Chapter 8
Synergistic Technologies for Precision Agriculture

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ABSTRACT

Precision agriculture (PA) as a concept allows input optimization by farmers and food producers in order to improve productivity and enhance quality yields while minimizing costs and environmental impacts. Developed countries typically identify with precision agriculture due to very large sizes of farms and the possibility of mechanized systems of crop production. The method involves the data collection, analysis, and plotting on productivity, soil quality parameters, and environmental levels at different locations within the field to decide on the amounts of the applicable inputs (such as water, nutrients, and fertilizers) to the field. In most developing countries, precision agriculture technology is still largely missing. The field sizes are smaller, and technology access, training, and financial capital are still grossly limited. Nonetheless, the farmers in the developing countries still explore the available resources and means at their disposal to increase their agricultural production and productivity.

INTRODUCTION

One of the major concepts for revolutionizing the food industry during the fourth industrial revolution (4IR) is precision agriculture (University of Stellenburg Business School, 2017). Precision agriculture (PA) as a concept, allows input optimization by farmers and food producers in order to improve productivity and enhance quality yields while minimizing costs and environmental impacts. Developed countries typically identify with precision agriculture due to very large sizes of farms and the possibility of mechanized systems of crop production. The method involves the data collection, analysis and plotting on productivity, soil quality parameters, and environmental levels at different locations within the field,

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to decide on the amounts of the applicable inputs (such as water, nutrients and fertilizers) to the field (Tran and Nguyen, 2006). In most developing countries, precision agriculture technology is still largely missing. The field sizes are smaller, technology access, training and financial capital still grossly limited. Nonetheless, the farmers in the developing countries still explore the available resources and means at their disposal to increase their agricultural production and productivity.

The world population is projected to be approximately 9.5 billion by the year 2050, while food production is estimated to be doubled to meet the consumption need of the people. Precision farming, a new technological development, supports the farmers to feed more people even from the same field size. Before the era of the agricultural revolution, almost 90% of the global population engaged in peasant farming. The trend has drastically changed, as 80% of the developed nations now engage in the service industry. As the agriculture workforce is steadily reducing, the ages of the farmers are increasing with youths not embracing it. A case study of the Republic of Korea, more than half farmlands are owned by 60 years old and more than 40% are owned by above 65 years of age. Noteworthy, 5% of the global population that works in agriculture contributes 60% of the global economy. The reality has forced many developed countries including the USA and Japan to make efforts at solving agricultural challenges through modernization, mechanization and automation in which the 4IR adequately represents (Sung, 2018; Lee, 2017).

Precision agriculture, sometimes called digital agriculture resulted from the third phase of the agricultural revolutions, after the advent of mechanization between 1900 and 1930s, and the green revolution in 1960s. The concept of PA has its first revolution in a form of weather prediction, aerial and satellite imagery, and varying fertilizer application. The second phase of PA development involved aggregation of machine data for topographical mapping, soil data, and more precise farming exercise (Kukuta, 2016). In the fourth food revolution (Food 4.0), digital agriculture will change farming, as PA and other technologies of the 4IR hold the answers to the challenges of sustainably feeding the growing global population (Dongoski, Rob & Selck, 2017). The change-agent technologies in the food sector include driverless tractors, smart robotics, sampling sensors, drones, and agricultural robots. The food industry, being a representative industry where there is any inconsistency between inputs and outputs, requires a method that will effectively construct an optimized agricultural model which strikes a balance among production, distribution and consumption. Despite that enough foods are produced globally, many people still die of famine because about 30-50% of the produced foods are wasted.The interest in PA is steadily increasing due to its balance between minimizing environmental pollution and maximizing the production of food products. Precision agriculture enables sustainable intensification of increased yields through a prudent and minimal application of inputs. Also, soil moisture and quality could be improved while reducing the environmental impact due to excessive input applications. Moreover, farmers tend to involve in more competitiveness through lower production costs and targeted inputs application (Sung, 2018). A solution for reducing the agrochemical inputs as well as the adverse environmental impacts is presented by PA. This is emphasized through three fundamental benefits: economy increased yields, and environmental benefits (Kendall, *et al.,* 2017).

Digitalization of agriculture and food means that almost every aspect of the industry is mostly reliant on the hardware, being controlled by the software. Despite the possible resistance from the traditional and analogue ways of food production, the industry is being transformed through the innovative and technological disruptions, which are synergistic with precision agriculture. PA as a concept involves drones, big data, farm management software, and sensors in the various aspects, which include environmental control, smart packaging, micro-farms, and gene manipulation. The technologies and innovative practices