User-Technological Index of Precision Agriculture: Methods of Collecting data

Jan Masner[1], Jan Jarolímek[1], Jiří Vaněk[1], Pavel Šimek[1], Edita Šilerová[1],

[1]Department of Information Technologies, Czech University of Life Sciences Prague, Czech Republic, e-mail: masner@pef.czu.cz

Abstract. User-Technological Index of Precision Agriculture (UTIPA) is a comprehensive system based on mutual sharing of opinions and experience within community of people related to precision agriculture - farmers, technology suppliers and researchers. The main goal of UTIPA is to present the calculated index level for particular technology (method) for precision agriculture and compare it to other technology. The index is based on evaluation of technological advancement and usefulness for agricultural practice. The paper discusses methods for collecting data for questionnaire in general. It elaborates on the technical solution developed for data collection for UTIPA. The system allows data collection as well as visualizations available to all participants.

Keywords: precision agriculture, survey, questionnaire, farmers, web, visualization

1 Introduction

The concept of precision agriculture is in the interest of the professional public since the 1990s. It generalizes the effort to identify solutions, tools and processes that can improve productivity and profitability while protecting the environment (Cambouris et al. 2014). Precision agriculture plays a vital role in increasing production and is seen as part of the agricultural process efficiency and environment-friendliness. In summary, the concept of precision agriculture is based on observations and measurements followed by the appropriate responses - for example through the introduction of new technology or by changing manufacturing processes. Precision agriculture technologies allow farmers to identify problems and opportunities and apply solutions with far greater accuracy (Lindblom et al. 2016).

A key factor in deciding whether a particular technology should be incorporated to practice is the understanding of agricultural production processes as well as the technology itself. Workers in agriculture management must choose among various options for applied research and technology and in this decision-making process there is a necessity to merge previous experience of the staff and the introduction of new technologies and procedures (Kumhala, F; Kroulik, M; Masek, J; Prosek 2003). It is vital to establish effective decision models and support resources for that particular phase of the production process.

Proceedings of the 8th International Conference on Information and Communication Technologies in Agriculture, Food and Environment (HAICTA 2017), Chania, Greece, 21-24 September, 2017.

The data for evaluation is collected from farmers, technology suppliers, researchers and general public. The optimal way to get the data is to run a survey. Therefore, there is a need to spread questionnaires and get them back. Questionnaires can be disseminated in two major forms - printed on paper or electronically via Internet. As (Gordon & McNew 2008) suggests, it is important to make informed decisions as to the right technology which to implement. Besides, many authors and studies suggest the internet as the best carrying medium (Lumsden 2005; Van Selm & Jankowski 2006; Andrews et al. 2003). On the other side, web based surveys generally exhibit a lower response rate (Fan & Yan 2010; Hamilton 2009).

2 Materials and Methods

The purpose of the User-Technological Index of Precision Agriculture (UTIPA) is to propagate the knowledge of users, suppliers and researchers in the use of modern technology in agriculture. It is primarily based on a five-point evaluation of selected technologies (methods) of precision agriculture in terms of technological advancement and applicability in agricultural practice. It evaluates technologies in principle and does not reflect specific products, brands or manufacturers (Jarolímek et al. 2017).

The questionnaire for UTIPA is compiled from several general questions (email, country, background) and rating for each technology (1 – 5 for both evaluation criteria). Rating is based on individual knowledge and experience of the respondents. An important characteristic of the evaluated technology is also its unfamiliarity among the respondents. The web based version of the rating is shown in Figure 1.

Many surveys usually only spread a questionnaire and collect data. Results are delivered to the participants only occasionally. On the contrary, UTIPA works on the principle of "what data I provide is the type of data I gain access to". Therefore, each participant who filled the questionnaire has access to the results and can benefit from them.

Fig. 1. The online form of questionnaire. Rating for technologies.

The system of data collection for UTIPA works on a simple principle. Each participant fills email address, basic information and the ratings for selected technologies (approximately around 10, based on the questionnaire and the occasion). To validate the contribution a confirmation email is sent to the given address. Once the provided link is clicked, the data are verified and the participant

can create a password. The user is automatically signed in and can immediately access all the collected data. The whole process is shown in Figure 2.

Department of Information Technologies runs a survey among Czech farmers about their ICT equipment every two years since 2010. Questionnaires are primarily spread over the Internet via emails. Aside from that, some of questionnaires are sent in paper form via classic post. The return rate of the printed questionnaires is still on a significantly higher level. In addition, the level of ICT equipment among Czech farmers is lower than a national average. The level of a knowledge is significantly low in long-term as well (Šimek et al. 2014). As mentioned above, the return rate of the printed form of questionnaire is higher than the electronic form. Therefore, the questionnaire for UTIPA is spread in printed form besides the electronic as well. The data gathered this way is inserted into the system manually later.

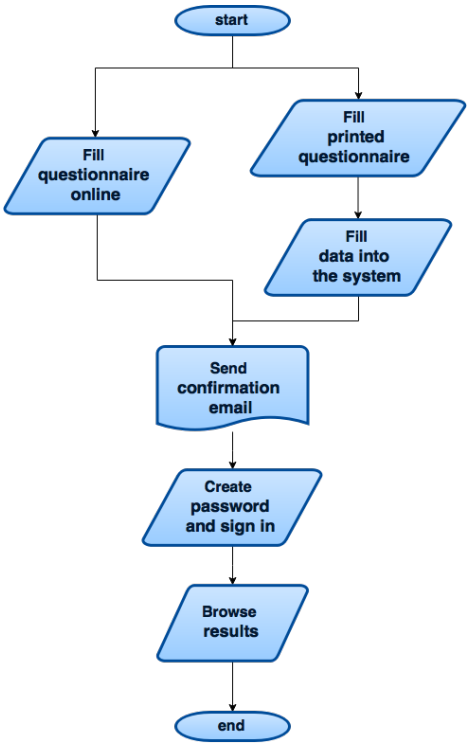

Fig. 2. The process of filling questionnaire and access to the data.

3 Results

User-technological Index of Precision Agriculture is a complex system that includes a methodology for collection, processing and presentation of data and

software, which is available via a web interface. The software is optimized for mobile devices. It will be also possible to use native applications for iOS and Android operating systems (currently under development).

The data collection system for the questionnaire was maximally simplified. While user is filling the form all data are continuously saved via AJAX. This approach allows having the data even when some participants do not finish the questionnaire for whatever reason. The user can even continue filling it in later.

After successful email confirmation all participants have access to the collected data. There are currently two main views. Each view then can visualize the data in a different way.

3.1 General results

This view contains three visualizations. The main one shows the results for each technology in a chart as shown in Figure 3. The X-axis indicates applicability in agricultural practice and the Y-axis indicates technological advancement. Each point in the chart represents certain technology. When the number is hovered over, additional information is displayed. It contains name of the technology, exact values for both evaluation criteria, and the computed UTIPA index. The index consists of two parts, the numeric value and an additional character. The numeric part of the index has values between 0 and 1 and reflects the degree of usefulness and sophistication of the technology. The numeric value can be supplemented with the character, which can be either "u" or "t" and expresses better ranking in favor of applicability in practice or technological advancement - the location in the chart in Figure 3. The methodology for calculation of the index was published by (Jarolímek et al. 2017). In addition, users can compare own evaluation with the calculated values. The visualization is shown in Figure 3.

Fig. 3. Visualization of the General results with comparison of own evaluation.

Participants of the survey have also an option to indicate the unfamiliarity with certain technology. It is an important characteristic for the results. The output is then a comparison of unfamiliarity of technologies.

3.2 List of technologies

Another view lists all the technologies with the calculated values for each technology. It shows the UTIPA index, both criteria value and technology annotation. If the user has not rated the technology, the rating option is shown. In the detail page of each technology, there is a heat map chart showing graphical presentation of scatter of all the ratings (Figure 4). Users have also the possibility to change their ratings when the technology evolves, opinion changes or their knowledge raises.

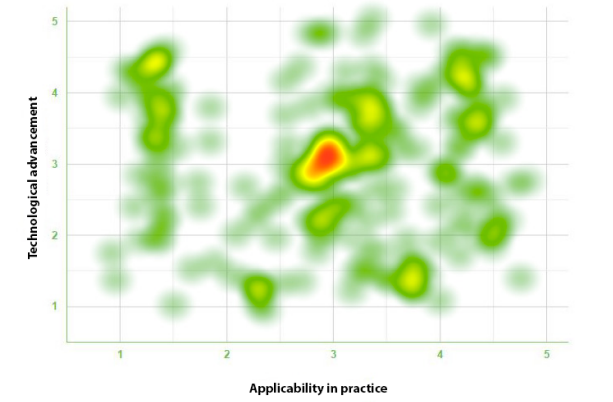

Fig. 4. Heat map visualization of the scatter of ratings by individual respondents.

4 Conclusion

User-Technological Index of Precision Agriculture is a complex system for the international community of people related to precision agriculture, it is accessible to anyone who respects the rules of use. It works on the principle of "what data I provide is the type of data I gain access to".

The proposed system for collecting questionnaire data was designed primarily as a web application gathering data online. It is also simultaneously spread in a printed form. The data is continuously saved during the filling of the online form. In addition, the system provides access to the visualizations of collected data for all participants. Moreover, as the number of technologies increases it will be possible to rate them individually.

The UTIPA index benefits all the stakeholders. Farmers can find out whether a given technology is useful and has real importance. Suppliers need to know what their customers (farmers) want or expect, but also how they perceive their products. For academia it can be a source of data for science and research. The importance and significance of the index grows with the number of respondents.

Future research will focus on two main areas. Firstly, there will be analyzed the data from collecting surveys. The question is to determine the optimal way of spreading surveys of this type, where and why people stopped filling the form etc. Secondly, the visualization of the gained data will be enhanced. New types of displays and comparisons will be introduced.

UTIPA system is freely available as a web application at https://www.utipa.info/.

Acknowledgments. The results and knowledge included herein have been obtained owing to support from the following institutional grants. Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences in Prague, grant no. 20171023, „User-Technological Index of Precision Agriculture “.

References

1. Andrews, D., Nonnecke, B. & Preece, J. (2003) Conducting Research on the Internet : Online Survey Design , Development and Implementation Guidelines. International Journal of Human-Computer Interaction, 16(2), pp.185–210.
2. Cambouris, A.N. et al. (2014) Precision Agriculture in Potato Production. Potato Research, 57(3–4), pp.249–262.
3. Fan, W. & Yan, Z. (2010) Factors affecting response rates of the web survey: A systematic review. Computers in Human Behavior, 26(2), pp.132–139.
4. Gordon, J.S. & McNew, R. (2008) Developing the online survey. The Nursing clinics of North America, 43(4), pp.605–19
5. Hamilton, M.B. (2009) Online Survey Response Rates and Times. Ipathia, Inc., N/A(White Paper), pp.1–5.
6. Jarolímek, J. et al. (2017). User-Technological Index of Precision Agriculture. Agris on-line Papers in Economics and Informatics, 9(1), pp.69–75. Available at: http://online.agris.cz/archive/2017/01/06/.
7. Kumhala, F; Kroulik, M; Masek, J; Prosek, V. (2003) Development and testing of two methods for the measurement of the mowing machine feed rate. Plant Soil and Environment, 49(11), pp.519–524.
8. Lindblom, J. et al. (2016) Promoting sustainable intensification in precision agriculture: review of decision support systems development and strategies. Precision Agriculture. Available at: http://link.springer.com/10.1007/s11119-016-9491-4.
9. Lumsden, J. (2005) Guidelines for the Design of Online-Questionnaire. National Research Council Canada, NRC/ERB 11(June), pp.44–64.

10. Van Selm, M. & Jankowski, N.W. (2006) Conducting online surveys. Quality and Quantity, 40(3), pp.435–456.
11. Šimek, P., Stočes, M. & Vaněk, J., 2014. Mobile access to information in the agrarian sector. Agris On-line Papers in Economics and Informatics, 6(2).