The impact of data, information and knowledge from precision agriculture on the economy and business management*

Edita Šilerová[1,†], Jiří Vaněk[1,†] and Lukáš Poláček[1,*,†]

[1] Czech University of Live Sciences, Kamýcká 129, Prague, 165 21, Czech Republic

Abstract

The principles of precision agriculture are gradually becoming a trend in the entire agricultural sector – crop production, animal production, the use of technology, but it is necessary to incorporate the principles into the economy and management of agricultural enterprises. Precision agriculture enables efficient and economical management in the mentioned agricultural companies. Precision agriculture is therefore oriented towards the maximum use of the potential of soil, plants, machines, animals and, of course, also the human factor. In order to maintain the competitiveness of enterprises, it is necessary to address the use of data obtained from plant production, animal production and the use of technology in a complex manner in connection with the economy and management of the agricultural enterprise. The aim of the contribution is to propose a structure of data usage for improving the economic situation of the company and for its management.

Keywords

Precision agriculture, economics, information, data, knowledge, management

1. Introduction

Precision agriculture has become a trend of the 21st century. Precision agriculture gradually enables efficient and economical management in agricultural enterprises. The development of precision systems is globally supported for the innovative divide in the agricultural sector. Precision agriculture is a key part of the third wave of modern agricultural revolutions. [1]

Traditional record-sorting software is gradually being replaced by expert systems. The automation of procedures and the robotization of activities facilitate daily decision-making and eliminate the disadvantages resulting from the dependence of production on the human factor. A precise approach in agricultural production also ensures the efficient use of all resources, thereby significantly contributing to the sustainability of farming.

Precision agriculture is a management concept that relies on intensive data collection and processing to guide targeted actions that improve the efficiency, productivity and sustainability of agricultural operations. The rate of adoption of precision agriculture technologies on field crop farms in developed countries was evaluated, in America it is approximately 20% higher than in Europe [4]. The possibility of using the principles of precision agriculture and their economic benefits are also discussed by Gerhards and Sökefeld. [2] The issue of the use of data and information is also dealt with in [8], [10], [13], [14].

The amount of data obtained with regular monitoring of individual activities in plant and animal production, when using technology, technology, data from the economy, management is rapidly

* Short Paper Proceedings, Volume I of the 11th International Conference on Information and Communication Technologies in Agriculture, Food & Environment (HAICTA 2024), Karlovasi, Samos, Greece, 17-20 October 2024.

* Corresponding author.

† These authors contributed equally.

silerova@pef.czu.cz (E. Šilerová); vanek@pef.czu.cz (J. Vaněk); polacekl@pef.czu.cz (L. Poláček)

0000-0001-7289-4961 (E. Šilerová); 0000-0002-4573-5348 (J. Vaněk); 0000-0003-2648-5790 (L. Poláček)

increasing and it is necessary to work with them further and use them to increase the effective processing of individual resources. The data obtained on the basis of the activities of the principles of precision agriculture will significantly affect the competitiveness of the company. It is very important to address security and the method of data processing, which is also addressed by Benda et al. [12]

Sgroi carried out research activities on vineyards to prove the economic viability of carrying out mechanical harvesting using the principles of precision agriculture. [3] If a farmer concentrates a large amount of data and information about the entire agricultural production, he is not yet practicing precision farming. They must be able to continue to work with this amount of information, which is stored for the entire monitored period. The stored data must be given meaning, the data must be converted into a specific operational solution. Nowadays, only those who cannot only produce economically, but also sell very efficiently are successful. It is therefore important to work with all the data created in the agricultural enterprise. For this, it is possible to use the right and high-quality software, which will create conditions for, among other things, monitoring of financial flows in the company, processing of economic evaluations, comparing product prices. The use of well-processed company data has a high influence on quality management decisions. Currently, the principle of using precision agriculture plays an important role in agricultural enterprises, which leads to a reduction in costs, and thus the possibility of increasing profit and the quality of work with data, which must be monitored in agricultural enterprises. The issues of company management, economic management and the use of data and information to increase competitiveness are addressed in publications [7], [9], [11].

2. Materials and Methods

Objective: the objective of the contribution is to propose a data model usable for precision agriculture in the field of economics and management based on the analysis carried out in agricultural enterprises. Farmers need to know whether management methods have been successful and how to proceed next year to evaluate the year's results and for further planning. The main goal is to propose the integration of the obtained data from all parts of the agricultural enterprise and the possibility of using them for the assessment of reality and other predictions.

Methodology: The article was prepared based on scientific methods - using holistic methodology, analysis, synthesis, induction and deduction. The theoretical part was prepared based on the study of secondary literary sources, the study of scientific and professional literature. The authors will use their long-term knowledge and experience and cooperation with practice to process the contribution. Based on investigations carried out in selected agricultural enterprises, a methodology for the usability of data warehouses for use in business management will be proposed. Farmers will be able to use data to create simulations, planning, predictions and farm development.

3. Results and Discussion

However, the economic benefit from precision agriculture is still not well known. The positive effects of precision agriculture can be caused by precisely specifying the costs of the entire production process. Sgroi [3] deals with the positive benefits in his research, which deals with the economic efficiency of using the principles of precision agriculture when harvesting wine grapes.

Figure 1 shows that precision agriculture requires accurate information, highly skilled human capital and local application – these are factors that will create ideal resources for further processing and evaluation of economic efficiency. This means guaranteeing that the amount of input used exactly matches the cost incurred.

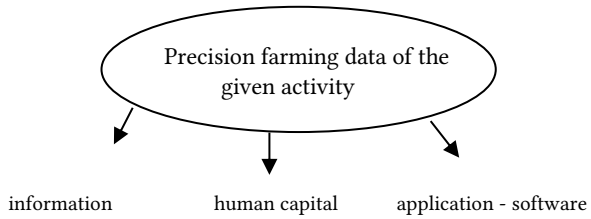

Figure 1: Use of data from precision agriculture

The principles of precision agriculture are already very well developed for the use of the potential of individual plots of land. The obtained data, which are stored in data warehouses, are the source of further qualitative shifts in the use of land - it is possible to use this data directly in the design of a solution to the sowing procedure, to find out how the use of the principle of precision agriculture has affected the entire efficiency of the enterprise. Cultivation interventions should be converted into graphic form for a better comparison and aligned with the proposed cultivation measures. The situation of use in the Czech Republic is mainly influenced by the amount of expenses associated with the acquisition of technologies necessary to introduce the principles of precision agriculture. Precision agriculture is a management concept that relies on intensive data collection and processing to guide targeted actions that improve the efficiency, productivity and sustainability of agricultural operations. [3] Agriculture and food production have entered an era of digitally supported processes where data can be generated during various agricultural activities. [6] Koliapka solves the problem of the predictive problem of precision agriculture, which is important for precision agriculture. [5]

Based on the investigations carried out (September, October, November 2023) in agricultural enterprises implementing the principles of precision agriculture, the following results can be stated. The investigation was carried out in 76 agricultural enterprises, the method of direct questioning was chosen.

Table 1
Use of data and information

Unit	Yes	No
Use for plant production	48%	52%
Use for livestock production	36%	64%
Use for economy	12%	88%
Use for management	9%	91%

Respondents who answered the question Use for business management positively, i.e. that they use the data for other activities, they use it precisely to implement the principles of precision agriculture and work with the data to create model situations. Very often, they only use data stored in individual databases for this, and they process the data stored in this way manually on paper or in Excel tables.

Unfortunately, companies do not have the software that would allow them to use the data. Nor has an integrated data structure been created, which would have to be used and further worked with. In many cases, they use the capabilities of an available spreadsheet (Excel) and often acquire data again, they do not have the opportunity to use saved data.

Current information and communication technologies make it possible to process large volumes of data. Companies often have atomized databases and connecting them is difficult and often impractical. Especially in agricultural enterprises, there are applications that are often used by only one worker, and it is he who works with the data of the given application, and it is not possible to perform analyzes that use all the data in the company. It is necessary to design integrated databases and then be able to work with this data within the entire company. Appropriate data sharing leads

to a qualitatively higher use of all resources, the result is a reduction in costs, an increase in yields and, in the case of precision agriculture, also an improvement in the quality of the environment.

Figure No. 2 shows a proposal for an integrated database that would make it possible to use all the data generated in the agricultural enterprise. Individual plots, crops grown on the given plots will be compared. Comparisons will be possible according to individual types of machines, workers performing the given operations, costs for the given plot of land, for cultivated plants and realized prices of cultivated crops. Data from individual processes taking place in the company are stored in a unified database or individual databases connected to each other. It will be possible to further use the stored data through the corresponding software tools. The knowledge of managers in the given field (in our case, agriculture) and also their knowledge of working with stored data will make it possible to create a long-term competitive advantage. You can use software that will be created directly to work with the designed data - this option will be more financially demanding, but easier for many users. You can use software that will be created directly to work with the designed data - this option will be more financially demanding, but easier for many users. The user will only learn to use these queries (functions) and create usage models according to his knowledge. The second option is a solution with the use of software such as a database environment or a spreadsheet.

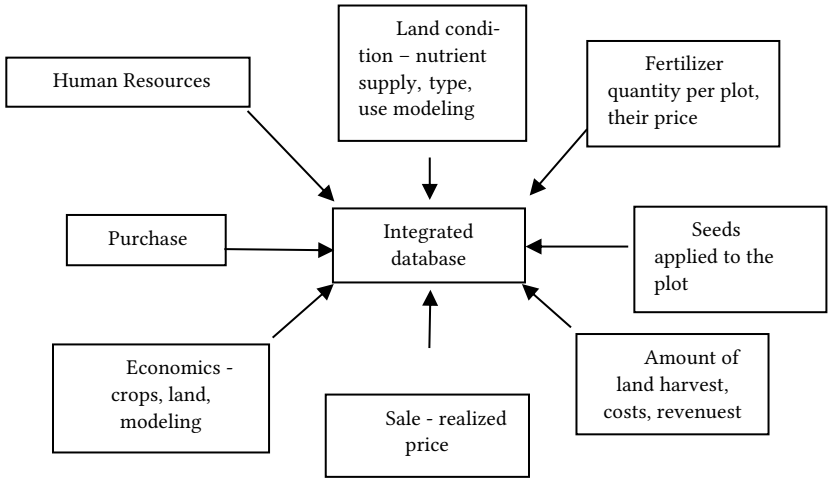

Figure 2: Data integration

The advantage of the created integrated database is the possibility of access, according to the user's request and his access rights, to the necessary data for his activity. Models can be created (Fig. 3) when we make predictions in crop production - we use company data (internal) and process it with external data (e.g. expected market prices, sales volumes, etc.) to create the best efficiency models. In the current economic environment, an important element for increasing competitiveness is not only to use the latest scientific knowledge, but also to gradually get involved in this activity.

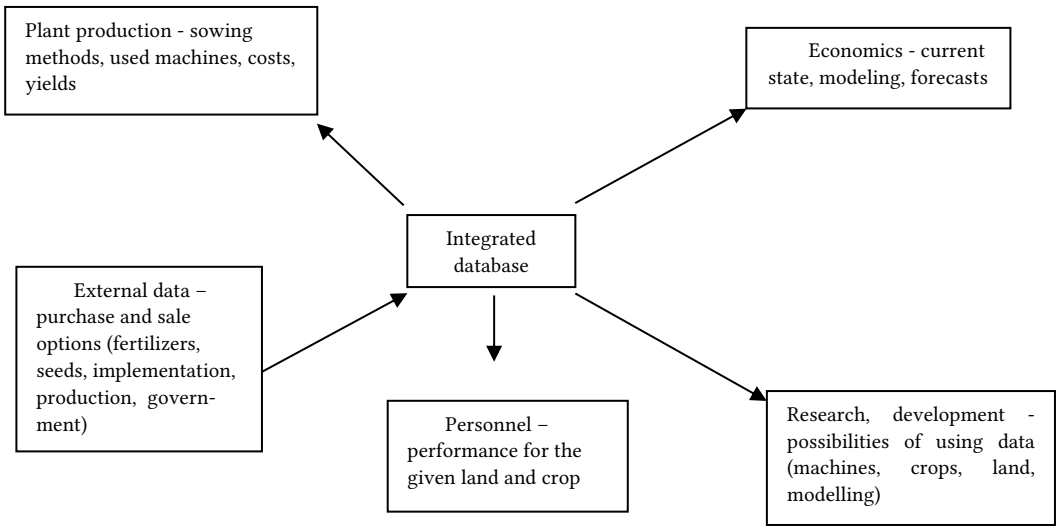

Figure 3: Data usage proposal

4. Conclusions

Data and information have become one of the most valuable business resources. Their use, importance, influence on the further development of the company is fully influenced by the ability of managers to use all data and information (internal and external). The quality of the information strategy is determined by the team's ability to define information needs. When creating a database that will be used by individual modules of the information system, its individual elements must be clearly defined. When creating a database, the team must include a representative of each company department in order to create a high-quality database that will become the basic starting point for the creation of reports for further decision-making. Agriculture is becoming a knowledge industry where what employees will know (what data and information they will get) is a key factor in profitability.

An important element is the involvement of precision agriculture tools in the entire business chain of production - sales - employees - economy - management. Precision agriculture will fully support business development if all parts of the business are connected, and this is only possible if we model stored data from all ongoing business activities.

Acknowledgements

The results and knowledge included herein have been obtained owing to support from the following institutional grant: Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences Prague, grant no. 2022B0006 – “Life Sciences 4.0. Plus”.

Declaration on Generative AI

The author(s) have not employed any Generative AI tools.

References

[1] Digital agriculture: Helping to feed a growing world". 15 April 2024. Archived from the original on 15 October 2018. Retrieved 3 April 2018

[2] R. Gerhards, M. Sökefeld, Precision farming in weed control -: system components and economic benefits. Precision Agriculture, 4th European Conference on Precision Agriculture, pp. 229 – 234, 2003, ISBN 90-76998-21-3

[3] F. Sgroi: Precision agriculture and competitive advantage: Economic efficiency of the mechanized harvesting of Chardonnay and Nero d'Avola grapes. Journal information Journal of Agriculture and Food Research. 2023, vol. 14. DOI 10.1016/j.jafr.2023.100774
[4] B. Nowak:Precision Agriculture: Where do We Stand? A Review of the Adoption of Precision Agriculture Technologies on Field Crops Farms in Developed Countries. Agricultural Research, Vol. 10, Iss. 4, pp. 515-522, DOI 10.1007/s40003-021-00539-x
[5] V. R. R. Kolipaka: Predictive analytics using cross media features in precision farming. IntternationalJoSpeech Technology, 2020. Vol. 23, Iss. 1, pp. 57-69, DOI 10.1007/s10772-020-09669-z
[6] M. Medici, M. Mattetti, M. Canavari: A conceptual framework for telemetry data use in agriculture. Precision Agriculture'21, 2021.Pp. 935 – 940, DOI 10.3920/978-90-8686-916-9_112
[7] T. E. Fiez, C. Baird, W.L. Pan. "Assessment of Spatially Variable Nitrogen Fertilizer Management in Winter Wheat." Journal of Production Agriculture. 7(January-March 1994): 17- 18, 86- 93.
[8] T. Brukner, J. Voříšek: Outsourcing informačních systémů. Praha:Ekopress, 1998 ISBN 80-86119-07-6
[9] J. Dohnal, J. Pour: Řízení podniku a řízení IS/IT v informační společnosti. Praha: VŠE, 1999 118 s. ISBN 80-7079-023-7
[10] P. F. Drucker: To nejdůležitější z Druckera v jednom svazku. Praha: Management Press, 2002. ISBN 80-7261-066-X
[11] Tanure, S.; Nabinger, C.; Becker, J.L.: Bioeconomic model of decision support system for farm management. Part I: Systemic conceptual modeling. Agricultural Systém, 115(2013), p. 104-116. doi: 10.1016/j.agsy.2012.08.008
[12] P. Benda, M. Šmejkalová, P. Šimek: Usability Analysis of Agricultural Portal eAGRI in Terms of the General Public, AGRIS on-line Papers in Economics and Informatics, (2016). Vol. 8, No. 4, pp. 15-23. ISSN 1804-1930. DOI 10.7160/aol.2016.080402.
[13] L. Pánková, R. Aulová, J. Jarolímek: Economic Aspects of Precision Agriculture Systems, AGRIS on-line Papers in Economics and Informatics, (2020) Vol. 12, No. 3, pp. 59-67. ISSN 1804-1930. DOI 10.7160/aol.2020.120306.
[14] R. Nelson, R. Coe, B. Haussmann: Farmer Research Networks as a Strategy for Matching Diverse Options and Contexts in Smallholder Agriculture, EXPERIMENTAL AGRICULTURE, (2019) pp. 125 – 144, DOI: 10.1017/S0014479716000454