Introduction of Smart Agriculture

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Chapter 14
Introduction of Smart Agriculture

Christian Zinke-Wehlmann and Karel Charvát

Abstract Smart agriculture is a rising area bringing the benefits of digitalization through big data, artificial intelligence and linked data into the agricultural domain. This chapter motivates the use and describes the rise of smart agriculture.

14.1 Situation

Agriculture is a central sector for all of us, but there are significant challenges that this sector and the whole society face:

- A growing populationraises the demand for food "by roughly 50 percent compared to 2013 agricultural output" [1].
- Globalisation is mixing food cultures.
- Healthy living and the elderly population are requiring different diets than before.
- Urbanization with an increasing demand for processed and high-quality food.
- Land abandonment due to growing urbanization.
- Limited and highly stressed natural resources—overused farmland becomes degraded (e.g., soil erosion, unbalanced fertilizer usage), water resources are threatened.
- Climate change affects crop growth negatively due to higher temperatures and poses higher risks for yield loss by droughts and floods.
- New policies influence agriculture production, and changes in the subsidies system can rapidly influence agriculture production [2].

Thus, the supply chain security of high-quality food products becomes very relevant, while at the same time, the global demand for food is growing [3]. To

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address these challenges, digitalization and data-driven approaches for agriculture have emerged [4]. However, digitalization of agriculture is not only economically driven, but also advanced by legal requirements, fertilizer ordinances and sustainable management of natural resources [5].

Crop modeling, yield monitoring, satellite navigation, earth observation, and cheap and high precision sensors are well-known examples of digitalization, or to be more precise, of precision farming/agriculture and smart agriculture [6].

14.2 Precision Agriculture

"Precision farming makes use of information technologies in agriculture. With the satellite positioning system and electronic communication standards, position and time may be integrated into all procedures connected to farming" [7].

The goal of precision farming is to do the right things at the right places with the right intensity—e.g., fertilizing [8]. However, it is an information-driven approach to support the farmer's decisions, mostly resulting in farm-management-systems. The forecasted market value of these technologies in 2023 is 9.53 billion US dollars. With the growth of technological possibilities and development (more sensors, the expansion of Internet of Things, more data sources, e.g., earth observation and weather forecasts), cyber-physical systems became relevant for agriculture [9]. The growth of information came along with the demand for intelligent solutions.

14.3 Smart Agriculture

Smart agriculture is not only about bringing information technology in agriculture, but rather more about creating and using knowledge through technology. Agricultural machines and devices should be enabled by information technology to process and analyze data—and finally, make some decisions, or prepare them semi-automatically [4, 10]. It is based upon the rise of big data technologies [11], the Internet of Things [12], satellite observation [13], linked data [14], and artificial intelligence [15] in all the agriculture supply chain stages [5]. The forecasted market value of smart farming worldwide is 23.1 billion dollars (including precision farming). The following chapters in Part V underlines the importance of smart farming in terms of agricultural productivity, environmental impact, food security, and sustainability, with applications in the areas of crops, soil, biodiversity, farmer's decision-making, and many more—in line with works like [6]. Concretely, the following chapters demonstrate how smart agriculture can be applied.

- Chapter 15 demonstrates smart farming services based on IoT, EO data and big data analytics. They are able to provide advice for fertilization, irrigation, and

crop protection in a flexible way to the farmers. The services promote sustainable farming practices for better control and management of the resources.

- Chapter 16 presents an approach for genomic prediction and selection of biomass. The data came from several sources, such as phenomics, genomics and sensors. The presented approach of smart agriculture provides the enabling technologies and knowledge to support crop breeding companies.
- Chapter 17 introduces yield prediction models for sorghum and potatoes. High-resolution satellite images were used to predict yields. Through the presented smart farming approach, farmers can improve their business operations through informed decision-making in planning field work, logistics and supply chains.
- Chapter 18 demonstrates the variable application of nitrogen fertilizers on farm fields based on satellite monitoring..
- Smart agriculture is not only about the primary supply chain; it is also about services to protect farmers. Considering the current challenges related to climate change effects and the increasing world population, insurance assessments may ensure a higher resilience of agriculture. Chapter 19 presents a first step towards data-based insurance for smart agriculture.
- To set up more environmentally friendly and efficient agricultural practices, tools and services to support compliance management, e.g., CAP, is needed. Chapter 20 demonstrates how the processing and analysis of Copernicus satellite imagery can offer compliance checking and a great range of supplementary information for public authorities and farmers.
- The concluding chapter in this Part V summarizes the presented work and gives a brief outlook on smart agriculture in the near future.

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