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Original Article

Influence of Ploughing on Soil Apparent Density, Humidity and Water Reserve

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Abstract

Rapid technological developments in recent years have brought radical changes to the working environment in the agricultural sector. Agriculture has entered a new era where the key to success is access to fast information gathering and elaborate decision-making process. In order to get high yields, a farmer must use information obtained by choosing the latest gadgets advances in research and technology. Farm management refers to decision taking and applying them for the purpose of organizing and operating a farm in order to achieve maximum yield and profit. Essential components of a farm management platform include crop-specific technologies, user-friendly interfaces, automated data processing functions, specialist knowledge and user preferences, etc. all available at affordable prices to farmers.

Keywords: *agricultural software, farm management functions, farm management structure.*

1. Introduction

Management of an agricultural farm is based on the agricultural economy for information on prices, markets, agricultural policies and on economic institutions, such as leasing and lending firms. It also relies on plant and animal sciences for information on soils, seeds and fertilizers, weed control, insect and disease control, and also animal breeding. At the same time, knowledge in the field of agricultural engineering is required for information on agricultural constructions, machinery and equipment, irrigation systems, crop drying, drainage and erosion control.

In making its decisions, the manager of an agricultural farm must integrate information from biological, physical and social sciences.

As farms differ widely, the significant concern of farm management applications is the specificity of each individual farm; the most satisfactory plan for a farm may be most unsatisfactory for another.

Farm management issues vary from those of small farms close to subsistence and family type farms, to commercial large farms, where trained managers use the latest technological advances and farms ran by individual owners and those managed by the State.

Thus, the nature of agriculture in a country is varied because farmers manage the resources under their control so as to obtain maximum profit through their decisions and actions that are taken in a wide variety of situations in terms of:

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- combinations of human capital,
- financial,
- capital and terrestrial resources,
- technological possibilities and
- social and political contexts.

The progress of agriculture depends on improving the quality of farm management and the environment in which farmers make decisions and how they are encouraged to adapt their decisions to the changing environment [5, 6].

2. Material and Method

Structure and Functions of a Farm Management Platform (FMP)

Rapid technological development in recent years have brought radical changes to the working environment in the agricultural sector.

Agriculture has entered a new era where the key to success is access to timely information and elaborate decision-making. An experienced farmer with updated knowledge must do this by choosing between different production variants, using the latest advances in research and technology. Decision making is an important aspect of farm management, and this is studied by several authors [2].

The basis for making the right decisions is access to information, as complete and timely as possible. However, the current situation in Europe's farms is that most data and information sources are dispersed, fragmented and difficult to access. This indicates that the full potential of this data and information is not fully exploited. The integration of spatial and temporal information, real-time data from farms, scientific sources, health and safety rules, environmental norms, economic models and so on into a coherent information management system is expected to remedy this situation. Farm management solutions in agriculture have evolved from simple recording systems to complex farm management systems in response to the need for communication and data transfer between databases and to meet the requirements of different farm owners.

Lewis (1998) noted that a farm management platform exists when decision-makers use information provided by a farm record system for business decision-making [4].

Sørensen et al. (2010a) has defined a farm management system as a planned system for collecting, processing, storing and disseminating data in the form necessary to exploit the farm in the best possible conditions [8].

The key components of a farm management platform include crop-specific technologies, user-friendly interfaces, automated data processing features, specialist knowledge and user preferences, etc. all offered at affordable prices to farmers [2].

The market offer of the Farm Management Platforms (FMP) is very large, covering a wide variety of crops.

Research in this area has been mainly geared towards field crops, as solutions for greenhouse crops involve the use of more complex control algorithms.

For applications available on the market, Robbemond and Kruize (2011) and Kruize et al. (2013) identified 11 generic functions as the main functions or services [3, 7] that FMP offers to farm managers (Table 1).

In addition, identification of these 11 generic functions was complemented by the recommendations of Abt et al. (2006) that agricultural software should include production planning, production integration, performance management, environmental resource quality and management, and sales and contract management [1].

3. Results and Discussion

Farm management platform functions analysis

Fig. 1 shows the distribution of the 11 FMP functions defined above, indicating how frequently these functions occur in most of the applications that are on the market and which are the most useful functions for farmers [2].

The most common features found in software applications includes field operations:

- management (63%),
- best practices (57%),
- finance (45%),
- precision location management (40%),
- inventory management (38%),
- equipment (28%) and
- human resource management (25%).

In addition, less useful features include:

- traceability (19%),
- quality assurance (19%),
- sales (18%) and
- best practices (16%).

It is eloquent that the functions supporting the operations and financial management of agricultural farms are used more frequently, together with reporting, as an integrated element of the FMP.

This analysis has clearly demonstrated that traceability is still in its beginnings in commercial management platforms as well as good practices that are directly related to food quality and could be used to differentiate and improve food quality [2].

One of the EU's strategies through the Directorate-General for Agriculture and Rural Development through the new Common Agrarian Policy is to facilitate as much as possible direct sales between farmers and consumers, and therefore more farm management platforms will be available in the coming years.

Table 1.FMP functions available in existent applications [3, 7]

Name	Functions characteristics
Field operations management	*Includes farm activity recording. This feature helps the farmer optimize crop production by planning future activities and by tracking the actual execution of the planned tasks. In addition, preventive measures initiated on the basis of monitored data can be taken.*
Best practices (and yield estimation)	*It includes production tasks and methods related to the application of best practices according to agricultural standards (eg ecological standards, requirements for integrated crop management). An estimate of production is feasible by comparing current requirements and alternative variants, resulting in hypothetical scenarios for best practices.*
Finance	*Includes cost estimates for each farm activity, input and output calculation, labor force requirements, etc. The projected and current costs are compared, resulting in a final economic assessment of farm viability.*
Inventory	*Includes monitoring and management of all production materials, equipment, chemicals, fertilizers, seedlings. The quantities are adjusted according to the farmer's plans and customer orders. A record of traceability is also an important feature of this feature.*
Traceability	*Includes crop withdrawal using an identity tagging system to control the products of each production area. Traceability sheets are related to the use of materials, employees and equipment and can be easily archived for quick recall.*
Reporting	*Generally, includes generation of farm reports such as planning and management, activity progress, spreadsheets and instructions, procurement orders, cost reports.*
Site specific	*Includes field mapping. The analysis of collected data can be used as a guide for variable rate application. The purpose of this feature is to reduce or optimize inputs and increase production*
Sales	*Includes order management, management and accounting systems, business transfer, service charges as well as labor, consumables and equipment costs.*
Equipment management	*Includes details on equipment wear, average cost per hour of work or per unit area. It also includes fleet management and logistics.*
Human resources management	*Includes employee management, including employee availability in time and space. The goal is to quickly manage employee issues such as working time, pay, qualifications, training, performance and expertise.*
Quality assurance	*Includes process monitoring and production evaluation in line with current legal standards.*

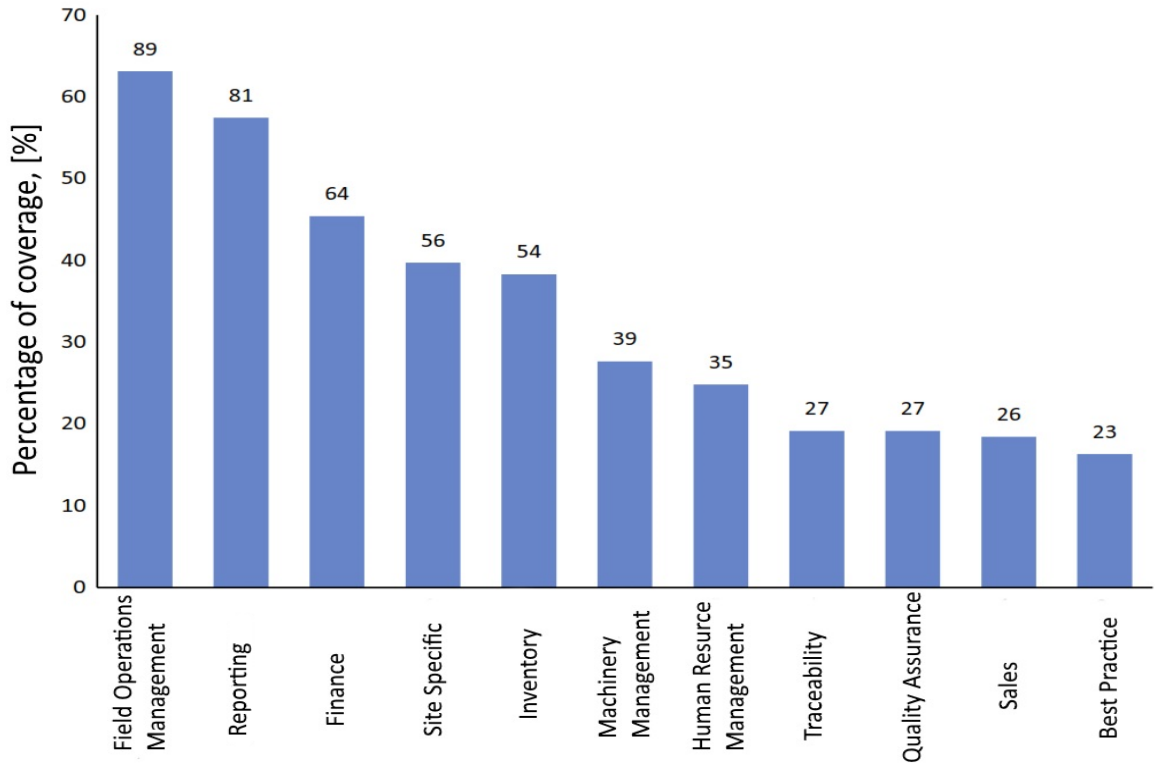

Figure 1. FMP function distribution [2]

Farm management platforms available on the market

A series of software farm management are presented, made by different companies from around the world.

A. AGRIVI FARM MANAGEMENT

Agrivi farm management software helps farmers plan, monitor and analyze all activities on the farm easily [9]. With the most complete feature-set on the market, Agrivi empowers farmers to manage all field activities, finance, inventory, workforce and get insight into overall farming performance with a single click. Built on top of a powerful agricultural knowledge base, Agrivi's automated pest and disease detection alert farmers to protect crops timely. Tillage, planting, crop protection, fertilization, irrigation, harvesting, and all other activities are managed with a few clicks.

Get an instant overview of a 7-day weather forecast or 3-year history for every field. Advanced detection algorithms alarm farmers if there is a risk of an insect pest or disease occurrence on their fields. Late crop protection claims 20-40% of yield worldwide every year. Apply on-time protection with the help of advanced insect pest and disease risk detection. Keep farm financial records and documents in one single place. Track sales, expenses, and capital investments and allocate them to each crop production. Don't miss payments with due date alarms that remind you which incoming and outgoing payments are expected. Identify why some crops grow better on some fields, find out the exact cost per kg/lb for every variety per field and identify ROI for every crop production.

Built-in reports let users get all important data in PDF, Excel or Word formats. Whether users want to print weekly tasks for every person, prepare legislative reports or just analyze performance, get all reports with a single click [9].

Functionalities of the software:

- Countrywide insect pest and disease alerting;
- Subsidy and loan risk management;
- Farm operations excellence - in-depth crop management with all field tasks included;
- Central registry of employees, seasonal workers, machinery.

B. GRANULAR

Granular is an enterprise farm management suite that connects the field to the office for more productive farming. It allows farm owners and managers to oversee all aspects of operations even while they are mobile, enabling them to make informed decisions all the time [12].

With Granular, farm administrators can even schedule and assign tasks to their workers. The software has native apps for Android and iOS devices that allow field and office hands to work collaboratively wherever they are. Moreover, Granular assists companies in keeping their stakeholders up-to-date.

The software comes with a reporting suite that lets users produce custom reports automatically. Granular FMS is an easy-to-use software. It includes intuitive tools and features that enable businesses to review their field and crop profits for them to be able to make informed management decisions at the field level. With Granular, farm owners and managers can take their office to the field and vice versa. Because it is a web-based application that is complemented by native Android and iOS apps, the solution allows users to track daily tasks in the field while keeping the office up-to-date with the latest information. Being an enterprise software, Granular supports multi-location management.

This enables farm owners and managers to maintain control over farms dispersed in different places through one window. Granular is continually updated with new features and tools. Designers of the software work with customers to understand their needs to make farming a less arduous process. This makes the software future-proof and scalable because it continues to change with the help of customer input and new agricultural innovations [12].

Functionalities of the software:

- Inputs & Inventory: Know projected and actual usage and costs;
- Crop & Field Planning: Create dynamic operational plans in a few clicks;
- Hit yield targets using predictive models and real-time monitoring tools;
- Satellite imagery enables users to view all fields from anywhere.

C. TRIMBLE

Trimble is partnering with farmers, crop advisors, e.g. retailers, and food companies around the world to transform the way they work [13]. By automating critical workflows, Trimble Ag Software saves time, reduces human error, and enables smart decisions that improve the bottom line. Trimble Ag Software is the only fully integrated desktop, cloud, and mobile software solution on the market today. This powerful yet easy-to-use software platform ties the entire farming operation together, and is available anywhere, anytime, 24/7.

Trimble Agriculture provides solutions that solve complex technical challenges across the entire agricultural supply chain. The solutions enable farmers and advisors to allocate scarce resources to produce a safe, reliable food supply in a profitable

and environmentally sustainable manner. Covering all seasons, crops, terrains and farm sizes, Trimble precision agriculture solutions can be used on most equipment on the farm, regardless of manufacturer. Trimble Ag Software provides farmers with tools that support better management decisions and drive profitability. Tracking field records, implementing precision ag practices and measuring ROI becomes simple and efficient, thanks to this industry-leading mobile app. Trimble Ag Software calculates the cost per unit of production throughout the growing season. Each report includes critical information such as expenses, landlord splits, and profit/loss.

Data tracking only works if it can happen in one simple step. Trimble Ag Mobile allows farmers to input and access records and activities in real-time from their smartphone or tablet. Trimble Ag Software's farmer bundles come with access to a powerful, yet an easy-to-use online platform that syncs automatically across devices so users only enter information once [13].

Functionalities of the software:

- Variable Rate Application Control: Simultaneously control the application rate of different materials including seed, granular fertilizer, liquid, and anhydrous ammonia in different combinations;
- Seed Monitoring: Increase the quality of seed placement and analyze population, singulation, skips/multiples, spacing, and quality of spacing for higher yield results;
- Real-time fleet tracking and utilization.

D. FARMERP

FarmERP software platform is the most advanced, successful and best farm management software platform being widely used globally for the farm, farmer, procurement, processing, supply chain and financial data management and analysis [14].

It has helped many leading companies in achieving an objective of profitable and sustainable agribusiness. This smart agriculture management software platform is highly scalable and is future ready. It possesses inbuilt powerful capabilities of any ERP solution covering all business functions.

Simultaneously it provides an advanced level of analytics to support business decisions.

Important modules it is comprised of are Admin, Planning, Purchase, Inventory, Production, Post-production, Contract farming, Biotech, HR, Accounts, Maps, Quality Control, and Farm analytics. FarmERP can be customized as per business requirements and can be easily integrated with smart devices as well as legacy ERP or Financial systems. With more than 200 reports and customizable data dashboards, it is the most scalable, tested and robust platform available in the market. FarmERP provides intelligent data insights for accurate decision making.

Smart Agriculture framework combines the power of FarmERP with Big Data, Internet of Agricultural Things (IoAT), Sensors, Robotics, Geographic Information Systems, Unmanned Aerial Vehicle (UAV)/Drones, Precision agriculture, satellite data, real-time cloud data sources, and predictive analysis. Data-driven agriculture and agribusiness is a future for almost all stakeholders in Agriculture.

FarmERP proves to be the best agriculture software platform which promotes Digital Farming, Smart Farming, and Data-driven Farming. FarmERP - smart ERP platform is helping various agricultural industry sub-verticals as a comprehensive Agriculture management system and it is undoubtedly a best farm accounting software platform available around the globe [9-15].

Functionalities of the software:

- Geo-mapping and Crop Scouting solutions
- Tree encoding and asset valuation
- User access permissions and roles up to plot level
- Table control of farms located at remote locations
- Farm analytics (BI) dashboards offer smarter data insights which enables management users to take right decisions at right time

E. AGWORLD

Agworld is the world's first Collaborative Farming Solution that enables growers, crop consultants, farm staff, precision specialists and operation managers to truly work as one [15]. Agworld's document management, data capture tools, farm maps, library of labels and communication tools improve workflow and increase production efficiency all in one easy-to-use, cloud-based platform.

Easily forecast inputs and create plans, recommendations, and budgets for clients with Agworld's comprehensive range of tools. Take the guesswork out of decision making by accessing all relevant information from a single source.

Flexible, simple and efficient farm scouting, from setup to reporting.

The easy-to-use and intuitive interface makes scouting tasks quick and uncomplicated for scouts, whatever their level of experience.

With tap, slide, pick or type options, users can customize collection method to suit various scouting projects and assign them to your scouts.

Experience the world's fastest recommendation writing tool. Use templates to quickly create activities from the office or out in the paddock. With desktop and mobile solutions, Agworld delivers true online and offline features that eliminate the frustration of double entering your data. Agworld Sampling simplifies company's sampling workflow by integrating the job creation, soil collection, lab submission and results into one easy to use platform.

With over 14,000 pests, crops, products, and active ingredients, the Agworld library includes the latest labels and MSDS, which can be viewed online or saved for offline use.

Access the latest information and write legally compliant recommendations confidently, without the bulk of carrying printed references. Receive captured data in real time for use in reports or save them as Excel files for further analysis [15].

Functionalities of the software:

- Uncomplicated farm information management;
- Professional-looking reports, complete with maps, rotation history, paddock plans, crop ratios and cost/gross margin analysis;
- Scout: Build custom scouting templates, collect infield data and report on farm scouting activities;
- Scheduling & Logistics: Transforms plans into actionable jobs in minutes.

4. Conclusions

This paper presented the main functions or services that Farm Management Platform offers to farm managers. An analysis of the applications currently on the market was used to determine the distribution of the 11 FMP functions, their occurrence frequency and the ones that are most useful to farmers.

The most common features found in software applications include field operations management, reporting, economic and finance, precision location management, inventory management, equipment and human resource management. In addition, less useful features include traceability, quality assurance, sales and best practices.

The applications that are on the market tend to focus on solving daily farm tasks and aim to generate income for the farmers through better resource management and field operations planning.

Software vendors must put more effort into adopting innovations from research, advanced systems and into collaborating with the academia in order to accommodate special requirements, such as those of precision farming.

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