Chapter 5
Agriculture 4.0 for a Sustainable Food System:
A Holistic Model for the Transformation of Farms Towards a Sustainable Precision Agriculture

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ABSTRACT

This chapter aims to analyse the concept and implementation strategies of Agriculture 4.0 within the framework of the study of disruptive technologies and eco-innovation, which allows facing the needs derived from a sustainable food system. To do this, it strategically reflects on the design requirements of a holistic model for the transformation of agricultural holdings, aimed at the implementation of sustainable agrotechnology. The Third Green Revolution, its antecedents, orientations, and purposes, as well as the concept and functional aspects of sustainable food systems are analysed. Finally, a model of transformation of agricultural holdings towards the implementation of Sustainable Agriculture 4.0 is proposed, as well as a generic methodology applicable to specific projects located in specific areas, through formula for change and cost-benefit analysis.

INTRODUCTION

Achieving the Sustainable Development Goal by 2030 for a future humanity in which there is no hunger is a very ambitious goal that implies having more productive, efficient, transparent, sustainable, resilient, and inclusive food systems. In addition to covering the approximately 690 million people who still suffer

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from hunger today, almost 9% of the world population (United Nations FAO, 2020), which will imply a very considerable increase in the demand for food that will be produced in the next 30 years. years, as the world population grows from the current 7.8 billion to the estimated 9.6 billion by 2050 (United Nations, 2021). It is estimated that their diet will require an increase in the world's food supply by at least 60%.

To face this situation (Hickey et al., 2019) it is necessary for the international community to do a decisive integral transformation of the current global agri-food system, considering current and future restrictions and challenges, such as the increasingly restricted availability of natural resources essentials such as fresh water and productive arable land. Likewise, the devastating effects of climate change (World Health Organization, 2020) and soil erosion will significantly modify the food production capacities of different regions and countries. In addition, the unbridled trend towards urbanization, with more and more people living far from agricultural areas, will make it necessary to find more efficient ways to produce and distribute food to large consumption centres.

In contemporary history, agriculture, as a fundamental support of the world food system, has undergone a series of revolutions that have increased its efficiency, performance, and profitability. The beginning of the First Green Revolution (Patel, 2012) occurred after the Second World War, beginning in the 1950s, and represented a major agricultural transformation that focused on advances derived from new farming methods, new practices and the implementation of new technologies, the partial mechanization of tasks, new irrigation systems by irrigation, as well as the use of pesticides, herbicides and chemical fertilizers, including the development of evolved varieties of cereals more resistant to pests and also to the harshest climates.

The figure of Norman Borlaug is recognized as the main promoter of the First Green Revolution (Swaminathan, 2009), a scientist who for several decades developed crosses of selected varieties of rice, corn, and wheat in developing countries, to achieve the most productive, seeking with their efforts to improve agricultural productivity in order to eradicate hunger and malnutrition in the most underdeveloped countries. This First Green Revolution in recent history achieved great success for decades and great recognition for achieving a sharp increase in production with high-yielding grains. However, the nutritional quality aspects were not considered with sufficient relevance, generating an expansion of the cultivation of cereal varieties that contained low quality proteins and excessive carbohydrate content, deficiencies in essential amino acids, and an unbalanced content of essential fatty acids. minerals, vitamins, and other essential elements for food quality (Sands et al., 2009). This nutritional impoverishment has generated the increasing incidence of certain chronic diseases, which affect not only the human diet but also the quality of meat products whose food base had been these new varieties of cereals.

At the beginning of the 1990s, new cultivation methods emerged based on the creation in the laboratory by means of certain techniques of genetically modified organisms, also called transgenics, which consist of the transfer between living organisms of genes responsible for certain desired characteristics, affecting their natural structure and, consequently, to its genome. Their application has increased exponentially since their appearance, but since their origin these transgenic crops have generated a huge discussion regarding their real and potential effects, both positive and negative, capable of significantly increasing the productivity of the land, but whose consequences on the Future health of individuals can be unpredictable (Montoya, 2007) (Muñoz, 1999). And likewise, the first outlines of so-called precision agriculture are beginning to be developed, as an innovation capable of reconfiguring farms of all sizes, allowing farmers to use only essential resources, and allocate them where they are needed. The concept of precision agriculture supposes a comprehensive management approach based on the collection and intensive processing of data, which allows orienting certain focused actions to improve the effectiveness,