is logged on a monitor and the monitor correlates the light signal with the yield.

In nuclear monitors, a small radioactive source is used to transmit a beam of particles across the clean grain elevator to measure how much grain is on the other side (Pierce et al. 1997). The more grain, the less radiation gets through the flow.

Conclusion

Yield monitoring technology is highly efficient. This technology is very helpful for farmers because it directly affects the decision-making process. The accuracy is also maintained through this technology. “As we have examined each aspect of yield monitoring technology, it proved that the major production strategic success factors in the yield monitoring technology are sensing and mapping system.”

The reason for choosing the sensing and mapping systems as major strategic factors in yield monitoring technology is that these both help the technology predict the next five years’ worth of data. Such predictions make the yield monitoring system the most proficient system. In this way, yield monitoring system become more active. The scope of yield monitoring technology will be greater than software (DSSAT & EPSIM etc.) in the future because the software only gives a prediction while yield monitoring technology gives prediction along with harvesting techniques.

The mapping system involves a global positioning system (GPS), and Geographic Information System (GIS), while the sensing system involves crop growth, moisture, and other sensors related to the crop. There is one of four monitor types. The selection of monitors depends upon farmer financial conditions and their availability in the nearby market. The highly proficient monitors are mass flow or impact-based and optical-based, both presenting high-accuracy

Yield monitoring technology will be the most common technique in crop production in the upcoming days. It will boost production with proper management. The last thing that should be noted is that through yield monitoring technology, precision agriculture will be easier and will be applicable in each farm and orchard. The process will be efficient because high yield will be obtained through low inputs. Yield monitoring technology will be another revolution in agriculture throughout the world.

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