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User-Centred Design and Multi-Actor Approach in Agricultural Innovations – Case: Combi Drill Design

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Abstract. The author has shown that modern technologies do not always meet the expectations of farmers, and this may adversely affect the pace of innovation. It has been confirmed that the developers of agricultural equipment do not clearly understand the context of the use of products and identified the need to use a multi-factor approach: therefore, partners possessing specific knowledge in different areas should join efforts in project activities at all stages of innovation. (*Research purpose*) To prove that a user-centered design and a multi-factor approach in the development of agricultural machinery increase their efficiency and accelerate the introduction of innovations. (*Materials and methods*) It is shown that Finnish research and development projects of agricultural machinery design involve numerous participants and end users. For example, the seven-metre-wide combi drill 'Junkkari W700' was designed by the Finnish manufacturer Junkkari Oy in close cooperation with end-users and researchers. As a result of the innovation process several benefits have been realized. The drill is easy to operate and service. The users appreciate the straight-forward construction and moderate cost of the drill as compared to competing pneumatic drills. The need for hydraulics is minimized and the row spacing and coulter design has been optimized so that economical tractors with moderate drawbar power can be used. The ISOBUS-based control electronics was designed to be fitted either in the existing tractor or, if ISOBUS is missing, with an optional cable-set and terminal. That enables the users to easily integrate the drill in existing machine chains, having either modern or older tractors, without extra tractor investments. Much attention was put on quality, e.g. individual feeders for every coulter give accurate dosage of seed and fertilizer. The prototyping together with end-users and researchers enabled Junkkari to speed up the innovation process. (*Results and discussion*) Several benefits proved to have been realized. First of all, the drill is easy to operate and service. The users appreciate the straight-forward construction and moderate cost of the drill as compared to competing pneumatic drills. The need for hydraulics is minimized and the row spacing and coulter design has been optimized so that economical tractors with moderate drawbar power can be used. The ISOBUS-based control electronics as well as an optional cable-set and terminal were designed to be fitted either in the existing tractor. That enables the users to easily integrate the drill in existing machine types, having either modern or older tractors, without extra tractor investments. The design quality was approved, e.g. individual feeders for every coulter give accurate metering of seeds and fertilizers. (*Conclusions*) The author proves that user-centered design and multi-factor approach methodologies have benefits both for the users and manufacturers. Swift innovation process saves resources and minimizes the need for excess iterations in the innovation process.

Keywords: agriculture, farm machinery designing, innovation introduction, user-centred design, multi-factor approach, combined drill.

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Применение ориентированной на пользователя конструкции и многофакторного подхода при внедрении инноваций на примере проектирования комбинированной сеялки

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Реферат. Показали, что современные технологии не всегда соответствуют ожиданиям фермеров, а это отрицательно сказывается не темпах внедрения инноваций. Подтвердили, что разработчики сельхозтехники недостаточно четко понимают контекст использования продуктов. Выявили необходимость использования многофакторного подхода: партнерам, обладающим специальными знаниями в разных областях, следует объединять усилия в проектной деятельности на всех этапах внедрения инноваций. (*Цель исследования*) Доказать, что ориентированная на пользователя конструкция и многофакторный подход при разработке сельскохозяйственных машин повышают их эффективность и ускоряют внедрение инноваций. (*Материалы и методы*) Показали, что в финских исследованиях и разработках конструкции сельскохозяйственных машин в процесс были включены многочисленные участники и конечные пользователи. Например, комбинированную сеялку Junkkari W700 с шириной захвата 7 метров финский производитель Junkkari разработал в тесном сотрудничестве инженеров и фермеров. (*Результаты и осуждение*) Подтвердили, что такой подход помогает реализовать несколько преимуществ, прежде всего простоту и удобство в эксплуатации и обслуживании сеялки, а также умеренную стоимость по сравнению с пневматическими аналогами. Потребность в гидравлике сведена к минимуму, а междурядное расстояние и конструкция сошников оптимизированы, что позволяет использовать экономичные тракторы с умеренной тягой. При агрегатировании с тракторами предусмотрены как система ISOBUS, так и дополнительный комплект кабелей и выводов. Установили, что фермеры могут легко интегрировать сеялку в существующие типы машин, используя современные или старые тракторы, без дополнительных затрат на новые тракторы. Подтвердили качество конструкции, например, индивидуальные дозаторы для каждого сошника обеспечивают точную дозировку семян и удобрений. (*Выводы*) Доказали, что ориентированная на пользователя конструкция и многофакторный подход имеют преимущества как для фермеров, так и для машиностроителей. Определили, что сокращение количества этапов внедрения инноваций ускорит инновационный процесс и сэкономит ресурсы.

Ключевые слова: сельское хозяйство, разработка сельскохозяйственных машин, внедрение инноваций, ориентированная на пользователя конструкция, многофакторный подход, комбинированная сеялка.

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Distinguished pioneer of innovation research, Dr. Joseph Schumpeter, made a widely utilized definition of innovation already in the 1930's. According to Schumpeter, true innovations need to give distinct benefits for their users and, simultaneously, they need to be widely adopted [1, 2].

Current innovation research models innovations as repetitive circles where the solutions develop iteratively. There are driving forces and obstacles for innovation. The changing innovation environment has various effects on the innovation process (*Fig. 1*) [3].

The Spiral of Innovation illustrates the phases of innovation from the initial idea to embedding in practise (*Fig. 2*) [4]. Innovation in agriculture often stops at the adoption phase. Dissemination and embedding so that true innovation is not realized.

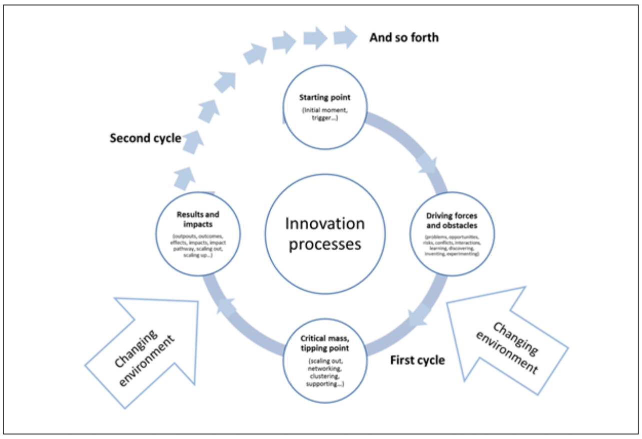

Fig. 1. The dynamic process of innovation development

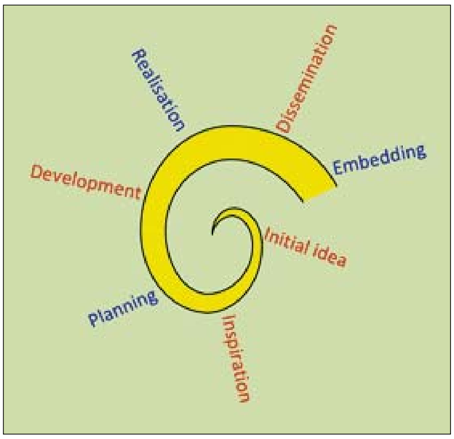

Fig. 2. The Spiral of Innovation

The reasons for poor adoption are traditionally regarded as economical. Higher cost and uncertain benefits are considered to the main reasons why new solutions are not purchased. However, according to recent research, there are other important obstacles for adoption. Usability issues in products or services cause the users to get bad experiences using new technologies [5]. Bad experiences are communicated effectively in the society. This causes mistrust on new solutions as a whole [6].

Consequently, in agriculture, the adoption of new technologies is considered slower than wanted [6]. This is best seen in radical innovations such as Precision Agriculture [6-8]. Incremental modifications of existing technologies are easier to accept. On the other hand, innovations on component level are easier to adopt than those in system level (*Fig. 3*) [3].

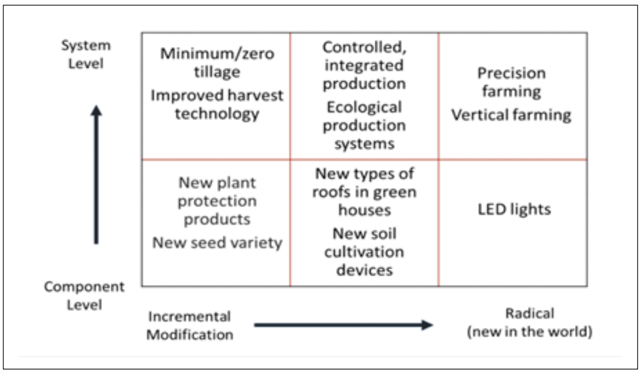

Fig 3. Agricultural incremental and radical innovations (modified Henderson-Clark Model)

If not widely adopted the innovations do not give their full potential. If the process is totally aborted, all the investments in R&D are done in vain, and the projected benefits of the new solutions are not realized [6, 8-10]. To avoid these losses, it is important that the developed products are accepted by their users. Users are in an important role.

According to recent research, an important buying criterion of new solutions in agriculture is usability [6]. Jacob Nielsen states that usable products have a good combination of ease-of-use, learnability, and efficiency [11]. They also operate with few errors. Finally, they are subjectively pleasing.

The technologies need first to be purchased, and then used in a proper manner so that their benefits are realized, so that the users return to buy again (*Fig. 4*) [6].

User-Centred Design (UCD) is a methodology for designing usable technologies and services. It is widely utilized to ensure better end-user acceptance. Inclusion of end-users in innovation makes the products more suitable for the users' variable situations. The UCD also builds the users' trust on the solutions. Eventually, UCD reduces need for iteration in the process, thus speeding up the innovation [6, 12]

Multi-Actor Approach (MAA) brings different kinds of people together to develop solutions. Best results are achieved when the participants have long enough cognitive distances. MAA speeds up the innovation processes as the products have been assessed from several angles [3]. The probability for reaching a winning product arise.

The research purpose is to prove that the User-Oriented Design and the Multi-Factor Approach applied in the designing of agricultural machinery increase

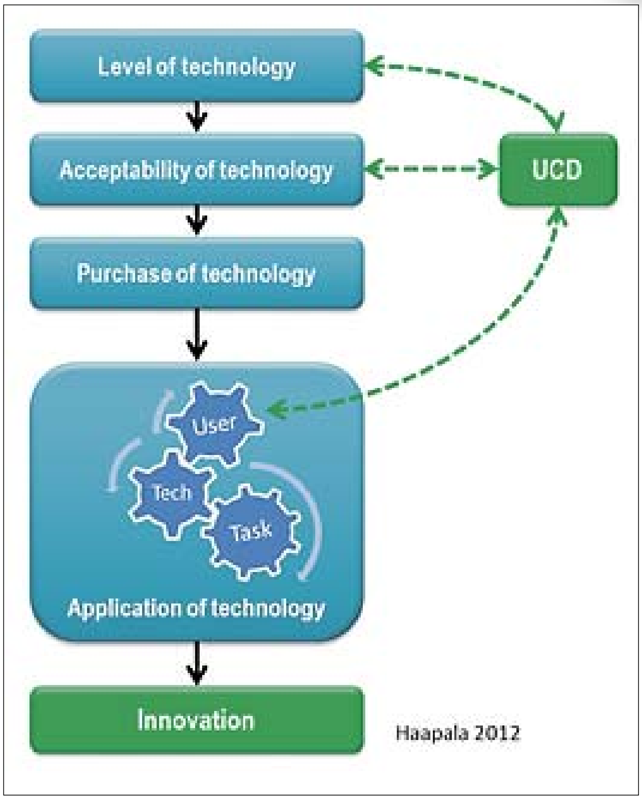

Fig. 4. User-Centred Design as a tool to enhance innovation

their efficiency and accelerate the introduction of innovations.

Materials and methods. Two research projects on agricultural innovations, ´Speeding up innovation in agriculture´ and ´AgriSpin´ were initiated. A case-study of designing a new type of combi drill was done.

´Speeding up innovation in agriculture´ (2011-2012) was funded by the of the Organisation for Economic Co-operation and Development. The research was done as a web-based questionnaire (N=41) and personal interviews of selected experts (N=10). Webropol™ software was used for the questionnaire. The respondents' competence profile was variable. They were strong in engineering, research and practical use of technologies at the farm level. Weeknessess were found in skills in marketing and sales. Neither they were familiar with teaching of design.

The questionnaire had three parts: assessing the current PF technology, the application rate of PF technology, and the acceptability as a challenge in PF. Furthermore, the responders were asked to tell what they thought about the applicability of UCD as a methodology to enhance innovation in agricultural engineering. The experts also gave their opinions and visions of the most important research and development topics of UCD in agricultural engineering. Finally, they rated the importance and urgency of UCD and PF related actions in research policy.

´AgriSpin´ (2015-2017), was funded by EU research and innovation program Horizon 2020. The objective of AgriSpin was to systematically explore innovation intermediaries' practices and support services in agriculture and rural development across Europe. The overall goal was to help create a stimulating environment for innovations.

The Cross Visit Methodology including thorough analysis of 50 innovation cases in Europe was applied and improved during the project. The Spiral of Innovation was used to illustrate the cases and to communicate them to wider audience. In Final Symposiums relevant stakeholders were informed about the findings, and challenged for developing the local innovation environment of agriculture.

The inclusion of end-users and multiple actors has been used in Finnish R&D of agricultural machines. As an example, the 7 m wide combi drill 'Junkkari W700' was designed by the Finnish manufacturer Junkkari Oy in close cooperation with end-users and researchers. The prototypes were assessed by multiple users with different drilling circumstances (*Fig. 5*). In 2018 there were 5 machines tested in Finland and one in Estonia [13]. An expert group was established that assisted Junkkari along the design process.

Fig. 5. User-Centred testing of the 7 m wide Junkkari W700™ combine drill for seed and fertilizer

Results and Discussion. Speeding up innovation in agriculture´ concluded that designers tend to have inadequate understanding of the use-context of the products [6, 8]. It was recommended e.g. that education of engineers, designers, marketers and end-users needs to include UCD methodologies. This is in line with the findings of Knierim et al. and Nielsen who see user-interaction as a basic tool for designing better usable products [3, 11].

The ´AgriSpin´ concluded that the social part of agricultural innovations should be better understood to be able to support them efficiently [3]. A recommendation was made that MAA should be used during the innovation process to tackle the challenges better. In MAA partners with complementary types of knowledge – scientific, practical and other – join forces in project activities from beginning to end. The analysed 50 cases revealed that the use of MAA produced innovative results [14]. The theories of the importance of the social process in innovations got confirmed [3].

The case-study, the design of 'Junkkari W700' combi drill, revealed benefits of increased user-interaction. The users tell that the drill is easy to operate and service. The users appreciate the straight-forward construction and moderate cost of the drill as compared to competing pneumatic drills. This was realized through the introduction of a novel type of mechanical material transport. The need for hydraulics was minimized and the row spacing and coulter design was optimized so that economical tractors with moderate drawpower can be used. The ISOBUS-based control electronics was designed to be fitted either in the existing tractor or, if ISOBUS is missing, with an optional cable-set and terminal. That enables the users to easily integrate the drill in existing machine chains, having either modern or older tractors, without extra tractor investments. Much attention was put on the quality of the drilling work. Individual feeders were installed for every coulter as to give accurate dosage of seed and fertilizer. The prototyping together with end-users and researchers gave Junkkari the possibility to speed up the innovation process. The results supported the theories of Nielsen on the importance of usability design [11].

Conclusions. As a conclusion, the UCD and MAA methodologies have benefits both for the users and manufacturers. The resulting swift innovation process saves resources and minimizes the need for excess iterations in the innovation process.

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REFERENCES

1. McCraw T. 2010. Prophet of Innovation: Joseph Schumpeter and Creative Destruction. Cambridge: Harvard University Press. 719 (In English).

2. OECD. Oslo Manual. The measurement of scientific and technological activities. Proposed guidelines for collecting and interpreting technological innovation data. European Commission. 3rd ed. 2005. 163. 8 (In English).

3. Knierim A., Koutsouris A., Mathe S., Ndah H.T., Temple L., Tromphe B., Wielinga E. Support to innovation processes: a theoretical point of departure: WP1 deliverable

1.1: report of the AgriSpin project. University of Hohenheim, Germany. 2015. http://agrispin.eu/wp-content/uploads/2016/01/Theoretical-Framework-of-AgriSpin.pdf. Last accessed 08.04.2019 (In English).

4. Wielinga E. AgriSpin cross visit manual: Space for innovations in Agriculture. 10th ed. 2016. http://agrispin.eu/wp-content/uploads/2016/11/Cross-Visits_Improved-Methodology-1.pdf. Last accessed 08.04.2019 (In English).

5. Haapala H., Nurkka P. Usability as a Challenge in Precision Agriculture – case study: an ISOBUS VRT. *Agric. Eng. International:* the CIGR Ejournal. 2006. 9 (In English).

6. Haapala H. The potential of User-Centred Design (UCD) to make radical agricultural innovations. In: Proc. International Conference of Agricultural Engineering – CIGR-AgEng 2012: Agriculture and Engineering for a Healthier Life. Valencia, Spain, 8-12 July 2012. C-0094 (In English).

7. Diekmann F., Batte M. Ohio Farming Practices Survey: Adoption and Use of Precision Farming Technology in Ohio. Experimentation report AEDE-RP-0129-10. 2010. 21 (In English).

8. Haapala H. How to speed up innovation in agriculture? Book of Abstracts. The 3rd Agromek-EurAgEng joint seminar. Advances and Innovations in Agricultural Engineering. Nov. 27-28 2018. Herning, Denmark. NJF sektion Technology. 2018. 31 (In English).

9. Haapala H. Speeding up innovation in agricultural IT. *Journal of Agricultural Engineering*. 2013. Vol. XLIV. 137-139 (In English).

10. Winstead A., Norwood S., Griffin T., Runge M., Adrian A., Fulton J., Kelton J. Adoption and Use of Precision Agriculture Technologies by Practitioners. In: Proc. 10th International Conference on Precision Agriculture, 18-21 July 2010. Denver, Colorado (In English).

11. Nielsen J. Usability Engineering. 1993. Academic Press Inc. 362 (In English).

12. Li W., Hess T., Valacich J. Why do we trust new technology? A study of initial trust formation with organizational information systems. *The Journal of Strategic Information Systems*. http://dx.doi.org/10.1016/j.jsis.2008.01.001. 2008. Elsevier. Vol. 17. N1. 39-71 (In English).

13. Anon. Junkkari W700. Genious Giant. ppt-presentation by Junkkari Oy. 2019. 29 (In English).

14. Wielinga E., Robijn S. 2018. Stories from All Corners, To Continue With. SEGES, Aarhus, Denmark. https://agrispin.eu/wp-content/uploads/2018/02/D3.2-End-user-book-002.pdf. Last accessed 08.04.2019. 228 (In English).

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