ORGANIC AGRICULTURE, BIODYNAMIC AGRICULTURE, QUANTUM AGRICULTURE AND PERMACULTURE - DIFFERENCES AND SIMILARITIES

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Abstract. *The world is now turning more and more to ecological, sustainable agriculture, and methods of agricultural production are turning to principles that were in the past, but which are still considered alternatives in most countries of the world. Ecological agriculture realized by methods of biodynamic agriculture, permaculture and quantum agriculture with the use of alternative sources of energy and the preservation of the environment and landscape in general, is becoming a growing need today. The European Commission, following the recommendation of world organizations, prescribed a series of recommendations and developed a series of strategies for each member state, which should reduce the emission of greenhouse gases by 2030 by at least 55%. Significant changes within agricultural production have become a necessary need for sustainable agriculture. The beginnings of different methods of soil cultivation, utilization and recycling (purification) of municipal water, as well as rainwater collection, are just some of the acceptable methods. The appearance of the principles of ecological agriculture, permaculture and quantum agriculture are therefore increasingly becoming the basis of interest and scientific study. The interaction of other sciences within agriculture and food growing is already known, but quantum physics with its laws are increasingly being tried to be implemented in direct methods of agricultural production. What are the differences and what are similarities and how scientists interpret the possible future scenario of sustainable agriculture, as well as the historical development of the mentioned principles and methods, are the topics of this paper. Through a short survey on the knowledge of the term quantum agriculture, more than 70% of respondents of the target group of agronomists and farmers have not encountered this term and do not know the principles of quantum agriculture.*

Keywords*: quantum, the future of agriculture, concepts, digitization.*

INTRODUCTION

Today, within agricultural production, more and more questions arise: how to improve yields, reduce cultivation, eliminate weeds, pests, and diseases, reduce soil degradation, improve crop responses to weather conditions, and how to incorporate carbon dioxide and nitrogen from the atmosphere back into humus in the soil is while remaining competitive on the market and making a profit. In a word, to eat healthily with the maximum possible high degree of preservation of landscape values and saving resources and money. Agriculture based on chemical means, intensive tillage, and low percentage utilization per unit area is no longer sustainable today. The entire agricultural community is trying to find an alternative sustainable system of agriculture, which is ecologically correct, and economically and socially sufficient and, sustainable. The entire world agricultural community is trying to make agriculture sustainable. It must be ecologically correct, economically and socially sufficient, and sustainable. Following the development strategy, agriculture must achieve the following goals in the future: full utilization of soil per unit area in terms of proper distribution of crop cultivation throughout the year, the interaction of plant and animal cultivation with environmental conditions, increase of areas under forests while reducing the cultivation of animals for human consumption, water saving while reducing the consumption of pesticides and other chemical agents for protection and nutrition. Accordingly, new concepts and guidelines in agricultural production appeared, which are the topics of this paper.

MATERIAL AND METHODS

This work relies on the historical development of sustainable and ecological agriculture, the development of Biodynamic preparations, Permaculture, and Quantum-Based Agriculture (QBA), and notes the available significant professional and scientific works related to the terms themselves and highlights their connection. The paper shows the increase of areas in the world that rely on the principles of ecological production and quantum agriculture (PAULL and HENING, 2020). Also listed are biodynamic standards (Demeter Labelling, Production and Processing Standard, 2022) and examples of production according to the principles of quantum agriculture, as well as cultivation methods according to the principles of permaculture. "Sustainable agriculture" is defined as the continuous production of primary agricultural products with the use of permitted chemicals that have an as little harmful impact on the environment and human health as possible, and where ecological effectiveness is more important than economic efficiency. "Permaculture" (MOLLISON and HOLMGREN, 1978) shapes and develops systems of ethical guidelines and principles for planning, designing, and maintaining people's living spaces in harmony with nature. The word "permaculture" comes from the word permanent agriculture (lat. permanent-permanent: to remain; permanent agriculture or stable, sustainable agriculture). "Ecological agriculture" (European Commission, 2022) implies ecological farming, i.e. a method of agricultural production whose goal is food production using natural substances and procedures. "Biodynamic agriculture" or Biological - dynamic agriculture is a form of agriculture that goes beyond the cultivation of crops without pesticides, is related to internal development, and is at the service of the earth and humanity. The name comes from the Latin words bios, meaning life, and dynamic, meaning energy. A circular economy and a unique organism, in which each organ stimulates the other and is made up of people, plants, animals, and the soil (STEINER, 1924). "Quantum-Based Agriculture (QBA)", assumes constant interaction between all system components, relies on the laws of quantum physics, and stimulates the vital energies of processes within agricultural production.

In the end, a short survey was created and processed, which was targeted to selected groups of farmers and experts in the field of agronomy via a Google form.

RESULTS AND DISCUSSIONS

Today, improving yields and protecting plant species without physical and chemical measures is not easy. The rules of the European Union on organic farming cover agricultural products, aquaculture products, and yeast, in all stages of production, from seed to final processed food (Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of ecological products and repealing Council Regulation (EC) No. 834/2007). The European Commission has adopted a series of proposals to make the EU's climate, energy, transport, and tax policies suitable for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. The goals of ecological agriculture are: responsible use of energy and natural resources, maintaining biodiversity, preserving the ecological balance in regions, increasing soil fertility, and maintaining water quality. Using the principles of quantum physics, which states that energy can be emitted and absorbed only in discrete amounts, quanta of energy (PLANCK, 1914), quantum agriculture becomes an agricultural concept inspired by quantum physics and is defined as a constant interaction between all system components, animal or plant farms, and the environment. The agricultural farm is therefore conceived as an organism in which there are soil, animals, and plants, but also the farmer himself, which can be rebalanced at the bioenergetic level, thanks the application of the principles of quantum physics. The creation of "artificial" ecosystems requires the creation of harmony between all components of the

agricultural world in which there is a constant flow of electromagnetic information and vibrations. QBA is based on the theories and concepts of quantum physics and biology that use a particle-wave-based approach (WRIGHT et al 2017). Taking into account biodynamic agriculture, which includes working with life processes ignoring physical matter or chemistry, as well as permaculture as a form of growing plants that serve our nutrition (MOLLISON and HOLMGREN, 1978), it is still necessary to strictly define what will be included in the form of agricultural production in the future. The biodynamic approach emphasizes life processes that have strong organizational (syntropic) effects for engaging minerals and chemical reactions. By applying so-called "biodynamic preparations" life processes are established, increased, and promoted (LOVEL, 2000), but QBA is based on theories and concepts of quantum physics and biology and only the features of biodynamic agriculture, together with more indigenous approaches to agriculture, can claim to be synonymous with QBA (WRIGHT at al 2017). ALBERT VON THAER (1810) declared agriculture to be a branch of the economy that operates solely for profit. Back in 1908, he made the first scientific attempt to evaluate animal feed on a comparative basis and developed "hay values" as a measure of the nutritional value of animal feed. As early as 1924, a group of European farmers who turned to Dr. Rudolf Steiner noticed a sharp decline in seed fertility, crop vitality, and animal condition. In the same year, he held an "Agricultural Course" (Kurs für die Landwirte) which was held on the estate of Count Karl von Keyserlingk in Kobierzyce near Breslau (today's Poland) where 111 farmers were present and where presented working principles and biologically dynamic preparations as the backbone of a new approach to "healthy" and fruitful agriculture (PAULL, 2020). In Australia, in the mid-19th century, farmers encountered large fluctuations in rainfall and drought, which hurt the cultivation of plants and animals. The ideas of Percival Alfred Yeomans, or P.A., to collect and store rainwater and large volumes of farm wastewater, to be naturally treated and used for subsequent irrigation, which until then had been contrary to the government's agricultural development strategies in Australia, they become the backbone of a new view on development and sustainable agriculture. Also, his idea about the organization of the biological environment to increase the fertility of crops and the use of rotary tillage equipment was initially considered unacceptable. His son Ken B. Yeomans H.D.A.A. compiled from his father's work and notes the "Key Plan for Water Management on the Farm" (YEOMANS, 1954), i.e. planning the development of a replacement landscape based on the two most permanent features of the natural landscape: (1) climate, which to a large extent shaped and determined its topography and (2) the existing shape and shape of the land with the fundamental influence of the geological structure of the area. This concept helped to solve priority problems in farm landscape design in Australia. The set "key scale of durability" is the order of planning based on the relative durability of various contents, which together make up the completed landscape and which are contained in the preservation of the climate, the shape of the land, water, the naturalness of access roads, trees and forests, the design of buildings, the preservation of the entire area, and the preservation of the soil (YEOMANS, 1954), and it can be successfully applied in the arrangement of rural as well as urban landscapes. Based on the material first published as 'Kay plan' (YEOMANS, 1954), in 1958 he edits "The Keyline scale of permanence" (KSOP) published in the book The Challenge of Landscape: The Development and Practice of Keyline. This Keyline scale specified a new order of planning based on durability. It includes modified techniques adapted to the new design of agricultural machinery. The basis was a contour line that has unique properties and that passes where the slope at the bottom of the valley increases significantly. Starting from this line, and cultivating parallel to it, both, above the line, and below the line, produced off contour furrows, which selectively drifted water out of the erosion vulnerable valley. He named this contour "The Keyline". The entire system

became "The Keyline System" (YEOMANS, 1993). The author is recognized as a pioneer of new techniques for improving and restoring soil fertility in broad-based agriculture. Keyline methods have shown that poor soil is capable of rapid improvement to a state of deep and active fertility, and the sustainability scale provides a priority guide for planning the various factors considered in landscape design. The designed design is unique for each property, so the plan is always made to measure a specific area. P. A. Yeoman's proposal for the application of the Keyline scale in urban design and waste water disposal first appeared in the book 'The City Forest' published in 1971.Then at the United Nations Habitat Forum at the Conference on Human Settlements (Vancouver, Canada 1976), P. A. Yeomans presented a paper entitled 'Australia's Key Plan for the Enrichment of Human Settlements' which mentioned the need to introduce forest belts around industrial plants and agricultural land as and the need for urban forest design. He proposed the creation of tropical and subtropical rain forests, within the city limits, as parks, as a source of exotic wood, and as a way of economically using the city's wastewater for the benefit of all. Today, the "City Forest" has become a textbook for landscape architects and urban planners. BIRD and TOMKINS (1989) in their book The Secrets of the Soil report (chapter Cosmiculture) a conversation with T. Galen Hierony (mus head of the Advanced Sciences Research and Development Corporation,) who deals with channeling cosmic energy into the earth for the well-being of plants and who says: "All around us is a great sea of energy: cosmic energy, solar energy, lunar energy, planetary energy and the energy of the Earth itself. But, unlike chemicals sold in stores, this energy is free and non-toxic; it is very useful. All we have to do is touch it." The first is research on quantum biology (AL-KHALILI and MCFADDEN, 2014). dealt with the application of quantum mechanics and theoretical chemistry to biological objects and problems. And while biodynamic agriculture and biodynamic preparations emphasize life processes that have strong syntropic effects on the input of minerals and the initiation of chemical reactions, which refers to the processes in the soil and their correlation with the planets Mercury, Venus, and the Moon located between the Sun and the Earth, for the growth and development of plants are equally important and the processes that take place in the atmosphere and where the processes are completely different (photosynthesis, flowering, ripening...). These processes are related to silicon and planets outside the solar system and refer to Mars, Jupiter, and Saturn. Thus, biodynamics can be defined (LOVELL, 2000) as a link between the processes that occur above the ground and those that occur below the surface, affecting the life of plants. LOVELL (2015) claims that the application of quantum principles in agricultural techniques increases the efficiency of inputs and the well-being of animals, while at the same time reducing the negative side effects of cultivation on the environment. He is also considered the founder of the new scientific discipline of quantum agriculture, and together with his wife Shabari Bird is the founder of Quantum Agriculture Consultancy. Citing the claim (ALTIERI, 1995) that if "the scientific basis for industrial agriculture is chemistry, then the basis for sustainable agriculture is agroecology", WHITRIGHT, KIEF and VON DIEST propose that agriculture in the future be based on, or at least aided by, the science of quantum theory.

Permaculture again extends the design of the garden to the house, to domestic animals and birds and uses organic gardening and farming practices, but goes beyond those practices and integrates the garden and home to create a lifestyle that has less impact on the environment. The main difference between permaculture and organic farming is the energy cycle. A farm (field) is a source of energy, and permaculture creates an energy loop. The system within permaculture also sometimes uses native resources that are not certified or seeds from non-native plant species. HILL (1991) argues the essence of permaculture designs. WRIGHT, CAMDEN-PRATT, and HILL (2011) present Social Ecology as providing a holistic

framework for change, based on the interrelationships between the personal, social, environmental, and "spiritual" and describe it as an emerging field of science, and its practices touch upon the skills of design, creativity, traditions, aesthetics, intercultural learning and a multitude of interdisciplinary knowledge, i.e. it deals with the interrelationships between the personal, social, environmental and spiritual.

The differences and similarities between organic and biodynamic agriculture are shown in Figure 1.

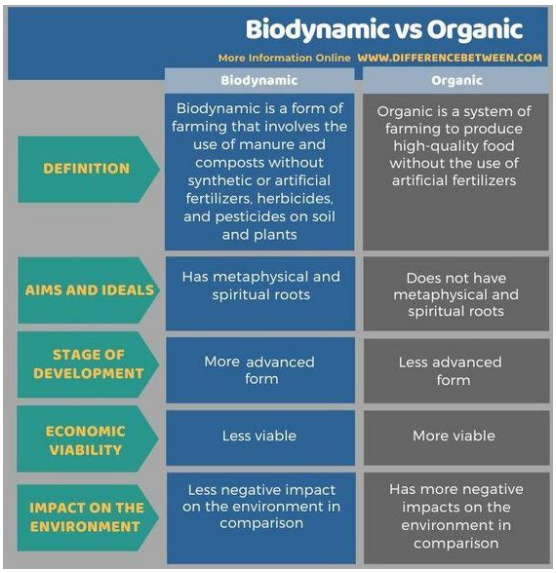

Figure 1. The similarities and differences between organic agriculture and biodynamic agriculture. Source: https://www.pinterest.com/diffbw/

The World Government Summit Organization (2018) launched a report called Agriculture 4.0 - The Future of Agricultural Technology, in collaboration with OLIVER WYMAN for the 2018 edition of the international event. The report looks at four major developments that are putting pressure on agriculture to meet the demands of the future: demography, lack of natural resources, climate change, and food waste. By 2050, due to population growth, 70 percent more food will have to be produced. Today, around 800 million people around the world are starving. According to predictions, 8 percent of the world's population (or 650 million) will still be undernourished by 2030. Farmers will use the minimum amount of water needed and target very specific areas. The report states that farms and agricultural activities will have to be managed differently, primarily due to advances in technology such as sensors, devices, machines, and information technology. The agriculture of the future will use sophisticated technologies such as robots, temperature and humidity sensors, aerial images, and GPS technology. (DE CLERCQ, VATS and BIEL, 2018).

In Croatia, organic agriculture is defined within the Law on Agriculture (OG 118/18, 42/20, 127/20, 52/21) by Council Regulation (EC) no. 834/2007 of June 28, 2007. on organic production and labeling of organic products and repealing Regulation (EEC) no. 2092/91 and the Ordinance on ecological agricultural production (OG 19/2016). Rudolf Joseph Lorenz Steiner (1861-1925) was born in Donji Kraljevac (Croatia). He say: „Try to become one with the world—that will be the best and most important 'program.' It is something that cannot be contained

in statutes but needs to burn in our hearts as a flame."(SELG. 2019). The Dr. Rudolf Steiner Center was founded in 2007 in Donji Kraljevac (Croatia) and is a multidisciplinary institution that combines science, art, and tourism based on the science and knowledge of Dr. Rudolf Steiner. Certification of products and biodynamic preparations is carried out in Slovenia according to Demeter standards (International Standard for the use and certification of Demeter, Biodynamic and related trademarks, Production, Processing and Labeling, 2021), while certificates for advisors in biodynamic agriculture are awarded by the Center. In 2015, the association "Croatian Permaculture" in cooperation with the Permaculture Association (Britain) launched a scholarship fund for permaculture teachers. Today, all associations dealing with permaculture are united on the Internet through Perform (https://www.perforum.info/). The portal is edited and managed by the international network for the development of permaculture in the Balkans. After the 72-hour permaculture design course (eng. 72-hours Permaculture Design Certificate course; abbreviated PDC) a diploma is obtained.

In a short survey that was conducted on a Google survey form and was aimed at the target groups of farmers and highly educated agronomists, and in which 202 respondents participated, the question was asked: Are you familiar with the concept and practice of "Quantum agriculture", 77.2% of the respondents answered that they are not familiar with the concept and practice of quantum agriculture, and only 24.8% of respondents answered positively (Figure 2).

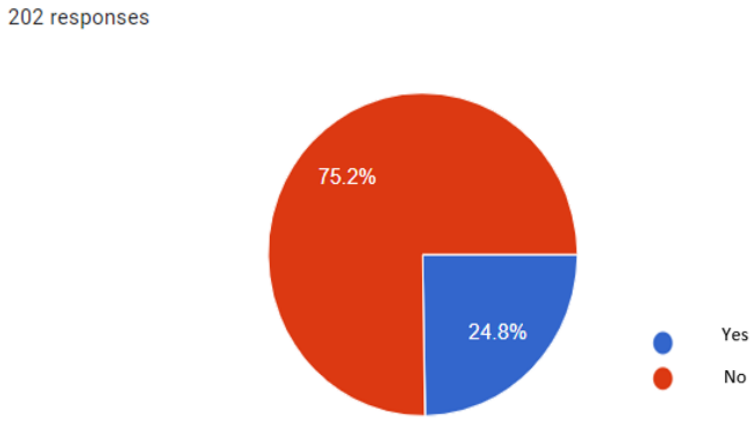

Figure 2. The result of the survey
Source: Author, 2022.

CONCLUSIONS

Climate change, rapid population growth, and problems in the exploitation of natural resources are becoming a threat to the survival of humanity. Demand for food is increasing at the same time that supply faces constraints in terms of land and agricultural inputs. Therefore, sustainable development, sustainable agriculture, and food production, in general, are topics that the global social community deals with. Some see the future of agriculture as an ecological approach to food production. While one part of scientists advocates the development of agriculture in interaction with natural processes that are connected to the soil, but also with energy coming from space, others are oriented towards new technologies that imply the introduction of IT technologies in agriculture and the replacement of human workers with

robots. The common goal is to encourage more ethical and sustainable practices on farms, such as higher standards for the welfare of domestic animals and reduced use of chemicals and water, as well as the introduction of digitization in agriculture. Although the models of biodynamics, permaculture, and quantum physics are slowly approaching the laws of ecological food production, most farmers and the majority within the profession are more inclined to accept modern technologies. Only 24.8 respondents of the target groups of farmers and professionals know about new knowledge in agriculture, such as methods of applying quantum physics in quantum agriculture, while 75.2 percent of them have never heard of this term and practice.

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