A Pocket Information System for Farm Contractors (APIS)

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ABSTRACT

Farm contractors have the necessity to quickly know if an agricultural operation request is convenient or not, using their agricultural machineries. Field dimension, shape and slope are key factors to determine operations costs. In addition, high machinery power and characteristics, spare parts, and energy consumption are main components difficult to quickly evaluate to understand the operation benefit or loss. The possibility to estimate such costs beforehand is a critical factor for strategic and tactical decision making. Nowadays there are few web-based mobile applications for agricultural machinery cost estimation to help farm contractors in their decision.
Aim of this work is to present a quick and easy-to-use mobile web app, that allow the users to insert their machineries, the shape and the area of the field to evaluate the economic feasibility of a specific field operation. The app was built using the open-source Drupal framework with a module that use a cross-platform approach. Outputs of this app are multiple scenarios with combinations of tractors and equipment inserted by the users with a detailed cost and time analysis based on the requested field operation . The tool is free and does not require any installation on the end-users mobile devices.

Keywords: agricultural mobile app, farm contractors app, agricultural operation cost

1   INTRODUCTION

Farm contractors have the necessity to quickly know if an agricultural operation request is convenient or not, using their agricultural machineries. In fact equally to farmers, contractors can assess a number of options on different decision levels: strategic (e.g. purchase additional machines), tactical (e.g. understand the break-even point of the machinery investment) and operational (e.g. change the price of the service) as shown in Sopegno et al. (2016).
Type of performed operation, field dimension, shape and slope are key factors to determine operating costs which is directly connected to the machine use intensity (Schuler and Frank 1991). In addition, high machinery power and characteristics, spare parts, and energy consumption are main components difficult to quickly evaluate to understand the operation benefit or loss (Bochtis et al. 2014). The possibility to estimate such costs beforehand is a critical factor for strategic and tactical decision making (Busato and Berruto 2014). Nowadays there are few web-based applications for agricultural machinery cost estimation to help farm contractors in their decision and lower mobile apps are available (Xin et al. 2015). This is in contrast with the growing utilization of mobile technology and with the opportunity for this technology in the agricultural machinery management sector (Gartner 2014).

Aim of this work is to present a quick and easy-to-use web app, that allow the users to insert their machineries and the field operation parameters to evaluate the economic feasibility of a specific field operation.

A mobile web app is, in many ways, hard to distinguish from a native app. For instance, there are no visible browser buttons or bars, although it runs in browser (e.g. Safari when accessed from an iPhone or Chrome when accessed from an Android device). Users can use the navigation menu to move on the sections of the app. Mobile web apps reside on server without installation on devices, and both debugging and fixing are possible in real-time execution. Another important feature of the mobile web apps is the opportunity to market directly to the users without the need to competition in app stores.

The web app described in this work is available at: https://www.apis-app.eu

2   MATHERIAL AND METHODS

2.1   Tool design

The database and the content part of the web mobile app was built using the open-source Drupal framework. Drupal is a modular web content management framework written in PHP maintained and developed by a community of more than 630,000 users and developers. Drupal core effortlessly allows to assign roles to users and to have different permissions related to each role. This permits a simplified and optimal management of the database and together with the high number of the Drupal community members and related extensive documentation, made this framework the ideal choice for the presented work.

2.2   User Interface (UI)

The user interface is designed using a cross-platform approach with a Drupal theme (Corolla) that allow to use the Media Queries CSS technique to make Responsive Web Design. Furthermore the use of a Drupal module (Mobile Detect) permit to hide regions in mobile devices, or move the regions blocks to another region when a mobile device is detected. In order to make it more user friendly, the jQuery UI Touch Punch, a touch-optimized JavaScript library, was also used.

The cross-platform approach used for this work meaning that the tool operates on any device through a web interface and it is supported by various browsers. This approach was made possible by using a database that resides on the server, through which user data is not stored on individual devices but associated to the user account and accessible from anywhere.

Regarding the security aspects of the application, through the authentication provided by Drupal users can access only their own inserted data and the communication between the server and the different client applications (web and mobile) are encrypted using the HTTP-Secure protocol which ensures data confidentiality during the connections.

2.3   Main pages

There are four main pages: "Home", "Inserted Tractors", "Inserted Machinery" and "Results". Each page shares the same navigation header for a quick switching between the pages and the footer. History tracking and back button is also enabled on each page.

In the Home page(Figure 2) is located the Navigation menu, designed to make the insertion of the various inputs as easy as possible. This menu is divided into three sections: tractor data, machinery data and field operation data. The tractor data section allows the users to insert the input data required for the tractor, corresponding to the yearly hours of use (h), the power (kW) and the purchase value of the tractor (€). Regarding the machinery input data section, after selecting the machine type on a select menu, the user must input the yearly hours of use (h), the required power (kW), the machinery lifetime (h) and the purchase value (€). The last step for the data insertion is the field operation input in which user can select the previously inserted tractor and machinery and the operation working width (m), the working speed (km h^{-1}) and the consumables cost (€ ha^{-1}) must be inserted. Except for the purchase value, all the above mentioned parameters may be chosen with the range slider that help users to avoid mistake.

Figure 2. Home page.

In the Inserted Tractors and Inserted Machinery pages the inserted tractors and machineries of the user are shown and it is furthermore possible edit the previously inserted values.
In the results page, as it is possible to see in Figure 3, through available filters it is possible to compare the different combinations of tractors-equipment-field operations inserted from the user.

Figure 3. Results page.

3   RESULTS

3.1   Case study

In order to demonstrate the applicability of the APIS app, a case study was carried out. One of the potential uses of APIS is the cost comparison among different combinations of tractors-equipment-field operations. The case study was focused in the field operation of the ploughing changing only the tractors parameters (tractor power and tractor purchase value) as it is possible to see in Table 1.

Table 1. Input parameters and values of the case study

Input	Value of case 1	Value of case 2	Value of case 3
Tractor yearly hours of use (h)	500.00	500.00	500.00
Tractor power (kW)	85.00	95.00	105.00
Tractor purchase value (€)	80000.00	85000.00	95000.00
Type of machinery	Moldboard plow	Moldboard plow	Moldboard plow
Machinery yearly hours of use (h)	80.00	80.00	80.00
Machinery power requirement (kW)	60.00	60.00	60.00
Machinery lifetime (h)	2000.00	2000.00	2000.00
Machinery purchase value (€)	14000.00	14000.00	14000.00
Working with (m)	2.00	2.00	2.00
Working speed (km h^{-1})	5.00	5.00	5.00

In Table 2 are listed the outputs provided by the web application APIS for the case study mentioned above.

Table 2. Output parameters and comparison using APIS tool

Parameters	ploughing case 3 with Tractor 105kW and Moldboard plow 60kW	ploughing case 2 with Tractor 95kW and Moldboard plow 60kW	ploughing case 1 with Tractor 85kW and Moldboard plow 60kW
Tractor	Tractor 105kW	Tractor 95kW	Tractor 85kW
Tractor Depreciation (€/year)	2651.39	2372.30	2232.75
Tractor Interest (€/year)	2628.89	2352.16	2213.80
Tractor Insurance (€/year)	100.00	100.00	100.00
Tractor total fixed cost (€/h)	10.76	9.65	9.09
Tractor Repair and maintenance (€/h)	4.56	4.08	3.84

Parameters	ploughing case 3 with Tractor 105kW and Moldboard plow 60kW	ploughing case 2 with Tractor 95kW and Moldboard plow 60kW	ploughing case 1 with Tractor 85kW and Moldboard plow 60kW
Machinery	Moldboard plow 60kW	Moldboard plow 60kW	Moldboard plow 60kW
Machinery Depreciation (€/year)	448.00	448.00	448.00
Machinery Interest (€/year)	420.00	420.00	420.00
Machinery Insurance (€/year)	100.00	100.00	100.00
Machinery total fixed cost (€/h)	12.10	12.10	12.10
Machinery Repair and maintenance (€/h)	7.07	7.07	7.07
Operation name	ploughing 3	ploughing 2	ploughing
Manpower cost (€/h)	15.00	15.00	15.00
Fuel consumption (€/h)	17.53	17.01	16.77
Machines costs (€/h)	67.02	64.91	63.87
Field capacity (ha/h)	0.85	0.85	0.85
Machinery operation cost (€/ha)	78.85	76.36	75.14
Consumables (€/ha)	0.00	0.00	0.00
Total operation cost (€/ha)	78.85	76.36	75.14

As it can be seen in Table 2, as expected only the tractor costs (tractor depreciation, tractor interest, tractor total fixed cost and tractor repair and maintenance) varies according to the input parameters in which only the power and price of tractors are changed. However this change affect also the final operation cost that is higher for the case 3 that produces a higher cost per area unit. This is due to the highest tractor purchase value and tractor power of this case. This information can support the farmer contractor's decision making on choosing the appropriate combinations of tractors-equipment-field operations that fits in her/his production constrains, in terms of economic resources and well-timed execution of operations.

4   CONCLUSION

Outputs of this web mobile app are multiple scenarios with combinations of tractors and equipment inserted by the users on the database with a detailed cost and time analysis based on the requested field operation. The user can make subsequent calculations by varying the input parameters and choosing between different machines in the database in order to compare the results in a sensitivity analysis basis. Through these results APIS app can support the strategic decisions of the farm contractors.

The tool is free and does not require any installation on the end-users mobile devices.

5   REFERENCES

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