VII. ECOLOGICAL AND SUSTAINABLE AGRICULTURE

PROBLEMS AND PERSPECTIVES IN ORGANIC CULTIVATION OF CEREALS – OVERVIEW

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Abstract: In this study, an overview is made and a comparative analysis of articles, reports and materials dealing with organic farming of LWC, in the period 1970 to 2021 is performed. After analysing the literature, the following conclusions are made:
Cereals occupy a particularly important place in organic farming, the main advantages of their cultivation are easy farming techniques, relatively easy mechanical weed control, disease control through rational crop rotation, opportunities for biological control of major pests.
The soils in organic farming are better structured than those in conventional agriculture. Organic farming practices are related to improving soil properties, including the addition of organic matter to the soil, increasing the population of earthworms, biodiversity, soil fertility and more. Biological management provides a more stable soil structure. The larger pores observed in biological management have a beneficial effect on the physical properties of the soil, such as water flow and water capacity. The greater porosity of the soil provides a good habitat for soil microorganisms. Organic farming contributes to creating a better soil structure.
Organic farming systems have traditionally been based on crop rotation. The aim of organic farming is to achieve a balance between crops that reduce soil fertility and crops that restore fertility. Crop rotation is the main tool that integrates the maintenance and development of soil fertility with various aspects of plant production in biological systems.
Specialised selection programmes for creating varieties suitable for organic farming are too few due to the small number of users and high costs. The most common practise includes testing the suitability of conventional varieties in biological conditions, propagation and distribution of the best in the biological sector.
Sowing norms directly control the sowing density, as well as the nutrient area of each plant. Changing sowing rates is also an excellent method for controlling weeding in biological fields.
Concerning yields from organic and conventional agriculture, organic farms are less productive than conventional ones and their productivity is lower. But if environmental variables are taken into account, organic farms show the same or higher efficiency.
A major problem facing organic farming in the future is the protection of fields from pollution by genetically modified organisms. An option for protecting biological fields is to maintain a buffer zone between the farm and the neighbouring conventional fields to prevent accidental contamination with GMOs.

Keywords: organic farming; cereals, sustainable agriculture.

INTRODUCTION

The responsibility to feed a growing population has led to remarkable changes in the way we produce food and to the emergence of the so-called 'Green Revolution', also known as the conventional agricultural system [1]. This "revolution" has led to drastic changes in the production and processing of food products worldwide. Established by centuries of production methods gave way to modern forms of agriculture and processing, which proved to be much cheaper against the background of growing demand. It was not long before the first symptoms of ill health appeared in these technologies. Industrial and high-intensity agricultural systems contribute in part to climate change – directly and indirectly, to the eventual loss of parts of the pristine nature, of human health, of culture, of history, of human life [2].

Organic farming shows clear environmental benefits in terms of environmental toxicity and the use of biological resources [3]. It is, albeit small, a link in the chain of activities aimed at protecting natural resources and human and animal health. Therefore, this agricultural system is a priority in the future [4]. Based on current and relevant studies, long-term application of organic farming also increases species diversity [5]. Although more studies are needed on the effect of organic farming on agroecocenoses, studies have shown its positive impact on increasing biodiversity [6, 7]. Hole et al. (2005) [7] found that some management practices specific to organic farming systems are particularly favourable for wildlife – reduced use of fertilisers and pesticides and proper management of uncultivated habitats.

MATERIAL AND METHOD

This study provides an overview and comparative analysis of articles, reports and materials published on the Internet in the following scientific databases

doi.org/10.32006/eeep.2021.2.0511

Scopus, ResearchGate, Google Scholar. The study also analysed publications in the specialised database OganicEprints, https://orgprints.org. A search in the scientific and specialised databases used a combination of keywords with logical queries for the period from the early 70s of the last century to 2021. The main Latin keywords that are used are "organic wheat", "organic production" and "cereals", "organic fertilizing" and "organic cereals", "sustainable farming" and "cereals" "organic wheat", "organic production" and "yields","organic wheat" and "weed control","pest control". The following keywords are used in Cyrillic: "organic farming" and "cereals", "weeding" and "organic farming", "fertilisation" and "nitrogen nutrition" and "organic farming".

RESULTS

Concept and principles of organic farming

Organic farming is emerging due to the problems of the environment and health of future generations. It is borrowed from nature itself and strives to be in harmony with it without harming it. Organic farming does not allow the use of mineral fertilizers, pesticides, growth regulators and feed additives and in which to maintain and improve soil nutrition relies on crop rotations, crop residues, manure, green manure and organic plant protection [8]. Crop protection strategies in organic farming are preventive and curative, and aim to prevent insect, disease and weed problems by optimising the cultivation system as a whole [9].

Organic cultivation of cereals

Cereals occupy a particularly important place in organic farming. They are the main field crops from which baby and diet foods are produced and are in great demand both on our and the international market. Organic products include bread, cereals, biscuits, baby food and many other products [10].

The main advantages of growing these crops are easy farming techniques, relatively easy mechanical weed control, disease control through rational crop rotation, opportunities for biological control of the main pests [11, 12, 13]. Despite the realisation of lower yields from organic farming, the purchase prices of the produced products are higher than those produced in conventional agriculture and compensate for the lower yields. The average prices of organically produced wheat are 30%-50% up to 200% higher than those for the conventional one [14, 15, 16, 17]. In the Republic of Bulgaria are successfully grown naked and husky oats, naked and husky barley, soft and durum wheat, rye, triticale and other cereals, whose grain, produced organically is widely used for the production of various types of food [2].

Maintenance of soil fertility and the application of reduced tillage

In organic farming, the main challenges are to improve nutrient management and increase yields [18]. The organic farming system differs fundamentally in the level of soil fertility, in the control of pests, diseases and weeds, and has higher requirements for the quality of production and the stability of yields than in conventional agriculture [19]. Organic farming does not allow mineral fertilizers as well as pesticides and the main goal is to maintain a permanently closed food cycle on farms, to protect the quality of the environment and to improve favourable biological interactions and processes [20].

Another critical aspect in the organic cultivation of cereals is the maintenance of soil fertility and the benefits it gives to the soil, plants and the quality of the products produced. Nitrogen (N) deficiency is a major problem in organic farming systems. [21]. Long-term application of animal manure improves soil quality, accumulates more organic matter and microbial biomass, thus improving the nutrient cycle in this agricultural system [22]. Organically grown soil has a significantly higher content of organic matter, a stronger soil horizon, a higher content of organic carbon, a lower modulus of destruction and less soil erosion compared to conventionally grown soil. Many studies have shown that organic farming systems regularly lead to a positive N balance (i.e. input is greater than exports) [24, 25]. Simultaneously, there is sufficient evidence to show that reducing the intensity of use and application of reduced tillage in the organic farming system increases the resilience and quality of the soil and protects it from erosion [26, 27, 28]. In a ten-year experiment related to reduced tillage in organic farming, Armengot et al., (2014) [29] found that reduced tillage did not affect yields compared to conventional tillage and maintained the level of weeding on the farm. at acceptable levels. Baldivieso-Freitas et al., (2015) [30] also concluded that reduced tillage along with manure fertilisation did not adversely affect cereal yields. Organic farming systems seek to keep the soil covered with plants for most of the year to optimise nutrient management [31, 32]. According to Büchi et al. (2018) [33] with the right selection of the cover crop, even when used and for only two months, it could drastically increase the content of organic carbon and total nitrogen in the soil when the cover crop is sown between two winter wheat crops, as it keeps weeding low even in conditions of reduced tillage. The same author believes

that it is best to use legumes along with reduced tillage. Therefore, the main purpose of growing cover crops in the organic farming system is for them to act as a nitrogen-fixing crop between the main crops to increase soil fertility and minimize nutrient loss through erosion [31, 34]. A particular challenge for the organic farming system is to examine the extent to which reduced tillage can increase soil fertility without imbalanceing other aspects of management, such as weed control [26]. Hofmeijer et al., 2019 [35] considers that reduced tillage can provide equivalent and even higher yields compared to conventional tillage in organic winter wheat cultivation if weed management is improved and good nutrient supply. In the long term, the organic farming system is more efficient than the traditional agricultural system in reducing soil erosion and therefore in maintaining soil productivity [36]. Another critical aspect of organic farming is that the cultivated soils have a higher content of organic matter and provide a more stable soil structure compared to conventionally cultivated soils. Soils in organic farming are better structured than those in conventional management. Organic farming practices are related to improving soil properties, including the addition of organic matter to the soil, increasing the population of earthworms, biodiversity, soil fertility and more. Biological management provides a more stable soil structure. The larger pores observed in biological management have a beneficial effect on the physical properties of the soil, such as water flow and water capacity. The greater porosity of the soil provides a good habitat for soil microorganisms. Organic farming contributes to the creation of a better soil structure for plant production [37, 38]. This supports the notion that there is a greater potential for improving soil structure in biologically treated soils than conventional management [39, 40].

Compilation of correct crop rotations

Organic farming systems have traditionally been based on crop rotation. The goal of organic farming is to achieve a balance between crops that reduce soil fertility and crops that restore fertility [25, 41]. Crop rotation is the main tool that integrates the maintenance and development of soil fertility with the various aspects of plant production in biological systems [24]. The results show that longer crop rotations with more phenologically diverse crops can reduce populations of important deciduous weed species in organic farming systems [42]. In this sense, the establishment of proper crop rotation is an important issue because of its impact on the management of soils, nutrients, pests and weeds [43]. Another critical aspect of crop rotations is that they can overcome the negative effects of water stress, which plants experience in insufficient rainfall during their growing season. Of great importance is the choice of a suitable predecessor. In the conditions of climate aridization, crop rotations are beginning to play an increasingly important role [44, 45]. The proper crop rotation allows better absorption of soil moisture and significantly prevents the negative effects of drought [44, 45, 46, 47; 48, 49]. Properly constructed crop rotations, in accordance with the agro-ecological conditions and the production direction of the farm, are the basis for the effective use of other factors – tillage, fertilisation and plant protection measures in the cultivation of crops [46, 47, 48, 49, 50, 51]. According to Stamatov et al., (2014) [52] the best precursors of cereals are field cereals (peas, lupine, borchak, axe, chickpeas, beans, soybeans, peanuts, etc.). They enrich the soil with nitrogen, harvest early and allow timely and quality pre-sowing preparation of the area. The main disadvantage of non-tillage legumes is that they allow the multiplication of weeds at the end of their vegetation, which leads to the accumulation of a stock of weeds in the soil. Trench crops are a good precursor, especially for autumn sowing. They leave the soil free of weeds and bring it to a suitable structural condition for sowing the next crop, with less tillage. Sunflower, corn, rapeseed and vegetable crops can serve as predecessors in this respect. The use of other cereals as precursors is not recommended, as they unilaterally deplete the soil and are attacked by the same diseases, weeds and pests.

Use of suitable varieties for organic cultivation of cereals

At this stage, the specialised selection programs for the creation of varieties suitable for organic farming are too few due to the small number of users and the high costs. So far, the most common practise includes testing the suitability of conventional varieties in biological conditions, propagation and distribution of the best in the organic sector. The environmental conditions in organic farming are much more diverse than in traditional agriculture, so the varieties that are created for its needs must be much more adaptable and durable, and the stability of the yield is much more important than its size. [14, 55]. Research aimed at selecting suitable varieties and their seed production for the needs of organic farming is the most limited, although the variety is a key factor for the success of any crop system, incl. and biological [54]. It is estimated that more than 95% of the organic production of cereals is based on varieties of crops grown for the conventional sector. Recent

studies show that such varieties do not have the qualities to grow in organic production. This is mainly due to the selection in conventional programmes, which occurs against a background of high inorganic fertiliser inputs and crop protection [55]. In order for cereals to perform better in organic farming, it is necessary to select genotypes with high nitrogen uptake efficiency, weed competitiveness and disease resistance [56].

The choice of cereal varieties suitable for organic farming requires a different but complementary approach to that used in the development of crops for conventional systems. Some key characteristics generally applicable to organic cereals include: good adaptability, high cultivation ability, increased plant height, good cover ability, to provide sustainable yields. The data show that the dense cover of the soil surface of the crop is one of the most important characteristics for weed control and stable yield. Organic varieties should have good germination energy and ensure that plants germinate together in different climatic conditions, as well as have good community [57].

According to the rules of organic farming, it is necessary to use only those crops most suitable for the local conditions of the farm [58]. It is necessary to select those crops and varieties, which are most resistant to diseases, pests and weeds [59]. In organic farming, farmers use more diverse varieties and types of cereals than their conventional counterparts. Various cereals are used mainly for human consumption, they create a great variety of organic foods. Probably the most widespread alternative cereal is einkorn, which has already found its place on organic farms and among consumers [60]. Einkorn is an alternative for farmers who can include another crop in their crop rotations, which would guarantee them a stable yield in conditions of abrupt climate change. Due to its advantages, einkorn is not only an extremely valuable plant, as a healthy product with high biological value, but its cultivation does not require the use of plant protection products and mineral fertilisers [61]. During a three-year comparative experiment in the period 2013–2016 on experimental fields of the Institute of Agriculture in Karnobat, Bulgaria, to establish the phytosanitary condition and yield of wheat (Triticum aestivum) and einkorn (Triticum monococcum), grown in organic and conventional Maneva and Atanasova (2018) [62] found that einkorn is more diseases-resistant, pests and weeds than wheat in both farming systems and is more suitable for growing in organic farming. These facts make production at an extremely low cost and give the crop an advantage over others in the system of sustainable agriculture [52]. One-grain einkorn (*Triticum monococcum*), two-grain einkorn (*Triticum dicoccum*), naked barley (*Hordeum vulgare L. subsp. Vulgare conv. Celeste; Hordeum vulgare subsp. Distichon L. Koern. Convar. Nudum*), naked oats (*Avena sati*). Nudae Mordv. Khorasan wheat (*Triticum turgidum*), spelt (*Triticum spelta*) and rye (*Secale cereale*) are beginning to be rediscovered by consumers. Varieties more resistant to lodging and to some economically important diseases suitable for organic cultivation are used.

The use of large species and varietal diversity of crops in organic farming has many advantages over the monoculture sowing of fields in conventional agriculture. The greater the biological diversity of a community of organisms, the greater the stability of that community [63]. Biodiversity, in the organic system of agriculture, through various ecological processes could help balance it, such as regulating the microclimate, the circulation of nutrients, pollination, biological pest control and others [62, 64, 65, 66]. This supports the thesis of the role of different plants and the behaviour of insects in species-diverse crops. "Association Resistance", according to which a plant species growing at the same time as other plant species will suffer less from attacks than plant species that are alone. Pests in monocultures have more suitable conditions for developing their populations due to the weaker ecological response of these crops compared to that of species-diverse crops [67]. This is confirmed by other authors who recommend increasing the role of specific and polyphagous predators in cereal crops next to them to grow annual and perennial grasses, nectar-bearing plants, shrubs [68, 69, 70, 71]. These cultures create conditions for additional nutrition and hosts on which to enter the entomophagous. In the conditions of organic farming, weeds at relatively low density can play a positive role in the form of provided food (habitat for living) for the beneficial organisms found in the agrobiocenosis [69, 72, 73]. Encouraging natural enemies by growing flowering plants on which the adult forms of some predators and parasites feed are an effective method of pest control in biological systems. However, it is important to determine which plants are most effective in attracting suitable insects for the most effective pest control [74].

Use of different sowing norms in organic cultivation of cereals

Sowing rates directly control crop density as well as the nutrient area of each plant [75]. Changing sowing rates is also an excellent method for

controlling weeding in biological fields. Maneva et al. (2012) [76] report that in the conditions of organic wheat cultivation the yield is not affected by the sown number of seeds, but in the increased sowing rates there is a reduction of weeds and aphid infestation, but this does not significantly increase the yield. Under the conditions of organic cultivation of cereals, significant problems constantly arise in satisfying the quality of production. Increasing the distance between the rows of winter wheat from 12.5 cm to 50 cm proved to be favourable for the values of indirect quality parameters and the content of gluten and crude protein in winter wheat. Due to the increased risk of erosion and to improve the value of the previous crop, it is necessary to create a green area with legumes between the rows [77]. Mazo et al., (2006) [78] concluded that in organic farming, excellent results are obtained with the combined cultivation of spring wheat or triticale with lupine, and this combination improves the protein content of the seeds and eliminates the need for nitrogen. fertilisation, as lupine has an excellent nitrogen-fixing ability and thus enriches the soil with nitrogen.

Yields in organic cultivation of cereals

Concerning yields from organic and conventional agriculture, it was found that organic farms are less productive than conventional ones and their productivity is about 20% lower. However, if environmental variables are taken into account, organic farms show the same or a higher degree of efficiency [79]. De Ponti et al., (2012) [80] in their study on the efficiency of organic and conventional farming in terms of yields also concluded that organic farming is about 20% less efficient than conventional farming. Alaru et al. (2014) [81] found that yields in organic farming decreased by 25%-33%, while Arncken et al. (2012) [82] in three years of comparative experience of organic and conventional winter wheat cultivation found 42% difference between yields in favour of conventional agriculture. And according to Uhr et al. (2017) [53] the yield in the best organic farms is 20%-30% lower than the conventional one. Cereal yields are usually 60%–70% of those in conventional agriculture [15, 77, 83]. Great variation in yield results from different meteorological conditions over the years, field history and differences in agricultural techniques [84,85].

Protection against GMO contamination

One of the main problems facing organic farming in the future is the protection of fields from pollution by genetically modified organisms. This is considered a serious risk, especially by grain farmers [86]. An option to protect biological fields is to maintain a buffer zone between the farm and adjacent conventional fields to prevent accidental contamination [87].

CONCLUSION

Cereals occupy a particularly important place in organic farming, the main advantages of their cultivation are easy farming techniques, relatively easy mechanical weed control, disease control through rational crop rotation, opportunities for biological control of major pests.

The soils in organic farming are better structured than those in conventional agriculture. Organic farming practices are related to improving soil properties, including the addition of organic matter to the soil, increasing the population of earthworms, biodiversity, soil fertility and more. Biological management provides a more stable soil structure. The larger pores observed in biological management have a beneficial effect on the physical properties of the soil, such as water flow and water capacity. The greater porosity of the soil provides a good habitat for soil microorganisms. Organic farming contributes to creating a better soil structure.

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