Global trends in apps for agriculture

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ABSTRACT. Although applications (apps) for mobile devices show increasing popularity in the agricultural sector, studies regarding their availability are still incipient. In the present study, a survey was conducted to assess global trends of app availability for agriculture. This survey was conducted in 2015 and 2018 in two app stores with free access (Google Play and Windows Phone); searches for the following keywords were included in the survey: agriculture, agri, and farming. In 2015 and 2018, these searches found 244 and 599 apps from 33 and 61 countries, respectively. Countries with the largest number of apps (i.e., USA, Brazil, and India) accounted for ~64% of all surveyed apps. However, diversity and availability of paid apps was greater in USA and Brazil compared to India. Although many apps were related to magazines and market information, numerous other apps were available on farm management, pests and diseases, precision agriculture, and technical assistance. Related apps that used photographic input and citizen science data were also found. Our study indicates that the global development of apps for agriculture is growing rapidly, with most serving informative purposes at no cost to users.

Keywords: farm management; image analysis; crop production; portable agricultural technology; smartphones

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INTRODUCTION

History clearly shows that the evolution of agriculture was highly dependent on the introduction of new tools and techniques to maximize production and reduce labor. For example, animal power gave way to machinery, growth of genetic knowledge has enhanced plant and animal breeding, and manufactured fertilizers have superseded or supplemented organic residues as fertility amendments. In more recent times, the advent of computers, digital cameras, electronic agendas/planners, and mobile phones has introduced new tools to aid the activities of farmers, agricultural technicians and researchers (Romani et al., 2015; Barbosa et al. 2016; Bonke et al. 2018; Meena et al. 2018; Barbosa et al. 2020; Bezerra et al. 2020). Therefore, the Digital Era clearly represents a new phase in the evolution of agriculture.

Applications (apps) are software developed for mobile devices such as mobile phones, personal digital assistants (PDA), smartphones, and tablets (Pongnumkul et al. 2015; Meena et al. 2018). Specifically, smartphones combine the utilities of mobile phones and PDAs into a single device (i.e., minicomputers with telephone connectivity). App use began in 1992 when International Business Machines launched the IBM Simon smartphone; however, public exposure probably began in 2001 with the Palm Treo. In a relatively short period of time, increased memory, faster processors, and smaller devices spurred increased market demand (since ~2007), especially with the launch of Android (Google) and iPhone (Apple) (Terry 2010).

The consequent expansion of app markets has led to an increased variety of tools, with apps for virtually all agricultural sectors. Apps can be fairly simple or sophisticated and can be useful for general information and commodity quotes (Pongnumkul et al. 2015; Costopoulou et al. 2016), evaluation of plant nutritional status with the aid of satellite images (Nutini et al. 2018), or obtaining hydrological information associated with NASA databases (Maldonado Júnior et al. 2019). Digital cameras in mobile devices are useful tools for precision agriculture that can increase the range of use for agriculture apps to assist in various activities such as measuring insect damage (Machado et al. 2016), evaluating orange harvest points (Cubero et al. 2018), and determining the percentage of soil cover (Laamrani et al. 2018). By using filters to evaluate images in the near infrared band, Chung et al. (2018) demonstrated that the association of digital cameras and apps can be broadened. Additionally, some apps also aim to foster data collection through citizen science (Molthan et al. 2017).

The use of apps is becoming increasing popular in the agricultural sector (Inwood & Dale, 2019; Hossain et al., 2019). However, global assessments of types and availability of agricultural apps are lacking. Thus, the present study aimed to survey global trends in apps for agriculture.

MATERIAL AND METHODS

The survey was conducted in 2015 (September to November) and 2018 (October to December) in two virtual app stores (Google Play and Windows Phone) that provide applications for Android and Windows Phone operating systems, respectively. These virtual app stores were selected because they allow access with no cost to users.

In each database, an automatic search system was used to find agricultural apps using the following keywords: agriculture, agri, and farming. Each app within this search-generated list had to be individually accessed to obtain the following information: app name, country of origin, app usage area, and app purchase form (free or paid). Since information on country of origin was not always available in the Google Play and Windows Phone databases, a search within the app or developer website was often necessary. Apps were classified into the following agricultural categories: animal production, assistance, business/market, farm management, machines, magazines/information, maps/precision agriculture, meteorology/agrometeorology, pest/disease management, seeds/grains, soil/plant nutrition, and weed management. Regarding purchase form, apps were categorized as free or paid. For 2018, apps that used mobile device photos as input data and those using citizen science input were also noted. Search-generated game apps were eliminated from the survey. Survey information was input to and organized in spreadsheets.

The number of apps per country was quantified and used to create global distribution maps. The percentages of apps by purchase form and by application area were calculated.

RESULTS AND DISCUSSION

In 2015 and 2018, our survey found 244 and 599 apps from 33 and 61 countries, respectively. Regardless of survey year, the three countries with the highest number of agricultural apps were the USA, Brazil, and India (Fig. 1). In 2015, Germany and Spain were ranked fourth and fifth in number of apps. In 2018, Spain and Bangladesh were tied for the fourth position, while Germany and Australia were tied for fifth.

The large number of apps in the USA and Brazil was likely due to strength of the agricultural sector, country size, and popularity of mobile devices. All these factors spurred public and private institutions to create applications for solving agricultural problems. A survey conducted between January 2017 and August 2018 by Tejada-Castro et al. (2019) also found that the USA was the country with the largest number of internet searches for agricultural apps.

Most apps could be accessed for free (no cost to users) (Fig. 2). Similar results were also noted by Costopoulou et al. (2016) in a survey of agricultural apps in Greece and other countries. At least three factors influenced the prevalence of cost-free apps: (1) most apps are made available by non-profit government institutions (i.e., a form of intellectual investment by the government); (2) apps made available by non-governmental entities (e.g., commercial) as a form of marketing; and (3) apps that are free but allow users to purchase agricultural products or tools for use with the apps.

Since most are free access and require minimal knowledge for use, promoting available apps could be beneficial to farmers, agricultural technicians, or other interested parties.

In the USA, the percentage of paid apps (~11%) did not change between 2015 and 2018 (Fig. 2). Brazil reflected a larger change in purchase form with paid apps representing 27% of market in 2015 vs. 3% in 2018. In India, no paid apps were found in 2015 and only accounted for 1% of total apps in 2018. However, these results should not be interpreted as a lack of market space for paid apps. For example, a survey conducted in Germany found that 82% of farmers were willing to pay for apps, provided that these apps actually contribute to the efficiency of agricultural activities (Bonke et al. 2018).

The distribution of apps by agricultural categories revealed that India had less diversity compared to the USA, Brazil, and other countries (Fig. 3). In general, the first two categories (magazines/information and business/market) accounted for about 50% of apps, while this percentage was around 75% in India. Agricultural categories were also more limited in India (8 categories) than in other countries (12 categories). Similar results were observed by Patel & Patel (2016) and Sharma et al. (2018) who grouped Indian apps into nine and five categories, respectively. Thus, the potential for diversification of app development is high in India, which could benefit those involved with agriculture.

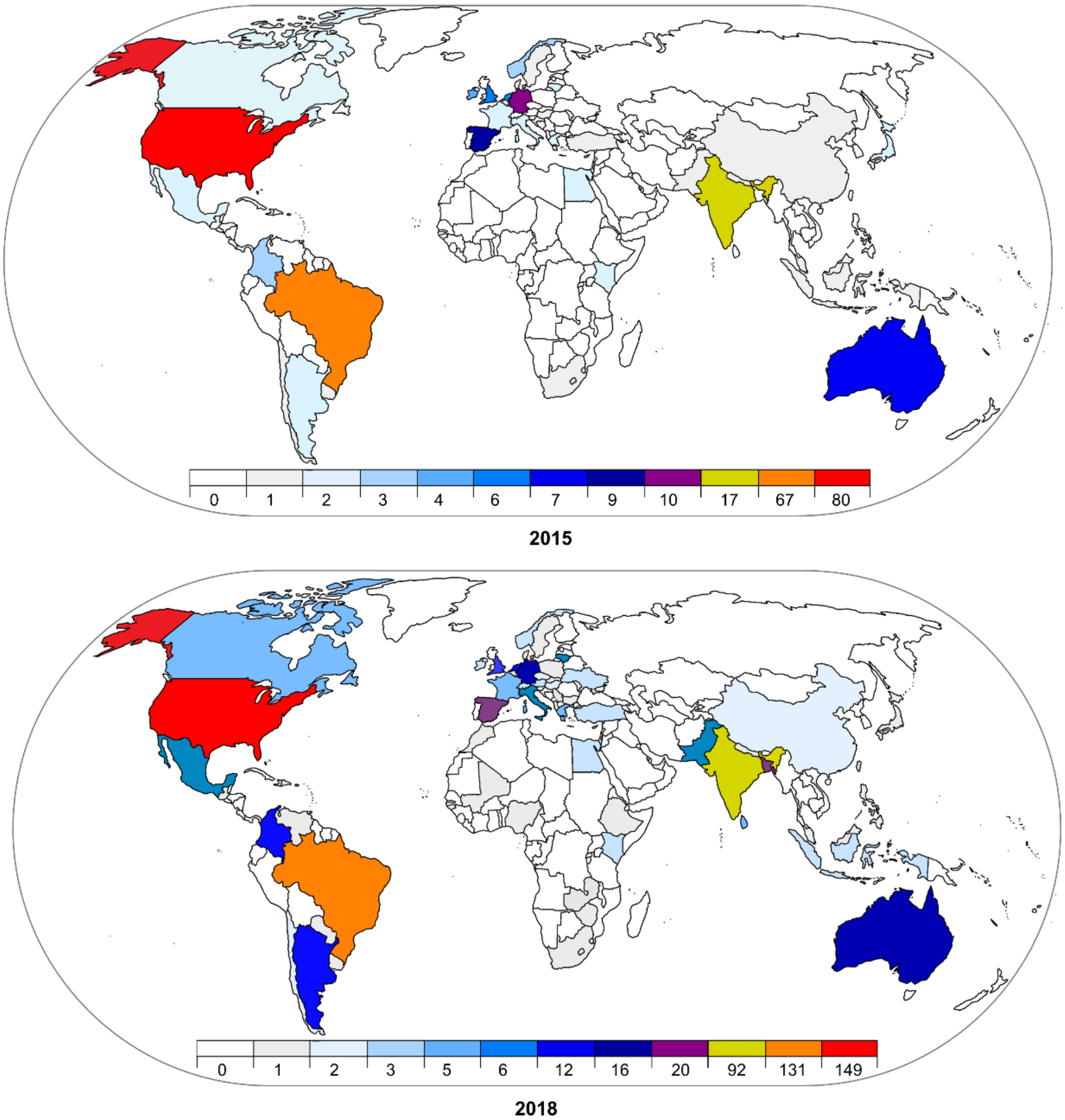

Figure 1. Number of agricultural apps by country in 2015 and 2018.

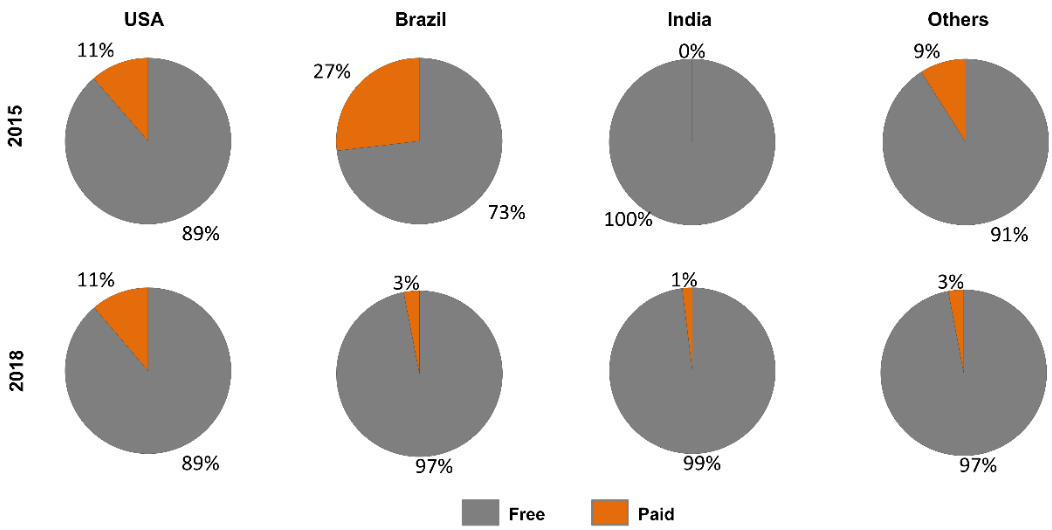

Figure 2. Percentage of apps with free or paid access in 2015 and 2018 for the USA, Brazil, India, and other countries.

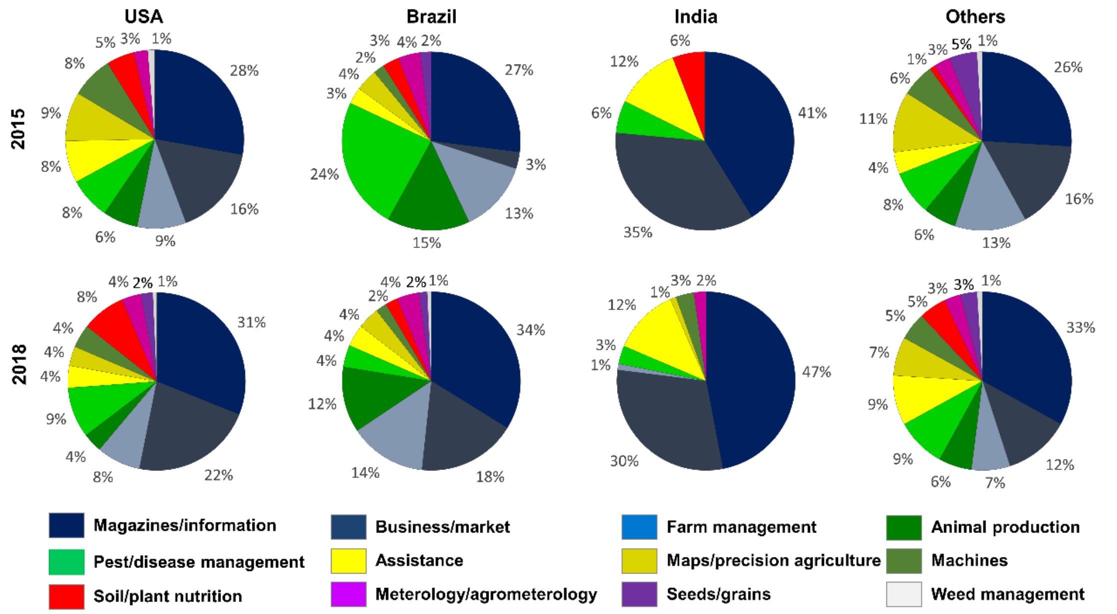

Figure 3. Percentage of apps per agricultural category in 2015 and 2018 for the USA, Brazil, India, and other countries.

Regardless of year or country, most apps were grouped in the magazines/information category (Fig. 3). The second category with the highest number of apps was business/market; Brazil was an exception with pest/disease management ranking second in 2015. Costopoulou et al. (2016) reported that the main app categories were farm management and magazines/information in Greece compared to business/market and farm management in other countries. Sharma et al. (2018) found that the top ranking app categories in India were related to information and market.

For apps that require input data, we found that most used simple quantitative data such as production per unit area, fertilizer rates, production costs, and geographic coordinate information. Although the potential for this type of analysis exists in agricultural apps (Barbosa et al. 2016; Chung et al. 2018; Cubero et al. 2018; Laamrani et al. 2018), only 12 apps that used digital photos as a data source were identified in 2018 (Table 1).

We identified eight apps in 2018 that were related to citizen science, with emphasis on meteorology/agrometeorology, pest/disease management, and weed management (Table 1). These apps have the dual purpose of providing information to farmers and getting farmers to provide information to researchers (citizen science). Citizen science has received increase attention (Molthan et al. 2017; Stroud 2019) since it allows farmers to engage with researchers in the accumulation of knowledge from real time information under field conditions.

A general inspection revealed apps with hundreds of downloads, while others ranged from thousands to millions. With more than 10 million downloads, the app Plantix stood out. Although developed in Germany, the fact that this app can be configured for different languages may have influenced the high number of downloads. Tejada-Castro et al. (2019) found that the USA had the highest number of searches for agriculture web apps, followed by Spain, Mexico, and Colombia; Brazil was absent from this list. Overall, results highlight the importance of evaluating the global popularity of available agricultural apps, access statistics by country, and agricultural categories in terms of downloads.

Table 1. Apps that use photos for input data and apps related to citizen science

Countries (Number)	App category (Number)
Photo use for data acquisition	
USA (3)	Pest/disease management (2), Maps/precision agriculture
Germany (2), Brazil (1), India (1), Serbia (1), Zambia (1)	Pest/disease management
England (1), Spain (1)	Maps/precision agriculture
Austria (1)	Soils/plant nutrition
Citizen Science	
USA (3)	Weeds management (2), Meteorology/agrometeorology
Argentina (2)	Meteorology/agrometeorology, Pest/disease management
England (2)	Meteorology/agrometeorology, Soil/plant nutrition
Australia (1)	Pest/disease management

CONCLUSION

Apps for agriculture encompassed a wide range of functionalities and were developed in several countries. Although most apps were related to magazines and market information, there was a prevalence of apps on farm management, pests and diseases, precision farming, and technical assistance. Countries with the largest number of apps were USA, Brazil, and India, representing ~64% of the apps found. However, diversity and availability of paid apps was greater in USA and Brazil compared to India.

Between 2015 and 2018, there was a considerable increase in the number of apps and countries that produced apps for agriculture, indicating a fast growing interest in this technology. Given this growing interest, users should be aware of newly developed apps and/or updates to existing apps. The development of apps with under-exploited features (e.g., those that use photo and citizen science inputs) should receive more attention since they can be useful in facilitating the acquisition of quantitative and qualitative information.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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