ANALYSIS OF ROMANIA'S SOFTWARE MARKET

Gabriel APUCĂLOAIE[1], Dinu CĂLĂRAŞI[1], Ana BALAN [1], Chiril BOTNARU[2], Constantin – Dragoş DUMITRAŞ[2]

e-mail: c_dumitras@yahoo.com

Abstract

In recent years, the use of software applications has become increasingly popular in agriculture, and this document presents a study on some of the most commonly used applications in the field. The study compares the different software applications and their respective functionalities, revealing that some applications focus on farm management, while others prioritize flexibility and user interaction. However, the study does not take a stance 3on whether certain applications are good or bad, as both types offer distinct benefits. Ultimately, the effectiveness of a software application depends on its ability to offer farmers the services they need, whether those services are limited or comprehensive. As technology continues to advance, it is clear that software applications will play an even more critical role in modern agriculture, providing farmers with valuable insights and tools to help them increase efficiency and productivity on their farms.

Key words: smart farming, digital farms, agricultural development, phone-enabled management

In recent years, the use of software applications in enterprise management has become a common practice. From management and analysis programs to accounting software, they are essential for users in different fields. In particular, for farmers, a new type of tailor-made programs has been created to meet the specific needs of the agricultural industry

However, many farmers found that none of the existing software products were good enough to fully meet their needs. Each farmer has his own requirements, from land visualization to farm inventory management or expense tracking. The choice of such software is also influenced by the size of the farm and its specific needs.

Customized software for farmers now helps farmers practice precision farming, reduce costs and measure their work efficiency. These tools help farmers visualize land, measure the amount of seed and fertilizer needed for each area of the farm, control the stock of products and track spending. These are just some of the examples of benefits such software products can bring to farmers.

MATERIAL AND METHOD

The study conducted on the Romanian agriculture software market involved a comprehensive approach. A combination of qualitative and quantitative analyses was employed to assess the advantages of the most popular applications. The qualitative analysis provided an in-depth examination of the functionalities offered by these applications, while the quantitative analysis categorized these functionalities to distinguish what is currently covered in the market. This rigorous methodology ensured a thorough and accurate evaluation of the Romanian agriculture software market.

RESULTS AND DISCUSSIONS

The Romanian market offers a plethora of software products designed to aid farmers in their daily work. While some are more complex and feature-rich, others are more functionally limited. However, many of these products have specific features that make them stand out from the crowd. With so many options available, it can be challenging to choose the right one. To simplify the process, we have compiled a list of 11 of the most well-known software products (See Figure 1) and compared the functionalities they offer. By doing so, we can identify the advantages of using each product and help farmers make an informed decision when choosing the best software for their needs. With a comprehensive comparison, farmers can evaluate the tools available to them and determine which product will offer the most benefits for their unique situation.

The advantages of Bayer Agro Solutions

---

[1] AXIOLOGIC SAAS, Iaşi, Romania

[2] Iasi University of Life Sciences, Romania

(Bayer, onsite) include a free app, offline usability, complete soil and water analysis, and the ability to identify pests, diseases, and weeds through pictures taken in the field.

FarmLogs (Farmlogs, onsite) provides several advantages for farmers to optimize their crops and maximize their yields. With detailed crop mapping, including growth stage, health status, and soil moisture levels, farmers can monitor their crops more effectively. Additionally, FarmLogs offers weather forecasts, crop planning, real-time cost monitoring, resource planning and management, and decision-making assistance. These features enable farmers to make informed decisions and implement effective strategies to improve their yields, reduce costs, and achieve better results.

With detailed crop mapping, growth stage, and health status monitoring, farmers can track the progress of their crops and make informed decisions with Agworld (Agworld, onsite). The app allows for the monitoring of at least two farms simultaneously, enabling farmers to manage multiple operations with ease. Additionally, Agworld provides crop planning, cost and performance analysis, resource planning and management, and integration with other technologies such as crop and soil monitoring sensors.

Cropio (Cropio, onsite) is an advanced platform that offers several advantages to farmers to improve their agricultural practices. With detailed crop mapping, growth stage, and health status monitoring, Cropio provides farmers with a comprehensive view of their crops. The platform offers crop planning, cost and performance analysis, resource planning and management, and integration with other technologies such as crop and soil monitoring sensors. With Cropio, farmers can make informed decisions about their crops and implement effective strategies to improve their yields, reduce costs and optimize their operations.

AgriWeb (AgriWebb, onsite) is a state-of-the-art agricultural management system that offers several advantages for farmers to optimize their operations. With detailed crop mapping and growth stage monitoring, AgriWeb enables farmers to track the progress of their crops and make informed decisions. The platform provides crop planning, cost and performance analysis, resource planning and management, and integration with other technologies such as crop and soil monitoring sensors. AgriWeb enables multiple users to access the platform simultaneously, improving collaboration and efficiency. Additionally, the platform offers stock management for agricultural products, enabling farmers to manage their inventory effectively

Table 1

Functionalites and advantages covered by the existing agriculture software applications

1	Crop monitoring
2	Detailed crop mapping (including growth stage and health status)
3	Crop planning
4	Cost and performance analysis
5	Resource planning and management
6	Integration with other technologies (such as crop and soil monitoring sensors)
7	Multi-user capability
8	Agricultural product inventory management
9	Real-time weather monitoring (to aid informed decision making)
10	Soil moisture monitoring
11	Offline availability
12	Agrochemical mapping (comprehensive analysis of soil and water)
13	Identification of diseases
14	Weeds and pest attacks based on pictures taken in the field
15	Real-time cost monitoring
16	Decision support
17	Innovation management (monitoring performance of new products or technologies in crops and assessing their impact on production and profitability)
18	Identification of potential problems
19	Data analysis (providing data analysis and reporting tools to help farmers make better decisions)
20	Document management (crop management plans, storage and transportation reports, and other agricultural production-related documents)
21	Budget planning (offering tools for planning and managing the agricultural budget
22	Including cost estimation and profitability calculation)
23	Employee management (enabling farmers to manage employee work hours and generate payment reports),

24	Invoicing and sales management (enabling farmers to generate invoices and manage sales, including monitoring income and costs)
25	Agricultural activity monitoring and management (real-time record keeping of agricultural operations), input management (inventory, consumption, and stock management)
26	A wide range of analysis tools and custom reports
27	Cost tracking
28	Agricultural operation planning, and simultaneous monitoring of at least two farms using the application.

AgriTask (AgriTask, onsite) is an innovative agricultural management platform that provides various benefits to farmers to enhance their operations. It enables farmers to monitor their crops' growth stages and progress through detailed crop mapping. The platform offers crop planning, cost analysis, resource management, and integration with other technologies, including sensors for monitoring crops and soil. AgriTask allows multiple users to access the platform simultaneously, which improves collaboration and productivity. Furthermore, it provides features for stock management, weather monitoring, and financial management such as billing, payment, and invoicing.

FieldX (FieldX, onsite) is a comprehensive agricultural management application that offers various benefits to farmers. With its detailed digital map of crops, the platform provides farmers with valuable insights into soil, topography, and vegetation. The app allows farmers to monitor the state of their crops in real-time, identifying potential issues such as diseases, pests, and nutritional deficiencies. Furthermore, it helps farmers manage innovations by monitoring the performance of new products or technologies in their crops, and evaluating their impact on production and profitability. The app also offers features for planning agricultural operations, integrating with other technologies such as sensors for monitoring crops and soil, and allowing multiple users to access the platform simultaneously. Additionally, FieldX provides tools for data analysis and

reporting, which assist farmers in making better decisions. The platform also helps manage documents such as crop management plans, storage and transportation reports, and other documents related to agricultural production. Finally, the weather monitoring feature assists farmers in making informed decisions about their agricultural operations.

Agroptima (Agroptima, onsite) offers a comprehensive set of tools to help farmers plan and manage their agricultural operations more effectively. The platform includes features such as crop monitoring, inventory management, weather tracking, and data analysis, all of which can be integrated with other agricultural technologies.

Agroptima also provides document management and budget planning tools, which help farmers stay organized and optimize their spending. With its wide range of functionalities, Agroptima is an essential tool for farmers looking to streamline their operations and improve their bottom line. Farmbrite (Farmbrite, onsite) offers various advantages for farmers, including the ability to plan their agricultural operations and monitor the status of their crops. It also enables them to manage their inventory, analyze data, and generate invoices and sales reports. The application also includes a weather monitoring feature that helps farmers make informed decisions about their farming operations. Additionally, Farmbrite allows farmers to manage their employees' work hours and generate payment reports, and it allows multiple users to use the application simultaneously. With its document management feature, farmers can easily store and access important documents related to their farming operations.

Granular (Granular, onsite) is an agricultural management app that offers several advantages for farmers. One of the primary benefits of Granular is its capability to manage agricultural inventory effectively. This feature enables farmers to track and manage their agricultural inputs such as seeds, fertilizers, and chemicals more efficiently, helping them to optimize their use and minimize waste. Additionally, Granular integrates with other agricultural technologies such as drones and sensors, which can provide farmers with valuable data and insights to inform decision-making.

Geofolia (Geofolia, onsite) is a widely known app among Romanian farmers due to its features such as crop monitoring, real-time tracking and management of agricultural activities, inventory management, and a wide range of analysis tools and personalized reports. It also offers cost tracking and document management capabilities, making it a comprehensive solution for farmers looking to streamline their operations and improve their overall efficiency. With Geofolia, farmers can easily keep track of their inputs, consumption, and inventory, while also being able to generate insightful reports and analysis to make better-informed decisions.

The analysed existing agriculture applications offer 28 different functionalities (See

Table 1) including crop monitoring, detailed crop mapping (including growth stage and health status), crop planning, cost and performance analysis, resource planning and management, integration with other technologies (such as crop and soil monitoring sensors), multi-user capability, agricultural product inventory management, real-time weather monitoring (to aid informed decision making), soil moisture monitoring, free usage, offline availability, agrochemical mapping (comprehensive analysis of soil and water), identification of diseases, weeds, and pest attacks based on pictures taken in the field, real-time cost monitoring, decision support, identification of potential problems, innovation management (monitoring performance of new products or technologies in crops and assessing their impact on production and profitability), data analysis (providing data analysis and reporting tools to help farmers make better decisions), document management (crop management plans, storage and transportation reports, and other agricultural production-related documents), budget planning (offering tools for planning and managing the agricultural budget, including cost estimation and profitability calculation), employee management (enabling farmers to manage employee work hours and generate payment reports), invoicing and sales management (enabling farmers to generate invoices and manage sales, including monitoring income and costs), agricultural activity monitoring and management (real-time record keeping of agricultural operations), input management (inventory, consumption, and stock management), a wide range of analysis tools and custom reports, cost tracking, agricultural operation planning, and simultaneous monitoring of at least two farms using the application.
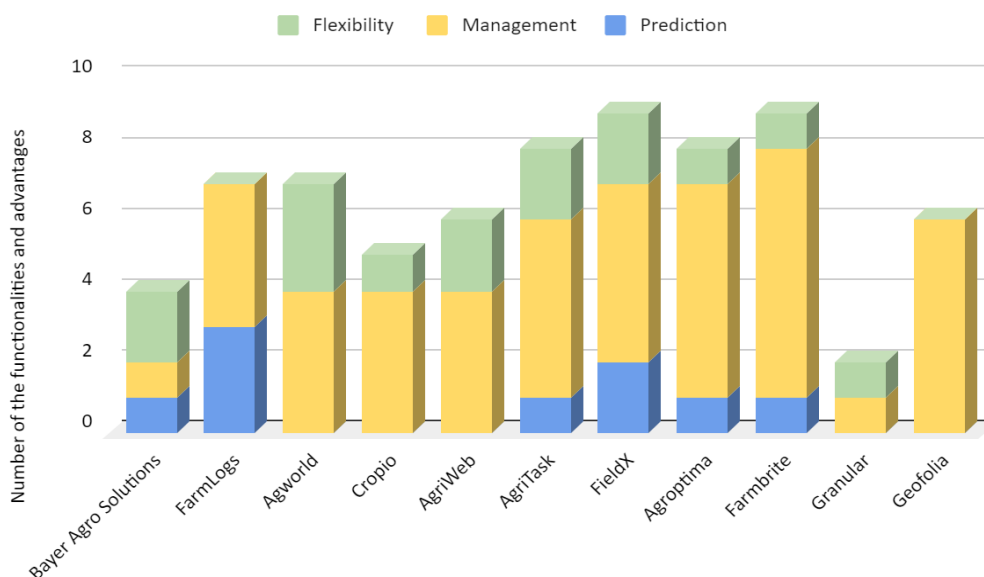
.

Figure 1. **Promised advantages and functionalities covered by the most well know 11 agricultural software applications available for Romanian market.** The vertical axis represents the number of functionalities covered by a specific application from the horizontal axis. The color represents the class of functionality. Green color represents the degree of flexibility, open access, integration with new technologies. The yellow collor represent different farm management functionalities and blue color represents predictions based on weather, quality of soil, water, etc.

CONCLUSIONS

This article explores some of the most popular software applications for agriculture in Romania and presents in detail their advantages and benefits they bring for farmers. From 11 applications (See Figure 1) it was identified a number of 28 different functionalities (See Table 1) which can be easily classified in three categories covering management 70%, predictions 10% and flexibility 20% (See Table 2). The majority of agricultural applications encompass a diverse range of management functionalities. However, a small subset of these applications exhibit predictive capabilities based on factors such as weather and soil humidity, as well as flexible functionalities, such as extensive coverage, free usage, and support for multiple users and farms. It is crucial to highlight that every application includes, at a minimum, one management functionality.5

The existing applications provide a wide range of features and tools to help farmers manage their crops more efficiently.

Crop Monitoring allows farmers to monitor their crops in real-time with detailed crop maps that show the growth stage and health status of each crop. This helps farmers identify potential issues early on and take corrective action quickly.

Planning and Management enables farmers to plan and manage their resources more effectively, including crop planning, budgeting, and inventory management. It also provides tools for tracking costs, managing input supplies, and generating customized reports.

Integration with Other Technologies integrates with other agricultural technologies such as crop and soil monitoring sensors to provide farmers with a more complete picture of their operations.

Real-time Weather Monitoring provides real-time weather monitoring to help farmers make more informed decisions about their operations. It also includes soil moisture tracking, which can be helpful in determining irrigation needs.

Crop Mapping offers a comprehensive soil and water analysis to help farmers understand the specific needs of their crops. Additionally, farmers can take photos of their crops to identify diseases, weeds, and pests and find appropriate solutions.

Multi-user Access allows multiple users to access and collaborate on data simultaneously, making it ideal for large farm operations.

Document Management includes tools for managing documents such as crop management plans, storage, and transportation reports, and other important agricultural production documents.

Innovation Management so that farmers can track the performance of new products and technologies and evaluate their impact on production and profitability using Geofolia.

Data Analysis provides powerful data analysis and reporting tools that help farmers make more informed decisions.

Employee Management allows farmers to manage employee hours and generate payroll reports, helping to streamline labor management.

Sales and Invoicing allows farmers to generate invoices and manage sales, including tracking income and costs, making it easier to manage their finances.

Overall, there are available excellent tools for farmers who want to increase productivity, reduce costs, and make more informed decisions about their operations.

There is a tendency to have a central management system, moving an existing database from the physical environment, based on reports and worksheets, to the online environment in a highly complex system, controlled by a responsible person and not necessarily the farmer and employees from a farm (Table 2)

Table 2

Classes and subcategories of software applications functionalities available for Romanianan agricultural sector and corresponding software applications

Predictions (9.86%)		Management (69.01%)			Flexibility (21.13%)			
Weather	Soil	Crops	Costs	Resources/Stocks	Integration with other technologies	Multi-user support	Coverage level	Accessibility level
FarmLogs FieldX AgriTask Agroptima Farmbrite	FarmLogs FieldX Bayer Agro Solutions	FarmLogs Agworld Cropio AgriTask FieldX Agroptima Farmbrite Geofolia Bayer Agro Solutions AgriWeb	FarmLogs Agworld Cropio AgriTask FieldX Agroptima Farmbrite Geofolia	FarmLogs Agworld Cropio AgriTask FieldX Agroptima Farmbrite Geofolia AgriWeb	Granular Agroptima FieldX Cropio FarmLogs	Agworld AgriWeb AgriTask FieldX Farmbrite	Bayer Agro Solutions	Bayer Agro Solutions

In conclusion, the agricultural industry can greatly benefit from the implementation of various applications to streamline farm management processes. These applications can help farmers monitor and control all aspects of their operations, from the management of resources and personnel to the tracking of crops and livestock. However, it is important to carefully evaluate and select the most suitable application that can cater to the specific needs of the farm. While there are many options available in the market, not all applications are created equal, and it is crucial to choose one that is adaptable, user-friendly, and provides the necessary features to improve efficiency and productivity.

Looking towards the future, the development of new applications in the agricultural industry will need to integrate the latest technologies, such as artificial intelligence and decentralized platforms, in

order to create an ecosystem in which all stakeholders in the farming process can utilize these applications and benefit from them. By incorporating these cutting-edge technologies, farmers can gain a deeper understanding of their operations and make more informed decisions about their resources, crops, and livestock. Ultimately, the integration of these advanced technologies will be essential to the continued growth and success of the agricultural industry, both in Romania and around the world.

ACKNOWLEGMENTS

REFERENCES

AgriWebb, onsite - *Livestock management software that moves your whole farm forward.* https://www.agriwebb.com/

AgriTask, onsite - *Resilient Supply Chains. Powered by Agronomic Intelligence.* https://start.agritask.com/

Agroptima, onsite - *Digitize your farm.* https://www.agroptima.com/en/

Agyekumhene, C., de Vries, J.R., Paassen, A., Schut, M. & MacNaghten, P. (2020) Making smallholder value chain partnerships inclusive: Exploring digital farm monitoring through farmer friendly smartphone platforms. Sustainability, 12(11), 4580. https://doi.org/10.3390/su12114580

Agworld, onsite - Agworld Inc. *Agriculture's preferred independent farm information management ecosystem.* https://www.agworld.com/eu/

Ayamga, M., Tekinerdogan, B., Kassahun, A. & Rambaldi, G. (2021) Developing a policy framework for adoption and management of drones for agriculture in Africa. Technology Analysis & Strategic Management, 33, 970–987. https://doi.org/10.1080/09537325.2020.185804

Balan, A., Alboaie, S., Kourtit, K., and Nijkamp, P. (2022), Blockchain Systems for Smart Cities and Regions, An Illustration of Self-Sovereign Data Governance. In: Knowledge Management for Regional Policymaking (Laurini R., Nijkamp P., Kourtit K. Bouzouina L. (eds)), Springer Verlag, Berlin. https://link.springer.com/book/10.1007/978-3-031-15648-9?sap-outbound-id=E21C23A0D15D22BBB4E2B197FAF80FE96CFBB7

Balan, A., Tan, A., G., Kourtit, K., Nijkamp, P., 2023, Data-driven Intelligent Platforms - design of self-sovereign data trust systems for digital healthcare, LAND Journal, (forthcoming)

Bayer, onsite - *Tailored Solutions. Better Answers for Farmers and the Environment.* https://www.bayer.com/en/agriculture/tailored-solutions

Bronson, K. (2018) Smart farming: Including rights holders for responsible agricultural innovation. Technology Innovation Management Review, 8(2), 7–14. https://doi.org/10.22215/timreview/1135

Clapp, J. & Ruder, S.L. (2020) Precision technologies for agriculture: Digital farming, gene-edited crops, and the politics of sustainability. Global Environmental Politics, 20(3), 49–69. https://doi.org/10.1162/glep_a_00566

Farmlogs, onsite - *Monitor your fields and keep detailed records.* https://bushelfarm.com/lite/

FieldX, onsite - *FieldX® is an independent agricultural software platform for agronomists and their customers in the US and Canada to collect, manage, and share data.* https://fieldx.com/

Farmbrite, onsite - *Easier farm management starts here..* https://www.farmbrite.com/

Granular, onsite - *Solve problems, drive profitability.* https://www.corteva.us/products-and-solutions/digital-solutions/granular-insights.html#anchor_2

Geofolia, onsite - ISAGRI. *Soluţia completă pentru managementul fermei tale.* https://www.isagri.ro/software/geofolia-program-de-management-agricol-isagri?gclid=CjwKCAjw6IiiBhAOEiwALNqncRhgaoX9X0tOn_E_W7Oi-MeivHn_ewhh6Advgl5z6x9sNlB9xa7zrRoCbzUQAvD_BwE

GSMA. (2020) Digital agriculture maps 2020: State of the sector in low and middle-income countries. https://www.gsma.com/r/digital-agriculture-maps/?utm_source=IDH&utm_medium=blog&utm_campaign=DAMs_IDH_site_traffic [Accessed 29th October 2021].

Hao, K. (2019) In 2020, let's stop AI ethics-washing and actually do something. MIT Technology Review, 27 December.

Higgins, V. & Bryant, M. (2020) Framing agri-digital governance: Industry stakeholders, technological frames and smart farming implementation. Sociologia Ruralis, 60(2), 438–457. https://doi.org/10.1111/soru.122975

Kenny, U. & Regan, A. (2021) Co-designing a smartphone app for and with farmers: Empathising with end-users' values and needs. Journal of Rural Studies, 82, 148–160. https://doi.org/10.1016/j.jrurstud.2020.12.009

Wigboldus, S., Klerkx, L., Leeuwis, C., Schut, M., Muilerman, S. & Jochemsen, H. (2016) Systemic perspectives on scaling agricultural innovations. A review. Agronomy for Sustainable Development. 36, 46. https://doi.org/10.1007/s13593-016-0380-z

Wiseman, L., Pesce, V., Zampati, F., Sullivan, S., Addison, C. & Drolet, J. (2019a) Review of codes of conduct, voluntary guidelines and principles relevant for farm data sharing. ICT for Agriculture Working Paper Working Paper No. 1, Wageningen.