Innovating Farmax spading machines by incorporating smart technology

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This thesis covers research conducted for Farmax B.V., Denekamp, The Netherlands, conducted as final assignment of the Bachelor Industrial Design Engineering, University of Twente, The Netherlands. Farmax is a producer of tillage implements called spading machines, which are mechanical machines that prepare soil for sowing. Farmax has largely focused their development on mechanical improvement to achieve larger working widths or depths. However, Farmax realises that mechanical improvement of machines has limits, and that smart technology brings new possibilities.

The purpose of this research was to provide knowledge about how smart technology can play a role in agriculture and add value to the spading machines. It is important for Farmax to gain insight into possibilities that smart technology have to offer and the challenges that their application bring, to determine a relevant vision and strategy. To provide Farmax with sufficient information to do so, the thesis was divided in three parts.

Part A documents motivation on multiple levels. For one, the United Nations projects the worldwide population to increase to nearly 10 billion by 2050 (UN, 2019) and the World Government Summit expects that this will have to be met by a food production increase of 70% (De Clercq, Vats, & Biel, 2018). Agriculture 4.0 is the umbrella term for using recent technological advances for agricultural purposes, and the World Government Summit describes Agriculture 4.0 as a key tool to cope with the increasing need for food. Furthermore, part A looked at contemporary tillage methods and soil fertility, to discover agricultural possibilities. Lastly, tractor and implement related properties are discussed.

Part B discussed smart technology and its applications at a broad level. Later, this scope was narrowed to agriculture. Market analysis showed different applications of modern technology in agriculture, such as automatic steering, implement control, and sensor systems. Furthermore, part B discusses sensors to measure agricultural properties such as nutrients (figure 1 and 3), or tractor and implement related properties, see figure 2. Part B also provides basic understanding of how raw sensor data must be processed before it provides insight.

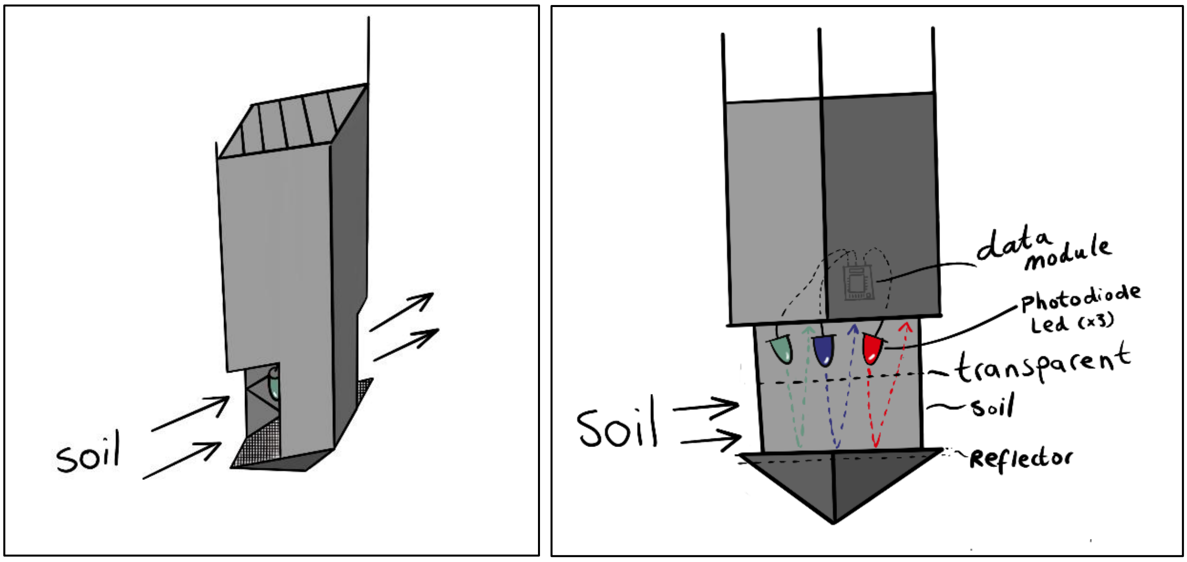

Figure 1: Optical sensor system used to measure soil nutrient on-the-go. Based on Ramane, Patil, & Shaligram (2015); Masrie, Rosman, Sam, & Janin (2017)

Part C showed scenarios that visualise how the researched topics can be applied in practice. The scenarios showed how some technologies from part B can be utilized to provide a benefit in real-life situations. Two scenarios were combined into a final scenario, which was for the tractor operator to improve control of some implements. Currently there is little insight into parameters which makes control of the machines expertise dependent. The final scenario showed multiple ways to improve this at different complexity levels. At low complexity, properties are measured and visualized, see figure 2, but the method of control is not altered. At medium complexity control is upgraded from an in-cabin physical button to a screen in the tractor, known as a Universal Terminal. This is more complex, as control of tractor systems is necessary. In that case communication must adhere to international standards for agriculture, ISO11783. At high complexity, the operator only specifies a target value; the system regulates behaviour without need for user interaction. An example is shown in figure 3 (not part of the final scenario).

Overall, this thesis identified possibilities to enhance the tillage process and analyse features of soil during the tillage process, that can be used to provide benefits such as increased insight in soil fertility through the creation of maps of agricultural properties. The hypothesis that emerging technology can be beneficial to the process that spading machines are involved in was shown, which holds for both agricultural properties as well as or performance related properties. Whether or not Farmax, and in turn the end-user decide that investing in smart technology is worth the cost, depends on many aspects. For smaller businesses, high investment cost can be a reason why an investment is not made. As a result, new business model opportunities have come to exist, to rent or lease machinery that are otherwise too expensive or not used frequently enough, or to provide a service for the user. Local subsidies funded through European Research programs can be a solution when investment costs are high.

The major conclusion of this thesis is that many technological opportunities exist that can provide some agricultural benefit, either directly to the tillage process or in another way. However, technical knowledge required to achieve medium to high level complexity solutions can be difficult and niche. As a result, outsourcing parts of the design process, or buying pre-made smart sensor solutions can be a way to reduce the required level of knowledge. While such solutions often have higher costs, it can avoid complex data processing or system development.

Figure 2: Low level complexity, properties are only visualised. Background photo: NewHollandAG, 2017

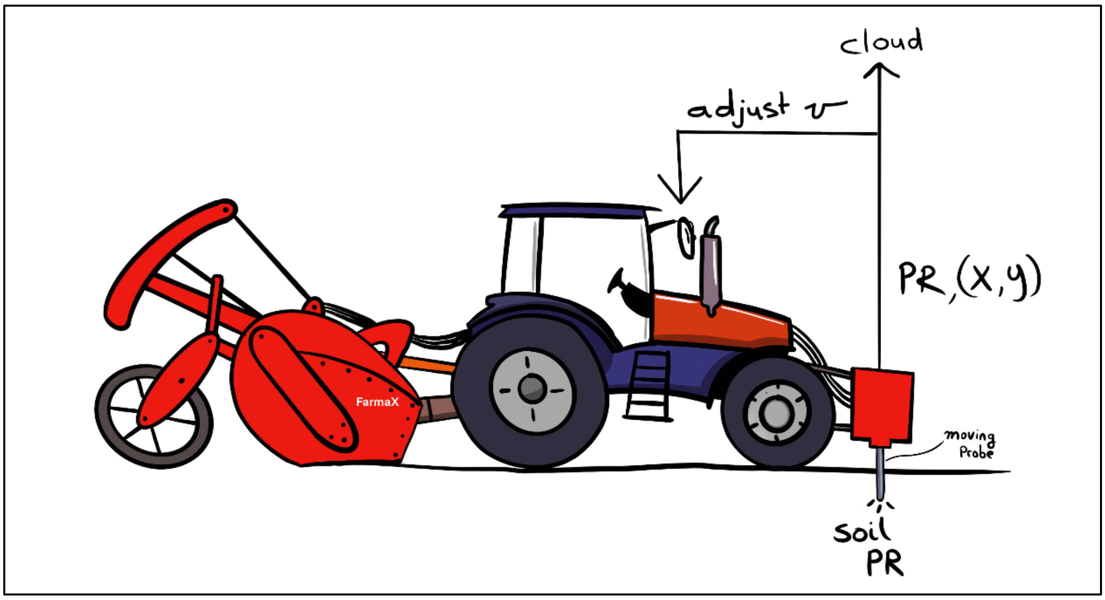

Figure 3: Example high level complexity system, measured compaction influences tractor velocity to affect tillage intensity

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