VOL. 11, NO. 21, NOVEMBER 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

IMPLEMENTING AND EVALUATE A MEASUREMENT TELEMETRIC SYSTEM FOR A HYDRAULIC DYNAMOMETER

Agustín Soto Otálora[1] and Y. H. Roberto Salas Ramírez[2]
[1]Department of Electronics Engineering, Industrial Automation, Universi dad Surcolombiana Neiva Av. Pastrana, Carrera
[2]Department of Electronics Engineering, Universidad Surcolombiana Neiva. Avenida Pastrana, Carrera
E-Mail: agussoto@usco.edu.co

ABSTRACT

We have implemented a telemetric monitoring system for agricultural pressure, considering the use of hydraulic dynamometer and the pressure on this when is working in open field, said pressure is enumerated, processed and interpreted for the user. This variable should be constantly monitored in order to have a good monitoring when evaluating the performance of tractor working in open field, for this we use two electronic cards, one for the acquisition and transmission of the signal obtained from the sensor, and the other electronic card is for the reception and storage of data in real-time using a software with graphical interface friendly to the user, this data are allowed in PC files that are then be used by the user. We use the Microprocessor Atmgea2560 for better performance in the Transmitter card, this card processes the signal and displays it on an LCD screen and after this the card send the data to the receiver device which is away for more than 100 meters from the tractor in working time. Another important part is the transmission of the data to be read and stored by the user in computer files, for this we use 2 devices XBee Pro Series 2 that allow us wireless communication between the Transmitter card and the computer program. We also performed Software that is able to analyze and calculate different characteristics in agricultural tractors in order to compare and analyze data to know that tractor model is higher in certain open field work in order to minimize costs and maximize efficiency.

Keywords: monitoring, dynamometer, XBee, atmega2560, wireless.

1. INTRODUCTION

Today electronics has reached almost every aspect of daily life and industry, including Agriculture.

In agriculture has always been necessary constant monitoring of the work already done in turn is essential to take complete control of the proper management of agricultural equipment, this process has always evolved at the same time it has done electronics as you can see through history, when electronics was in its infancy many agricultural processes were manual and their controls were rudimentary and often were unreliable, however, as the electronics was gaining strength it was also making the area where agricultural monitoring process by automating were in different agricultural areas by using sensors and automated records.

At present there are digital sensors capable of storing data in a register and display them via digital display, although these sensors are efficient lacking most useful because its cost is high compared to the task. It is therefore necessary tools to perform the same job with lower price and improved control of data are created.

Surcolombiana University has available an experimental farm in which they perform different tasks for development of students and the region in agriculture. Therefore it is necessary that always is monitoring the work done by the tractor tilling soil and possible variants that arise, giving the possibility of making work more efficiently to have more information which helps a best performance of the task with the lowest possible cost.
Therefore the implementation of a data acquisition system for the Experience Farm Surcolombiana University is necessary.

This system has a wireless transmission which allows me data transmission in a range of 1 kilometer and consists of a transmitter and a receiver, also it has a digital graphical interface of the transmitter, which allows you to view information in real time and also evaluate statistical data tractor efficiency in daily work and enables storage of acquired data, calculated and images in computer files which can be used at any time by the user.

2. METHODOLOGY

The SITTPA System (Telemetry System Agricultural Pressure) need some basic parameters for proper implementation and operation, and that the system meets the required needs. We can divide the system into three major stages: transmitter, receiver and system monitoring software and support.

In the next picture you can see the steps in the SITTPA system.

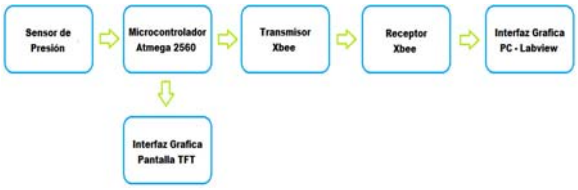

Figure-1. Diagram of SITTPA system.

The system must contain robustness while the supplied data reliability because were in critical environmental conditions must be easy to implement and handling. The user interface should be user friendly, simple and practical to read the monitoring and reporting and generated files should be easily accessible to the administrator.

The distance between the monitoring module (Tx) and receiver information (Rx) must have line of sight to make communication efficient and less time delay, taking into account the work of processing the ATmega2560 chip, this distance is not. It must be greater than 1 kilometer.

The monitoring system consists of 3 stages to level 2 to level hardware and software, which are sequentially coupled, making them dependent on each other, then turn himself in detail the assembly of each stage.

2.1 Hardware

Hardware stages are: Stage sensing, phase acquisition and processing and communication stage in real time. Which meet the operational requirements of the system; processing speed and communication speed, because the data must be presented in real time, and devices must withstand the conditions to which they are exposed.

2.1.1 Stage sensing

At this stage, it takes into account the signal to access the transmitter circuit directly and the respective measurements were taken, for this purpose it was decided to measure a physical variable that gives us good information about the performance of the tractor, the sensor manager that task is:

Pressure sensor

The sensor used is responsible for detecting changes in pressure which is subjected the hydraulic cylinder at the time of haulage work or other, which you have to make great efforts.

For the project one requirement was that a sensor with a measure of maximum 100 bar was used, however sensor 350 bar to ensure a margin of safety that allows damping device is acquired.

The sensor is an industrial transducer ¼ "NPT High Accuracy. In the next picture you can see the pressure transducer.

Figure-2. Industrial pressure transducer NPT.

2.1.2 Stage acquisition and processing

This stage is responsible for receiving data from the phase sensing in this acquisition and processing of such data to be transmitted tidily at the end user, for this purpose a card that gives us reliability and versatility was used is others on the market with an affordable cost, which is:

Card Programming ATmega2560

This card is responsible for the processing part of the primary data coming from the sensor, the card is programmed using a system based on C ++ language, we take the values read and using this card process such data as you read the card are high voltages low and thus adjust the data to our needs and actual measurement readable for the user.

2.1.3 Stage real-time communication

At this stage we use two XBee-PRO Series 2 modules these communicate through a high-level protocol based on the IEEE 802.15.4 wireless personal area network standard.

The ZigBee protocol assures lower power consumption than Bluetooth, more exactly, the ZigBee has a consumption of 30mA 3μA transmitting and resting against the 0.2mA 40mA transmitting and resting having the Bluetooth.

Figure-3. Module XBee PRO Series 2.

The modules which establish wireless communication will be configured under the Coordinator-Router topology, so that the sent data is more versatile and efficient, these modules can give higher performance in a network topology more complex, for example, have the option to encrypt communications if the user requires privacy in communication should believe that the data are operated, but our system for direct communication between the two will suffice.

2.2 Software

At the software level the system is divided into two functional stages: System Real-time monitoring and interface SITTPA calculation SITTPA (evaluator tractor performance and consumption).

2.2.1 Monitoring system SITTPA

One of the requirements of the project is to create a friendly graphical interface to the end user, which are responsible for managing this system.

The main objective of this graphical interface is that the user has the possibility to watch in real time the data are in addition to this interface also has the ability to store the data in a file which can be handled by measuring user at will so that the acquired data have greater utility.

2.2.2 Interface SITTPA calculation.

The calculation program SITTPA 1.0 has several tabs with different functions which analyze the behavior of the tractor in different working conditions so that they can analyze features like power tractor, fuel consumption, fuel prices between others, such data are calculated and are not taken in real time, so this part is called calculation tool. This is done in order to compare the performance of new Holland tractor with respect to other tractors.

These analytical data can also be stored in files which can then be used by the user at will.

The calculation program can be seen in the image below.

Figure-4. Graphical user interface SITTPA calculation.

3. RESULTS

The results are divided into two parts: a level of software and hardware level.

3.1 transmitter device

The following images show in a very general way the result of the implementation process card SITTPA data transmission system.

Figure-5. XBee Pro S2 and XBee base assembly for the Atmega 2560 card.

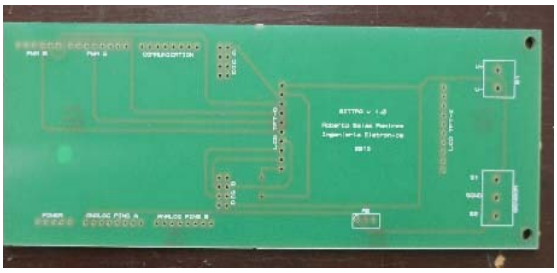

Figure-6. PCB TFT handler card.

This card was designed in Proteus ISIS 7.0, and its development was made by the company Micro assembly S.A.S in Bogota

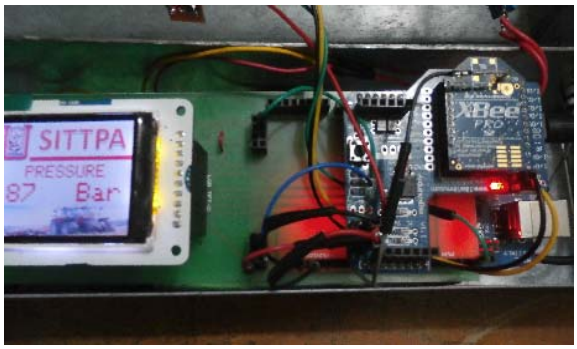

Figure-7. Transmitter card on operation.

The box is made of durable and ideal for operation in the open field project anti-corrosive metal.

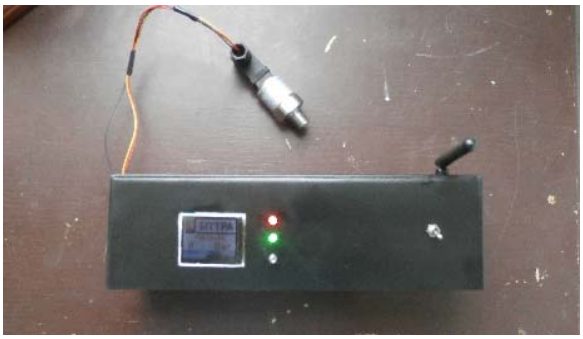

Figure-8. Transmitter device 100%.

3.2 Receiving device

The following images show in a very general way the result of the implementation process card data reception SITTPA system.

Figure-9. Receiver device 100%.

Figure-10. Receiver operating device with the computer where the software is hosted SITTPA.

3.3 Testing

3.3.1 Monitoring Program

SITTPA monitoring program consists of one tab which is responsible for real-time monitoring of pressure being transmitted which is exerted by the tractor via the hydraulic dynamometer.

Later we will see images and tables with their respective analysis of the tests were carried out using this tool and in turn will compare the work done by the application and the new system compared to the previous method of data acquisition.

Then we will see the interface monitoring operation.

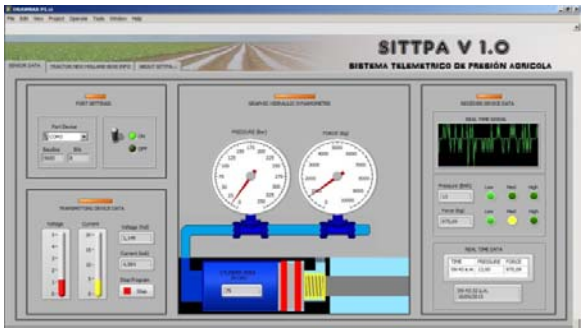

Figure-11. Program SITTPA performing real time monitoring.

The monitoring program carried a report which is stored in .tdms format, the file can be opened by Microsoft Excel, a time the file is opened can be handled at the user also can save to more file formats such as txt, then be read by parsers and data processing as Matlab or other programs, providing the possibility of giving endless uses data provided by the program. Here you can see the report generated by the monitoring program from Microsoft Excel seen.

The information presented in the report is everything related to the file the amount of data that contains the date and start time data acquisition and the date and time of the end of transmission, important data when you have a project that needs log, or even if you need a file of past medicines.

The data provided by the sensor card transmission found in the attached book which is called Untitled, as you can see in the picture below.

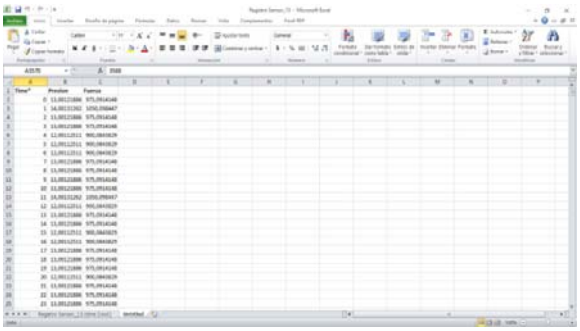

Figure-12. Report-data reading program.

As you can see in the picture there are three columns, the first that has to do with time, but this refers more to a guide on the number of readings in the presented case there is a total of 3568 data for nearly a time data collection. The second column is the read pressure and the third is equivalent to that pressure off. The presented test was performed on the experimental farm in an arid soil (Seco), it was observed that the force was minimal, this because the soil not being wet does not present an optimal condition for the tool to plow soil is adhered efficiently, and then this causes the discs do superficial work.

When testing on a wet field increased the force exerted is observed, since the discs are introduced greater deepness on the ground and being wet exerts greater resistance to perform work, achieving remove more land to prepare the land.

By comparing the results in soil when testing can say that dry or arid soil treatment outcomes soil are useless because a good job in the area is not done, whereas in the humid land removes better thus providing better soil treatment.

3.3.2 Analysis program

The Analysis program SITTPA is formed by flanges which contain different analysis tools for performance of the tractor, this section provides an example of using each tab so be shown that it can analyze

the results of two tractors New Holland but different references in order to show the potential of these tools when choosing a tractor at the time of a job or even before purchasing one.

The following table lists the most important characteristics of each tractor show; also it should be clarified that being of the same make most of its features are similar.

Table-1. Specifications tractors new holland series 30.

Specifications series 30		
Model	7630	8030
Power (Hp)	104,4	120,3
Torque (Nm)	430	490
Tank (Gal)	44,91	4,91

On this test work with two large sections of the PTO power application (power shot) and fuel consumption and its variants, specific consumption, consumption at part load and fuel costs in certain jobs.

3.3.2.1 Test PTO

In this test we analyzed the pulling power to each of the tractors and the results were as follows:

For the NH tractor - 7630 have the following results:

Table-2. Results of pulling power at different RPMs tractor NH - 7630.

RPMs - PTO vs RPM	PTO (Nm) - PTO vs RPM	RPMs - 86% Rule	PTO (Nm) - 86% Rule
1610	80,3	1610	85,4
1470	83,6	1470	89,0
1330	80,3	1330	85,4
1190	71,8	1190	76,4
1050	63,4	1050	67,4
910	54,9	910	58,4
770	46,5	770	49,4
630	38,0	630	40,4
490	29,6	490	31,5
350	21,1	350	22,5

And the respective graph is:

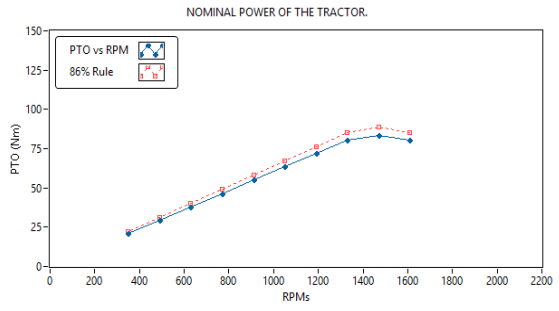

Figure-13. Nominal power vs RPM tractor NH-7630.

And the results of the tractor NH - 8030 are:

Table-3. Results of pulling power at different RPMs tractor NH -8030.

RPMs - PTO vs RPM	PTO (Nm) - PTO vs RPM	RPMs - 86% Rule	PTO (Nm) - 86% Rule
1610	91,5	1610	98,3
1470	95,3	1470	102,4
1330	91,5	1330	98,3
1190	81,8	1190	87,9
1050	72,2	1050	77,6
910	62,6	910	67,2
770	52,9	770	56,9
630	43,3	630	46,6
490	33,7	490	36,2
350	24,1	350	25,9

And the respective graph is:

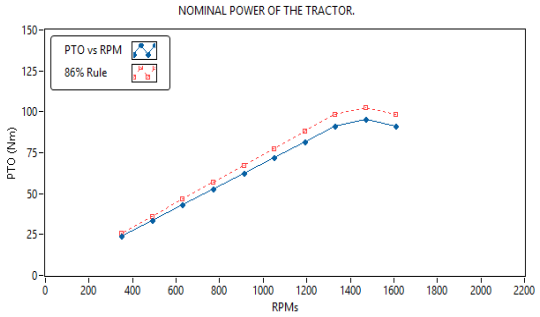

Figure-14. Nominal power vs tractor NH-8030 RPM.

In the graph it can be seen that the data found are by two methods, this in order to analyze the performance of the tractor with different methods one is used by test Nebraska and the other is under the so-called rule 86 this is also done with educational purpose for the user in this case are students or teachers can learn, differentiate and analyze these two methods.

In this test powers we can conclude that the NH-8030 tractor is very superior in firepower since the maximum power NH - 8030 is 102.4 Hp with rule 86 while with the Nebraska method is 95, 3 Hp and NH tractor - 7630 on the other hand is 89 Hp with rule 86 and 83.6 Hp with Nebraska method.

3.3.2.2 Test fuel consumption and fuel cost

In this test the tractor New Holland 8030 is only analyzed and the most important thing is to analyze the behavior of consumption of the tractor in different situations, and the tractor was chosen because it is currently in the experimental farm and is making the most experimental processes.

In this test consumption under the following conditions analyzed, specific consumption without loads and maximum acceleration, ie assuming that the tractor simply is moving without weighing consumption at part and full throttle loads, which refers to a specific job with some kind of charge regardless of weight and maximum

acceleration and finally fuel costs under certain working conditions were analyzed.
Results from the test are as follows:

- Specific fuel consumption.

In the specific consumption 3 methods of analysis the NTTL method is performed, the NTTL + method and ASAE method, all these methods are performed under standards that are currently used in many of the locations where the tractors are tested at the time of manufacture and subsequent proof. The purpose of this test is that the user knows different points of view the performance of their tractor.

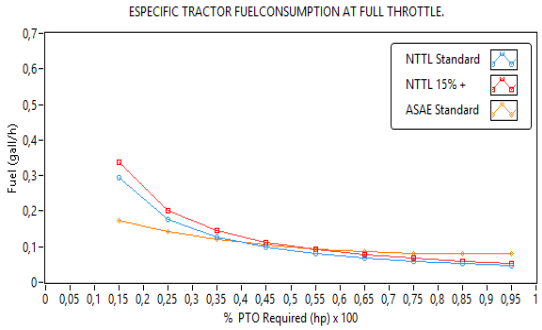

Figure-15. Specific fuel consumption at full throttle (Diesel Engine Fuel).

The NTTL standard used in this test is governed under the criteria of the laboratories of the University of Nebraska, as the criterion NTTL +, the difference between one and the other is that the NTTL + is added an extra consumption of 15% due criteria of soil condition, this in order to cover the loss in all fields where the tractor must travel and ASAE standard is used by Engineering Association of Agricultural Machinery Management.

The results obtained in this part indicate that when the tractor moving at a slower speed and the first speed will be increased fuel consumption and faster and in the last moves fuel consumption will be reduced drastically.

- Fuel consumption with partial loads.

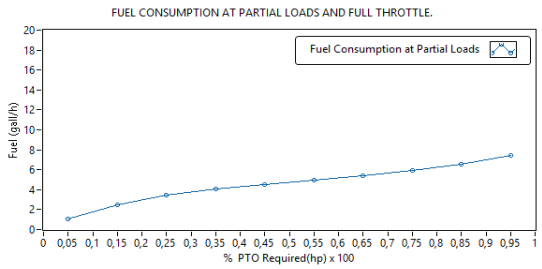

Figure-16. Consumption with partial loads and maximum acceleration (Fuel Diesel Engine).

The results obtained in the test indicate that the higher power requirement is greater fuel consumption and vice versa. But this in more specific terms means that when the tractor has a load and the power requirement for the job is minimal tractor will consume less fuel because the runtime will be lower, because the tractor can use the latest gear the gearbox which increase speed and also power is lower and could be enough to meet such work, however if the power requirement is greater the tractor will be forced to use the first marches which are not fast first gear and being force fuel consumption increases, while it also increases labor time.

- Fuel costs.

In this part fuel costs of both tractors NH-7630 and NH-8030, for a certain job where some work is required power is analyzed; It will first pose a job where the required power is 25 Hp, and another situation where the required power is 90 Hp be considered.
It should be clarified that in the examples for which we use the application the following data were used, with respect to the price of fuel.

For a diesel engine diesel fuel as fuel which is priced at 7,493 Colombian pesos for the month of November 2015 and the dollar around 3,000 pesos approximately which makes a gallon of diesel fuel in dollars have a price of 2 is used, $ 5 / Gal.

First labour development where the power requirement is 25 Hp have the following results.

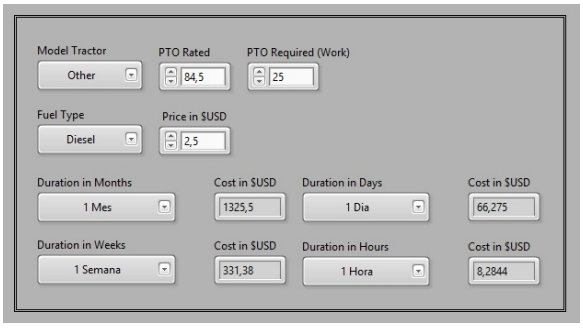

Figure 17. Cost of fuel for work of 25 Hp (Tractor NH-7630).

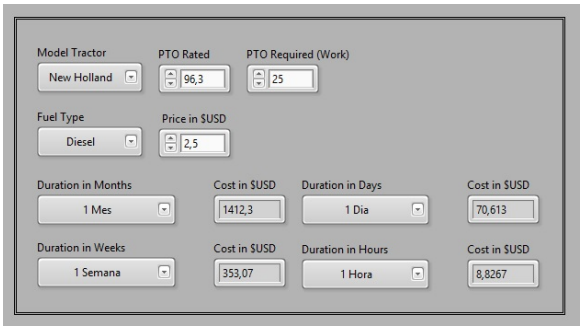

Figure-18. Cost of fuel for work of 25 Hp (Tractor NH-8030).

Now for the development of work where the power requirement is 90 Hp have the following results.

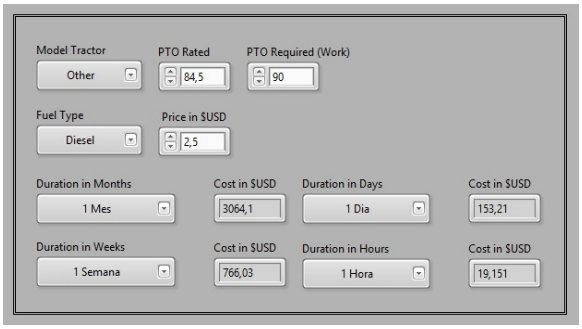

Figure-19. Cost of fuel for work of 90 Hp (Tractor NH-7630).

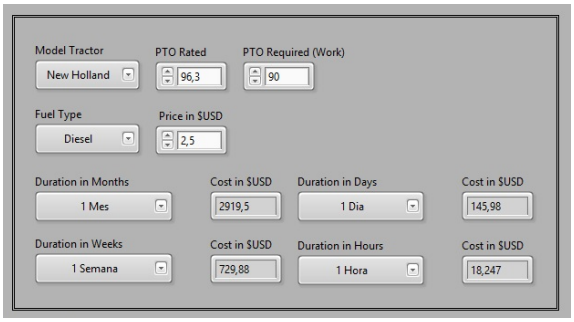

Figure-20. Cost of fuel for work of 90 Hp (Tractor NH-8030).

To finish analyzing the data obtained in the two tests on fuel costs can be said that for the first example where the work to be done required a power of 25 hp, the tractor 7630 does the work at lower cost and with no less effort as the working power is less than the characteristic tractor power compared to tractor 8030, which claim that for performing the first work the tractor 7630 is more than enough and also tells us that if work out for a month or more this tractor would save us about $ 100 approx. that at the current rate of change would be equivalent to 300,000 Colombian pesos, money that could be destined for other purposes.

In contrast to the second test the roles are reversed the tractor best suited to work is the 8030 as it would make me work and generate lower fuel costs unlike 7630. But there is something very curious to analyze in this second example and is the working power which is 90 Hp, we know that the tractor 8030 has no problems with that power because its power is 96 Hp, while the tractor 7630 is 84 Hp, then you. You must ask the question Does 7630 tractor if it could perform a task that requires 90 Hp?

The answer is yes, because if we look at the specifications on the table tractor features the rated power is 104.5 HP, but then why Hp 84 was placed on the analysis program, very simple 84 Hp is the maximum power with the number of revolutions that allow my engine has a long life cycle, this means that if you performed the task 90 Hp with tractor 7630 probably at first have no objection to such work, the detail is that for realize it would have to rev the engine above permitted which would effectively reached 90 Hp of the work that is below its maximum power of 104.5 Hp, but the engine would have a very short life cycle, it which would result, for example, that if this work was done daily for two months is very likely that the engine I present some type of failure the first month.

It can be concluded that the proper use of this tool will you. Select and use the tractor that best suits your needs which will save money and show you the best way to use your tractor in the different tasks carried out with this, ensuring maximum efficiency at lower cost.

REFERENCES

Power Performance. Donnell Hunt. Farm Power and Machinery Management (Tenth Edition). Waveland Press, 27/03/2008.

Tractors and Power Units. HARRY FIELD, JOHN SOLIE. Introduction to Agricultural Engineering Technology: A Problem Solving Approach (Third Edition). Springer Science and Business Media, 5/09/2007.

P.H Bomford and A. Langley. 2011. Farm Machinery. Richard J. Soffe. The Agricultural Notebook (Twentieth Edition). John Wiley and Sons, 2/12/2011.

Harry L. Field, Lawrence O. Roth. 1995. An Introduction to Agricultural Engineering: A Problem-solving Approach (Second Edition). Taylor & Francis.

E. Otavo Rodriguez. 1986. “Wood Extraction with Oxen and Agricultural Tractors. Food and Agriculture Org.

Jay Cheng. 2009. Biomass to Renewable Energy Processes” CRC Press, 1/12..

Joseph K. Campbell “Machinery Economics” “Dibble Sticks, Donkeys, and Diesels: Machines in Crop Production” Int. Rice Res. Inst., 1990.

Lotfie A.Yousif, Mohamed H. Dahab and Haitham R. El Ramlawi, Research Paper. 2013. Crop-machinery management system for field operations and farm machinery selection. Journal of Agricultural Biotechnology and Sustainable Development. 5(5): 84-90 Obtenido de http://www.academicjournals.org/article/article1379495724_Yousif%20et%20al.pdf.

Robert G. White. 1977. Matching Tractor Horsepower and Farm implement Size" Cooperative Extension Service Michigan State University. Ext Bulletin E-1152 SF 11 November 1977 Obtenido de http://archive.lib.msu.edu/DMC/Ag.%20Ext.%202007-Chelsie/PDF/e1152.pdf.

Goering, Carroll E., Marvin L Stone, David W. Smith, and Paul K. Turnquist. 2003. Engine and vehicle testing.

Chapter 3 in "Off-Road Vehicle Engineering Principles. 37-56. St. Joseph, Mich.: ASAE. © American Society of Agricultural Engineers Obtenido de http://210.27.80.89/2006/qiche/engine%20book/Engine%20and%20Vehicle%20Testing%20%283%29.pdf.

American Society of Agricultural Engineers. 2003. Agricultural Machinery Management. ASAE Standards. ASAE EP496.2 FEB03 Obtenido de http://facma.com.ar/PDF/Biblioteca/Machinery%20Management%20engl.PDF.

Robert D. Grisso; Michael F. Kocher; and David H. Vaughan. 2004. Predicting Tractor Fuel Consumption. Biological Systems Engineering: Papers and Publications. p. 164. Obtenido de http://digitalcommons.unl.edu/biosysengfacpub/164.

Robert Grisso, John V. Perumpral, Gary T. Roberson, Robert Pitman. Predicting Tractor Diesel Fuel Consumption. Publication442-073 Obtenido de https://pubs.ext.vt.edu/442/442-073/442-073_pdf.pdf

Robert Grisso, John V. Perumpral, Gary T. Roberson, Robert Pitman. Using Tractor Test Data for Selecting. Publication442-072. Obtenido de https://pubs.ext.vt.edu/442/442-072/442-072_pdf.pdf.