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Increasing Field Efficiency of Farm Machinery Using GPS[1]

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Today's competitive agricultural market requires better management of resources and minimization of operating costs to maximize profits. One of the major costs of any agricultural production system is machinery cost. Increasing the efficiency of agricultural machinery could result in major cost reduction. Most often, field managers do not know exactly how efficiently their field machinery is operating and/or where the source of inefficiency is in their field operation. The purpose of this article is to show how Global Positioning Systems, or GPS data, can provide very useful information about the efficiency of agricultural equipment.

Operational analysis is an approach to increase machine capacity and obtain efficient machine utilization. Driver performance and field conditions affect total operation costs, such as fuel, lubricants, and repairs, especially in larger machinery that have high hourly costs. Another issue that is important in any farm operation and which may affect farm machinery is timeliness. Better management strategies to improve planning and scheduling—such as motion-and-time study management—will reduce peak machinery demand and maintain a more stable machine force on the farm, leading to increased yield and profitability.

There are three factors that affect how a machine is utilized in the field: operator, machine, and field characteristics (such as field size, shape, topography, layout, row length, row-end turning space and field conditions that affect how fast one can drive in the field). In the past, calculating factors such as field efficiency was very difficult, time consuming, and required someone with a stopwatch on-site during operation. Now, GPS can be used to obtain this information much faster and simpler.

GPS receivers send out strings of data that contain information about the location (latitude, longitude, and elevation), speed, time, and date every second. The raw GPS data needs some processing before they can be used for any application. Also most GPS receivers do not store all the data that they generate. There are a few GPS receivers commercially available that can collect and store all of these data. These GPS receivers are mainly developed for GPS tracking. GPS tracking systems are increasingly used for different applications such

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as asset management and law enforcement. There are several tracking products available that can record the GPS data.

For example, Trackstick (http://www.trackstick.com/) is one of many companies that provides a GPS receiver with internal memory to store the data. The software that comes with the GPS can export the data into Google Earth (www.googleearth.com) format which can be opened inside the Google Earth program where the driven path will be overlaid on top of aerial images and can provide a great visualization of the driven path (Figure 1). Table 1 shows an example of the data stored by this type of GPS receiver. This system records GPS data every five to ten seconds. The "Status" column shows the speed of the vehicle. Also, if the vehicle stops at one location for more than a certain amount of time, it records that information. In Table 1, the record Number 60 shows that the vehicle was stopped for two minutes in that particular location. The program also allows the user to see the exact location by clicking in the last column where it says "Google Maps." Figure 1 shows the path of a field machine in a citrus grove. It shows exactly the location where the machine was driven in the field at a certain date and time. Just the visualization of this data can be very beneficial. For example, in Figure 1 it is clear that the driver skipped driving a row, and this might be very important for some applications such as spraying or fertilizing. If the tractor or field machinery is already equipped with a GPS, then it is only necessary to buy a small data logger that can record the GPS data and store it on a flash (memory) card. A software program can later analyze these data.

The collected data also can be exported into a spreadsheet program where more analysis can be performed. For example, it is possible to add up all the time the machine was stopped during a field operation. This could be machine downtime or stopping for other reasons; however, this is the time that the machine was not doing useful work. Adding up the total amount of machine downtime during a season can help the manager to decide if it is time to purchase a new machine or not. The GPS data also can show if the machine was operated at the optimum speed. The performance of two operators can also be compared from this data. All of this data can help the field manager to make better management decisions, and it only requires a little investment on purchasing the hardware (less than $200) and some time for learning the system and collecting and analyzing the data.

Figure 1. Driving path of a tractor to and from a grove.

Rec #	Date	Latitude	Longitu...	Altitude	Status	Course	GPS Fix	Signal	Map Link
49	05/18/2009 11:46 AM	28.106367	-81.714033	171.6 ft	5 mph	N	Y	10	Google Maps
50	05/18/2009 11:46 AM	28.106162	-81.714097	172.2 ft	7 mph	S	Y	9	Google Maps
51	05/18/2009 11:46 AM	28.105958	-81.714095	171.9 ft	7 mph	S	Y	9	Google Maps
52	05/18/2009 11:46 AM	28.105732	-81.714095	169.9 ft	8 mph	S	Y	9	Google Maps
53	05/18/2009 11:47 AM	28.105485	-81.714095	166.3 ft	9 mph	S	Y	9	Google Maps
54	05/18/2009 11:47 AM	28.105265	-81.714095	162.7 ft	6 mph	S	Y	9	Google Maps
55	05/18/2009 11:47 AM	28.105248	-81.714158	160.8 ft	5 mph	N	Y	8	Google Maps
56	05/18/2009 11:47 AM	28.105438	-81.714167	160.4 ft	8 mph	N	Y	10	Google Maps
57	05/18/2009 11:47 AM	28.105665	-81.714163	160.1 ft	8 mph	N	Y	9	Google Maps
58	05/18/2009 11:47 AM	28.105897	-81.714155	161.4 ft	8 mph	N	Y	9	Google Maps
59	05/18/2009 11:47 AM	28.106132	-81.714152	162.4 ft	8 mph	N	Y	9	Google Maps
60	05/18/2009 11:47 AM	28.106360	-81.714147	164.7 ft	Stopped 2 min	N	Y	9	Google Maps
61	05/18/2009 11:49 AM	28.106120	-81.714207	151.6 ft	7 mph	S	Y	7	Google Maps
62	05/18/2009 11:49 AM	28.105935	-81.714218	152.6 ft	7 mph	S	Y	9	Google Maps
63	05/18/2009 11:49 AM	28.105743	-81.714222	154.9 ft	7 mph	S	Y	9	Google Maps
64	05/18/2009 11:49 AM	28.105535	-81.714222	155.2 ft	8 mph	S	Y	9	Google Maps
65	05/18/2009 11:50 AM	28.105327	-81.714228	156.8 ft	7 mph	S	Y	9	Google Maps
66	05/18/2009 11:50 AM	28.105227	-81.714250	159.8 ft	2 mph	SW	Y	9	Google Maps

Table 1. An example of the data that can be recorded by GPS.

In selection of the GPS tracking system for agricultural applications, it will be ideal to choose a system that can log at least one data entry per second or better. The current systems are logging data every 5 to ten seconds, which makes the turning points very unrealistic (Figure 1). GPS receivers with accuracy of 1–3 feet will provide better results for visualization and analysis.

Getting more in-depth information from GPS data requires developing software that can better analyze the data to calculate the field efficiency information more accurately. For example, an accurate measure of field efficiency requires measuring the time that was spent at a turning point.

A computer program is being developed at the UF/IFAS Citrus Research and Education Center to process and analyze raw GPS data and collect accurate machine performance information. Better management of farm machinery could reduce production cost. GPS data can provide useful information to the field manager to make management decisions that could ultimately increase the productivity of field machinery and reduce the overall production costs.

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