AMACA: Agricultural Machine Application Cost Analysis

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Alessandro Sopegno[1], Angela Calvo[1], Remigio Berruto[1], Patrizia Busato[1]

[1] Università degli Studi di Torino, Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA), Grugliasco.

e-mail of corresponding author: alessandro.sopegno@unito.it

Summary

Today users want to be connected to useful information at any time and place. For this reason the use of mobile technology is growing rapidly, but despite the growth of usage of mobile technology, the agricultural sector is slower in its adoption when compared to other types of business.

Machinery and equipments are major cost items in farm since many years in different countries. In the last years, moreover, high power machines, new technologies, higher prices for spare parts and energy contributed to the rising of the machines costs.

There is not an unique rule to determine machine costs and the most accurate method of determining them is the complete records of the actual costs incurred: unfortunately this method is not usable for prompt forecast purposes. The possibility to know in advance such costs is strategic for the farmers, but the agricultural machine cost determination available by internet applications are lacking of a mobile app.

Aim of this work is to fill this gap with an easy to use mobile app, to determine the real machineries costs in different field operations and makes them available via web mobile application using a cross-platform approach.

A web mobile app called AMACA (Agricultural Machine App Cost Analysis), which allows the analysis of traction costs and operation costs, was studied and developed. This paper describes this app AMACA, created using the HTML language for the content, the JavaScript for the logic part and the CSS as a presentation style. To accelerate the development, the jQuery Mobile (JQM, a touch-optimized JavaScript library) was used.

Discussion is made applying AMACA to a case studio and comparing it with the results produced by other on-line applications.

The tool is readily available, and at no cost, without the need for any installation on the end users' devices.

key words: *mobile, cross-platform, tractor costs, machinery costs, operations costs*

Introduction

Information and Communication Technology (ICT) plays an increasingly important role and provides a powerful foundation for addressing many of the problems we are actually facing.

Today's users want to be connected to useful information at any time and place. For this reason the use of mobile technology is growing rapidly: in fact, mobile technology and apps have been identified as the top 10 strategic technology trends for 2014 by Gartner Inc. (Gartner, 2013).

Despite growth of usage of mobile technology, the agricultural sector is slower in its adoption when compared to mobile technology use in other types of business (Xin et al., 2015).

Machinery and equipment are major cost items in farm businesses since many years in different countries (Rotz, 1983; Piccarolo, 1989). In the last years, moreover, high power machines, new technologies, higher prices for spare parts and energy contributed to the rising of the machines costs. Actually, the cost of machinery remains a significant portion of the cost of production of a farm for many operations and continues to be one of the highest input costs for farmers (Buckmaster, 2003).

Many engineering and economic methods have been (and are) used to calculate agricultural machines costs, but they are almost confined in the academic places, also if an efficient farmer should primarily know these methodologies and apply them when deciding to buy, lease or share agricultural machineries.

There are two categories of farm machinery costs: annual ownership (or fixed) costs occurred regardless of machine use, and operating (or variable) costs directly jointed to the machine use intensity.

While the firsts (depreciation, interest, housing and insurance) are quite easily to be determined, the latter (maintenance, repair, fuel, lubricant, labour, timeliness) depend on many factors: hours of annual use, type of performed operation, field size and characteristic, estimate of the operator's time based on his skill, operation execution in time (Schuler and Frank, 2014).

There is not an unique rule to determine machine costs and the most accurate method of determining them is the complete records of the actual costs incurred: unfortunately this method is not usable for prompt forecast purposes. The possibility to know in advance such costs is strategic for the farmers, but the agricultural machine cost determination available by internet applications are lacking of a mobile app (as MACGEST – www.macgest.com - and bioresource4energy.eu, a part of the BioEnergy Farm project within the framework of the Intelligent Energy for Europe programme).

Aim of this work is to fill this gap with an easy to use mobile app, to determine the real machinery costs in different field operations and makes them available via web mobile application using a cross-platform approach.

Material and methods

Technology challenges to deliver cross-platform apps lie in the essential difference between two types of applications: mobile web app and native app. Mobile web apps reside on server without installation on devices, therefore it is possible make changes in real-time execution.

The main weakness of native apps is that they must be implemented separately for each platform and this leads to an increase of time and costs. The development of native apps for different mobile operating systems (Os) requires the use of different programming languages and architectures. Moreover, for a native app, once it is modified, the developer needs to oblige all users to update their apps to receive upgraded services (Mao & Xin, 2014).

For these reasons to develop the application it was decided to use the approach of the mobile web app using HTML language for the content, JavaScript for the logic part and CSS as a presentation style. Moreover HTML5, JavaScript and CSS languages are widely supported by all browsers, and this approach has become a popular choice to deliver cross-platform apps.

Modern Web apps can provide rich user experiences that mimic mobile app characteristics: even though the results may not be as attractive as native code, this kind of approach is good enough for our purpose since it is portable to the Web and it is a fast way to create cross-platform apps.

The decision was supported by the experience of Xin et al. (2015) at the University of Florida. They indicate that the cross-platform mobile development technology (JavaScript, HTML5 and CSS) is a viable solution for mobile apps.

A lot of work is required to build a mobile web application that looks and works like a native app, which also fits automatically various resolutions of devices. To accelerate the development, we decided to use jQuery Mobile (JQM) which is a touch-optimized JavaScript library.

The JQM framework provides many features to support JavaScript basic library. An example of this is represented by Ajax navigation system, that brings animated page transitions and a core set of UI widgets.

We used HTML5 local storage feature to store some variables which can be modified by the user, so that they can change some parameters used for calculations.

To have reasonable parameter ranges of field speeds and efficiencies the data available in the ASABE STANDARDS (2011) were referred.

Results and Discussion

To determine the real machineries costs in different field operations and makes it available via web mobile application using a cross-platform approach, a web mobile app, called “AMACA” (Agricultural Machine App Cost Analysis) was developed. The app is available at the following link: www.meccolt.unito.it/amaca/index.html.

The user interface was designed using JQM framework. There are two main pages: Home and Results. Every page shares the same navigation header for quick switching between the pages as well as the footer. History tracking and back button is also enabled on every page. A script for all the pages is implemented to automatically adjust the display size according to the browser/device’s resolution.

The Input page is designed to make it as easy as possible the inclusion of user input. This page is divided into two sections: tractor data and machinery data.

The tractor data section allows the users to insert the input of the tractor to be examined. The users fill in the yearly hours of use, the power (expressed in kW) and the purchase value of the tractor (Figure 1). For yearly hours of use and power field a value in a range with the use of range sliders may be chosen.

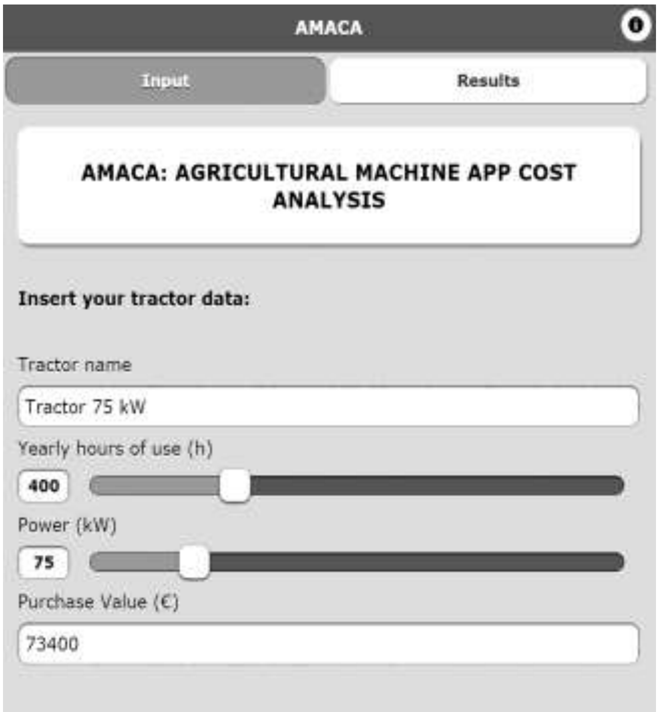


Figure 1: Input page of the tractor data section.

Regarding the machinery data section (Figure 2), after selecting the machinery type by tapping on a select menu, the users have to fill in the yearly hours of use, the power (if needed), the machinery lifetime and the purchase value. They have also to fill in the working width (expressed in meters) and the working speed (expressed in kilometres per hour) in field operation.

Except for the purchase value, all the data of the other fields can be chosen inside a range with the use of range sliders, which changes depending on the type of machinery.

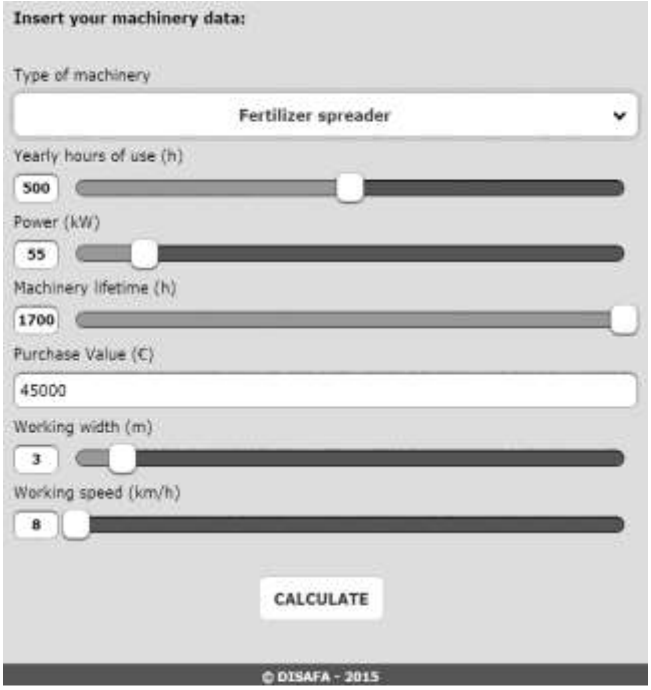


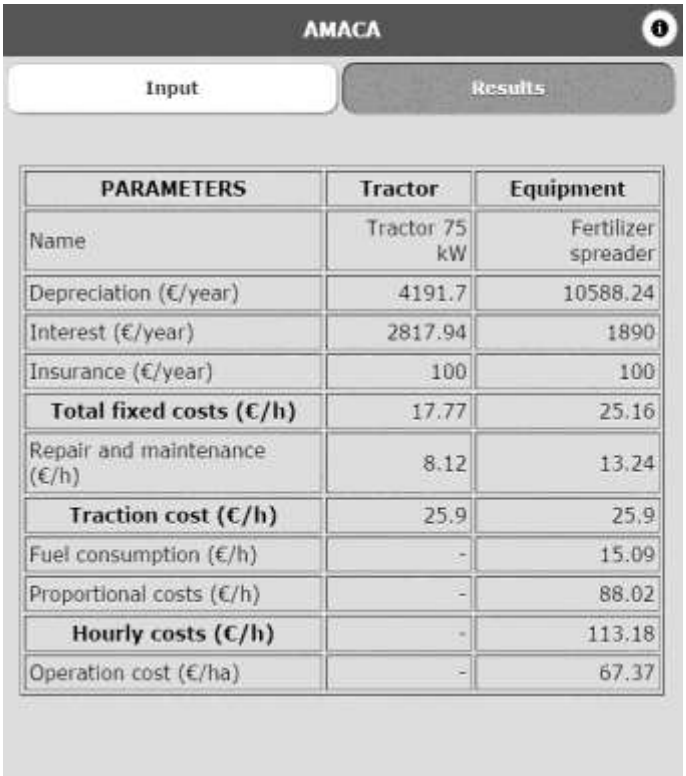
Figure 2: Input page of the machinery data.

The Results page (Figure 3, accessed by tapping the “calculate” button on the Input page), provides the cost analysis of both the tractor and the machinery inserted in the input page.

More in detail, the users can find the values of depreciation, interest and insurance that compose the total fixed costs, expressed as euro per year (€ $year^{-1}$). They can also find the repair and maintenance costs and the traction costs expressed as euro per hour (€ h^{-1}).

For the equipment are also reported the fuel consumption and the hourly costs as € h^{-1}.

As a final result, the costs of the operation as euro per hectare (€ ha^{-1}) is provided.



PARAMETERS	Tractor	Equipment
Name	Tractor 75 kW	Fertilizer spreader
Depreciation (€/year)	4191.7	10588.24
Interest (€/year)	2817.94	1890
Insurance (€/year)	100	100
Total fixed costs (€/h)	17.77	25.16
Repair and maintenance (€/h)	8.12	13.24
Traction cost (€/h)	25.9	25.9
Fuel consumption (€/h)	-	15.09
Proportional costs (€/h)	-	88.02
Hourly costs (€/h)	-	113.18
Operation cost (€/ha)	-	67.37

Figure 3: Results page

The “info” button in the header of the Input page is available to access the instruction page where it is possible to find detailed information about the application use.

Considering that we use HTML5 local storage feature to store some variables, tapping the “modify” button it is possible to apply changes to some of the parameters used for the calculations (Figure 4).

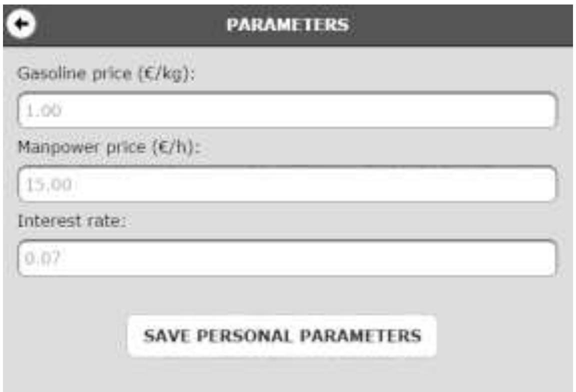


Figure 4: Edit of the parameters used for the calculations

The case study

To assess the functioning of the application, real data of a tractor and the equipment for the field operation of the spreading of manure were included as example (Table 1).

Table 1 Case study input

Input	value
Tractor yearly hours of use (h)	400
Tractor power (kW)	75
Tractor purchase value (€)	73400
Type of machinery	Manure spreader
Machinery yearly hours of use (h)	500
Machinery power (kW)	55
Machinery lifetime (h)	1700
Machinery purchase value (€)	45000
Working with (m)	3
Working speed (km h^{-1})	8

In Table 2 it is possible to see the corresponding case study output.

These outputs are comparable with the results produced by other on-line applications, such as bioresource4energy.eu.

Table 2: Case study output

Output	Value for tractor	Value for equipment
Depreciation (€ $year^{-1}$)	4191.7	10588.2
Interest (€ $year^{-1}$)	2817,9	1890.0
Insurance (€ $year^{-1}$)	100.0	100.0
Total fixed costs (€ h^{-1})	17.8	25.2
Repair and maintenance (€ h^{-1})	8.1	13.2
Traction cost (€ h^{-1})	25.9	25.9
Fuel consumption (€ h^{-1})	-	15.1
Proportional costs (€ h^{-1})	-	88.0
Hourly costs (€ h^{-1})	-	113.9
Operation cost (€ ha^{-1})	-	67.4

Conclusions

The web mobile app AMACA (Agricultural Machine App Cost Analysis) allows the analysis of traction costs and operation costs. The tool is free and readily available without the need of any installation on the end users' devices. It is a cross-platform application: it means that the app operates on every device through a web interface and it is supported by the major browsers.

The use of standard ranges is necessary to avoid user's mistake, to provide normalized results through the same method of calculation and to use common coefficients for a consistent comparison.

The future direction could be to send email to the users with the results to help comparison between different machineries and alternative machinery field operations.

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