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AdubaPE - Low code app to assist farmers in soil fertilization and correction in Pernambuco

AdubaPE - Aplicativo *low code* para auxiliar agricultores na adubação e correção de solos em Pernambuco

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A B S T R A C T

Information and communication technology has been gaining more and more space in the management of city and rural problems, bringing efficiency, agility in processes and improving results and people's quality of life. Access to apps, social networks, and IoT (Internet of Things) devices has been intensifying and becoming increasingly popular, enabling the inclusion of more people in the digital world.
The objective of this work was to develop a low code app that allows farmers, based on analytical reports of the soil, to verify the recommendation of fertilization and liming necessary for the crop to be planted. The technical data on fertilization and liming for the various crops planted in the state were obtained from the tables of recommendations for fertilizers and soil amendments for the state of Pernambuco, as Brazil, due to its large territorial dimension, has different types of soils, as well as predominant types of crops by region. The low code tool used was Kodular, developed in MIT App Inventor to facilitate the coding of apps. This product is expected to provide opportunities for farmers in the state to minimize costs and increase productivity, as well as help protect the environment, since the exaggerated supply of fertilizers and soil amendments can lead to contamination, as well as surface and underground water with damage to the main uses. It is expected that food production aligned with sustainable innovation can contribute to improving the quality of life for people and the environment.

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R E S U M O

A tecnologia da informação e comunicação, vem ganhando cada vez mais espaço na gestão dos problemas da cidade e do campo, trazendo eficiência, agilidade nos processos, melhorando resultados e qualidade de vida das pessoas. O acesso a aplicativos, redes sociais, e dispositivos IoT *(Internet of Things)* vem se intensificando e se tornando cada vez mais populares, possibilitando a inclusão de mais pessoas ao mundo digital.
O objetivo desse trabalho foi desenvolver um aplicativo *low code* que permita aos agricultores, com base em laudos analíticos do solo, verificar a recomendação de adubação e calagem necessárias à cultura a ser plantada. Os dados técnicos de adubação e calagem para as diversas culturas plantadas no estado foram obtidos das tabelas de recomendações de fertilizantes e corretivos do solo para o estado de Pernambuco, pois o Brasil devido a sua grande dimensão territorial, apresenta diferentes tipos de solos, assim como tipos de cultivos predominantes por regiões. A ferramenta *low code* utilizada foi o Kodular, desenvolvido baseado no MIT *App Inventor* para facilitar a codificação de aplicativos. Espera-se com esse produto oportunizar aos agricultores do estado, a minimização de custos e aumento de produtividade, bem como auxiliar na proteção do meio ambiente, uma vez que o aporte exagerado de fertilizantes e corretivos ao solo pode levar a sua contaminação, assim como da água superficial e subterrânea com prejuízos aos principais usos. Espera-se que a produção de alimentos alinhada à inovação sustentável possa contribuir para a melhoria da qualidade de vida das pessoas e do ambiente.

***Palavras-Chave*:**
tecnologia, agricultura, sustentabilidade

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Introduction

Agriculture is an activity that expands every day adopting more technology and increasing productivity, boosting the Brazilian Domestic Product (GDP) that is now represented by 23% by Brazilian agribusiness. The use of information from satellites, drones, ground sensors, intelligent agricultural machines, is a reality in the country. The use of apps for various purposes in this area has also become popular, however, there are still few apps available free of charge, intended to assist in the correction and recommendation of soil fertilization. The existing ones were developed for soils of South, Southeast and North of Brazil (EMBRAPA, 2018), (EMBRAPA, 2019), (FertFacil, 2022).

It is known that due to the continental dimensions of the country, it has soils with differentiated regional characteristics (Santos, et al., 2018), and it is important to follow the state technical recommendations, within the precepts for the establishment of sustainable cities and communities.

Before planting, farmers need to carry out soil analyses to verify the situation in which it is and whether there is a need for correction before fertilization. The correction of soil acidity, also known as limeing, is a very important agricultural practice for the best use of fertilizers used, improving productivity (Costa Veloso, Botelho, Lopes Fernandes Rodrigues, & Silva, 2020).

The correction and fertilization carried out assertively, in addition to minimizing costs, avoids damage to the environment by the exaggerated and often unnecessary supply of fertilizers, which is an indispensable conduct for sustainable agriculture.

The app proposed in this paper, will facilitate the access of farmers to technical guidelines, allowing autonomy through the choice of the crop to be planted, with the indicated amounts of fertilizers and correctives to be applied, enabling the choice of fertilizers, verification of the form and time of application of the same, contributing to a consumption of responsible materials and production, as well as environmental conservation within the bias of some Sustainable Development Goals (ODS), such as “Fome Zero” (zero hunger) and sustainable agriculture, cities and communities, and terrestrial life.

Therefore, the objective of this paper was to develop a low code app for mobile devices, with the purpose of recommending fertilization and liming for the main agricultural crops of the state of Pernambuco. It is expected to contribute to sustainable agriculture and to the consumption of responsible production and intake in the state of Pernambuco.

Theoretical Reference

Agriculture, technology and "ODS"

In 2015 the United Nations established 17 Sustainable Development Goals (ODS) to make up the 2030 agenda, aimed at building and implementing fundamental public policies for human development, involving people, planet, prosperity, partnerships and peace.

There are several themes covered in the "ODS", such as poverty eradication, food security and sustainable agriculture, health and well-being, quality education, gender equality, reduction of inequalities, clean and accessible energy, clean water and sanitation, sustainable patterns of production and consumption, climate change, sustainable cities and communities, protection and sustainable use of oceans and terrestrial ecosystems, inclusive economic growth, infrastructure and industrialization, and means of implementation (EMBRAPA, 2022). In Brazil, the contribution to the "ODS" was defined by Decree No. 8,892/2016, which created the National Commission for Sustainable Development Goals.

Agriculture and technology, instruments of this paper, move indirectly between some "ODS" and directly in others, constituting a basis and tool for increasing food production and sustainable use of natural resources.

Recommendation of fertilization and liming for soils of Pernambuco

Fertilization is an agricultural practice that is carried out according to the need of culture and soil conditions, assists in increasing production, reduces costs with unnecessary insums, as well as the risk of degradation to the environment. The state of Pernambuco has the second approximation of the recommendation (Cavalcanti, et al., 2008) of fertilization where the suggestions for fertilization for various crops of commercial interest are described, taking into account the potassium and phosphorus contents found in the soil. This publication is in the update phase.

The liming, practice of applying limestone to the soil, promotes the increase of pH, neutralization of exchangeable aluminum that is toxic to plants and the elevation of the bases constituting a very important step that precedes planting, because it provides the best use of fertilizers by plants, favoring their growth and productivity (Costa, Crusciol, Neto, & Castro, 2016).

In the state of Pernambuco, the most used methods of limestone recommendation are the neutralization of exchangeable aluminum and the elevation of calcium and magnesium contents (Cavalcanti, et al., 2008).

Apps for recommendation of fertilization and liming in Brazil

In the country, there are few apps intended for recommendation of fertilization and liming available free of charge. Most are for soils in Southern and Southeast Brazil. Among the existing apps one can mention, AdubaTec (EMBRAPA, 2019) which is a free software developed by "Embrapa Mandioca e Fruticultura" (Embrapa Cassava and Fruit Culture), where the interested party himself, informing the results of the chemical analysis of the soil, receives the recommendation of liming and fertilization for the selected crop (pineapple, acerola, banana, orange, tangerine, acid lime, papaya, cassava, mango and passion fruit) planted in the state of Bahia, in PDF format.

FertFacil (FertFacil, 2022) is another free app, which allows the user to interpret a soil analysis and calculate the required amount of fertilizers and acidity correctives for the main agricultural crops in Brazil (RS, SC, PR and Cerrado) and Paraguay (with Spanish version), based on official recommendations.

Nutrisolo (EMBRAPA, 2018), developed by the "Centro de Pesquisa Agroflorestal da Amazônia Ocidental" (Center for Agroforestry Research of the Western Amazon) is an app that helps agricultural technicians and producers to calculate the need for fertilization and soil dredging for the state of Amazonas, performing calculations from the results of chemical analyses of soils.

As previously mentioned, there is still no app for recommendation of fertilization and liming for the soils of Pernambuco.

Low code platforms

The high cost and long deadlines of software development, low supply and high demand for qualified personnel, combined with companies search for faster and cheaper solutions to meet their software needs, has driven the no code and low code development platforms (LCDPs) (Fritura, 2019).

Low Code Development Platform (LCDP) are development platforms that provide a graphical environment for building apps with little or no manual programming. They have become popular for practicality in the development of low code apps, based on GUI (Graphical User Interface), allowing the construction of solutions through predefined models, graphic design techniques and drag-and-drop tools with little code development (Alamin, et al., 2021).

Among the advantages of these platforms are the agility of processes, time savings and flexibility in creation, since semi-ready solutions are subject to customization. Another advantage is that several people can help develop the app, not just programmers.

There are several Low Code development platforms such as Appian, Mendix, Outsystems, Zoho Creator, Caspio, App Sheet, File Maker, Biznessapps, Airtable, Build Fire,

etc., such platforms integrate, in a single environment, various design components of traditional systems, reducing routine task efforts in the implementation of business apps, promoting productivity in software development, provided that project requirements can be met within the framework platform, in addition to other technical and economic conditions (Bock & Frank, 2021).

Methodological procedures

The work involved 3 main steps: the first was the appropriation of the app development tool, the second was the definition of the requirements for the prototype and technical data collections of the main crops planted in the state and the third step was the app development and usability tests, as detailed below.

The low code tool chosen for the job was Kodular, this platform is an evolution of App Inventor, created in MIT (Massachusetts Institute of Technology) that allows the fast and easy development of Android apps through a block editor, without the need for programming knowledge.

Functional and non-functional requirements for the app were defined. The functional ones understood as technical requirements that describe actions that the system must be able to perform, that is, what the system should do. And the non-functional as requirements that make up the system, which describe attributes that the system must have or restrictions under which it must operate.

The fertilization data of the main crops planted in the state, spacing data, cultivars, planting density and productivity were obtained from the official publication of fertilizer recommendation and liming for the state of Pernambuco. The liming value was obtained, considering the highest value between the calculation for the elevation of calcium and magnesium contents and the calculation for the neutralization of exchangeable aluminum, according to the following equations (Cavalcanti, et al., 2008).

$$NC = Al \times f \text{ ou } [2 - (Ca+Mg) \times 2] \quad \text{(equation 1)}$$

$$NC = Al \times f + [3 - (Ca+Mg)] \text{ (for some irrigated crops)} \quad \text{(equation 2)}$$

Where:

NC ($t.ha^{-1}$) = need for limestone.

Al ($cmol_c.dm^{-3}$) = exchangeable aluminum content made available by soil analysis.

Ca+Mg ($cmol_c.dm^{-3}$) = calcium and magnesium contents made available by soil analysis.

f = factor that depends on the clay content of the soil (f = 1,5 if the clay content < 150 $g.kg^{-1}$; f = 2,0 if the clay content is between 150 e 350 $g.kg^{-1}$; f = 2,5 if the clay content > 350 $g.kg^{-1}$).

Results and discussions

The following screens have been set for the app:

- ***Main Screen***
  On this screen the user accepts the terms of use of the app and is presented to a menu that can lead to the screen of choice of the crop to be planted, the screen of information about the app and the option to exit it, as shown in Figure 1.

Figure 1

Main Screen

- ***Screen of choice of the crop to be planted***
  By clicking the "Crops" button, the user is presented with the screen to choose the crop to be planted (Figure 2). When defining the crop, the screen is presented with information about it (Figure 3), such as photo, crops, spacing, planting density and productivity. Also on this screen, you can click on the "tools" button that allows you to access the unit conversion screen and "recommendations" that takes the user to the data entry screen for fertilization and liming. Here you also choose between the options, the spacing of the crop, from which is calculated the number of plants (number of plants/h = 10,000 m2/crop spacing). In the example, the spacing 1.0 x 0.5 m was chosen, resulting in 1800 plants per hectare (Figure 4).

- ***Fertilization and liming recommendations screen for the chosen crop***

  On this screen, the results of the soil analysis are entered: granulometry, clay content, calcium, magnesium, potassium, exchangeable aluminum and phosphorus. The relative total neutralization power (PRNT) of limestone should also be reported for adjustments to the amount of limestone (Figure 5).

Figure 2

Screen for culture choice

Figure 3

Information and recommendations screen

Figure 4

Data entry screen

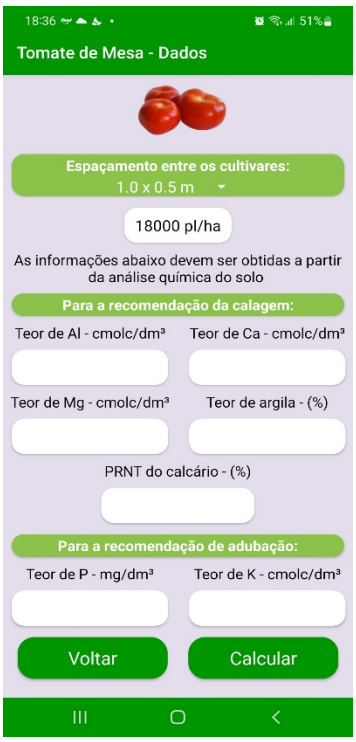
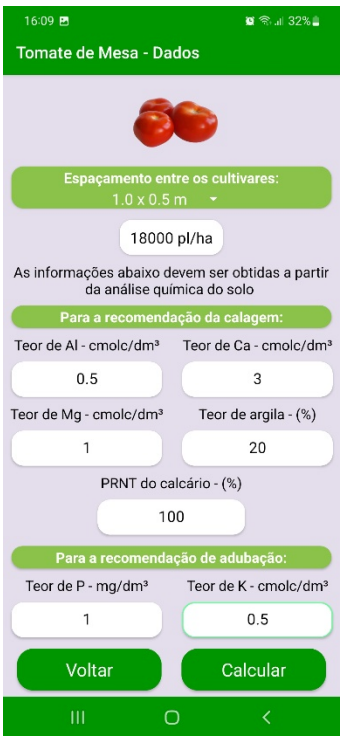


Figure 5

Screen with data for calculation



- ***Indication screen for fertilization and liming***

  On this screen, the liming is presented, with the indication of the amount of limestone to be applied, as well as nitrogen fertilization (N), phosphate (P_2O_5) and potassium (K_2O) in planting and cover. These amounts are a function of the contents of the elements found in the soil analysis, according to data entered in Figure 5 (aluminum 0.5 cmolc.dm-3, calcium 3.0 cmolc.dm-3, magnesium 1.0 cmolc.dm-3, clay content 20%, PRNT 100%, phosphorus 1 mg.dm-3 and potassium 0.5 cmolc.dm-3). The quantities of the fertilizers indicated may be expressed in the elemental form (Figure 6) or in the form of commercial fertilizers (Figure 7). These options are available in the drop-down menu tab where the nutrient name appears. The quantities of fertilizers for application per hectare or per plant are also calculated according to spacing.

Figure 6

Indication screen for fertilization and liming

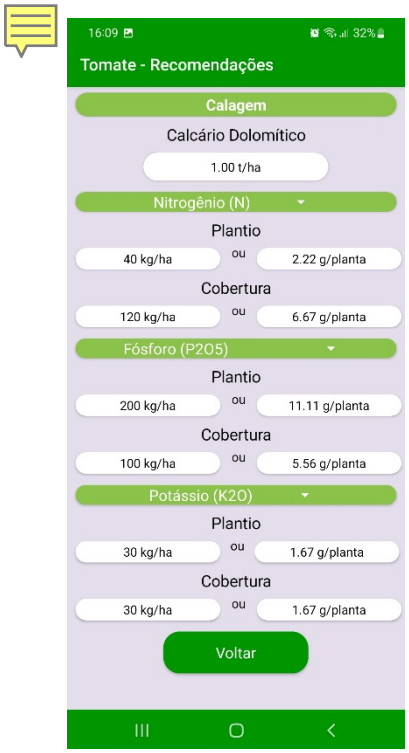


Figure 7

Screen with commercial fertilizers

Final Considerations

In this first stage of development of the AdubaPE app, it was verified that it is possible to use a low programming code tool and have a user-friendly interface product that meets the objectives of indication of fertilization and liming. In a next step, more crops that are grown in state soils will be included, as well as other increments to generate a more robust product, such

as reporting, graphs of interpretation of soil nutrients contents and storage of information in georeferenced databases.

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