UDC 575
DOI: 10.2298/GENSR1201201K
Review paper

MODERN TRENDS IN THE DEVELOPMENT OF AGRICULTURE AND DEMANDS ON PLANT BREEDING AND SOIL MANAGEMENT

Dusan KOVACEVIC[1,,3] and Branka LAZIC[2,3]

[1] Faculty of Agriculture, University of Belgrade, Zemun, Serbia
[2] Faculty of Agriculture, University of Novi Sad, Serbia
[3] Academy of Engineering Sciences of Serbia, Belgrade, Serbia

Kovacevic D. and B. Lazic (2012): *Modern trends in the development of agriculture and demands on plant breeding and soil management* - Genetika, Vol 44, No. 1, 201 -216.

Agriculture is usually developed as much and just society where there is a branch of the economy. Today, there are different directions from industry agriculture to many concepts based on ecological principles. Future of agriculture development in the XXI century will imply sustainable agriculture as the alternative to the industrial agriculture.

Conventional agriculture as an intensive one has a duty to ensure maximum production in terms of quantity and quality with the low cost. For this purpose we have many cultural practices, sometimes in addition to the expected positive but sometimes with many unexpected long-term negative effects in agroecosystems.

Corresponding author: Dusan Kovacevic, Faculty of Agriculture, Nemanjina 6, 11080 Zemun, Serbia. Phone: +381 11 2315615 , email: dulekov@agrif.bg.ac.rs;

Organic agriculture is one of the most interesting current trends in agriculture completely based on strong ecological principles and the absence of application of agrochemicals (pesticides, fertilizers, hormones), GMO, etc. Organic agriculture is a holistic way of farming: besides production of goods of high quality (better flavor, high content dry matter, vitamins, antioxidants); conservation of the natural resources (soil, water) and richness of biodiversity.

Key words: biodiversity, biodynamic agriculture, breeding challenges, conventional (industrial) agriculture, organic farming, sustainable development

INTRODUCTION

At the end of the second, and at the beginning of the third millennium, the presence of new philosophies and views are present. They are based on future development of agriculture. It is obvious that development of the agriculture in new millennium will depend on new technologies in crop production and plant protection. Those technologies would bring better equilibrium and stability of natural conditions inside of agricultural system (soil, water, climate, natural vegetation).

Sustainable agriculture is an exact example of anticipated concept of future development of agriculture in general. Term "sustainable agriculture" could be defined differently from country to country. It depends on ecological, economical, sociological or political starting points, or on person(s) who will speak about it. When agriculture is a subject of discussion, all of those aspects are interactive. Usually it can be defined as a direction of agricultural development. It needs to secure satisfaction stability of food production and plant production used in other technical purposes, with respect to basic natural resources, energy, ecology, economical efficiency and profitability in the same time.

The most important thing regarding a global sustainable system is to avoid conflict between economy and ecology as two opposite goals. Global considerations about this problem lead to first concrete results. These results guide unloading of world's conventional (industrial) production. Industrial agriculture depends on expensive inputs from off the farm (e.g., pesticides and fertilizer), many of which generate wastes that harm the environment; it uses large quantities of nonrenewable fossil fuels and it tends toward concentration of production, driving out small producers and undermining rural communities. Resource-intensive agricultural practices are considered unsustainable for two reasons: much of the consumption is of nonrenewable resources, in particular, fossil fuels and consumption of some renewable resources is occurring faster than the rate of regeneration.

The bad characteristics of that kind of development may be slowly directed to the alternate directions of development, based on biological foundations. The proliferation of factory-style animal agriculture creates environmental and public health concerns, including pollution from the high concentration of animal wastes and the extensive use of antibiotics, which may compromise their effectiveness in medical use.

Transition from industrial agriculture (intensive cultural practices, feedlot farming etc.) with intensive technologies of crop production (conventional tillage, usage of huge amounts of fertilizers and pesticides, GMO, hormones and antibiotics), to sustainable systems takes over low-input technologies (KOVACEVIC, 2004b; KOVACEVIC *et al*., 2004c) as result of domination of ecological paradigm.

Developing a sustainable economy involves more than just a sustainable food system, and the food system involves more than just agriculture. However, because agriculture can have such profound effects on the environment, human health, and the social order, it is a critical part of any movement toward sustainability.

The productive and ecological parameters are requiring in search of new sources and solutions for the best technological production of field crops and especially of vegetable crops. Those solutions would represent more flexible agro-technology which may interact by connection of well-known conventional methods as well as by modern technologies. To achieve the high standards as well as ecology parameters and given qualities would be the most important goal in the future. The main goal of this paper is to give readers the new survey of research aspects in crop production as well as to inform them about many conventional subsystems which are still used in our country and in all world. The other goal is to find possible rationalities in intensive land production.

CONVENTIONAL (INDUSTRIAL) AGRICULTURE

Today's conventional or industrial agriculture based upon high inputs is considered unsustainable because it is similarly eroding natural resources faster than the environment can regenerate them and because it depends heavily on resources that are nonrenewable (e.g. fossil fuels and fossil aquifers). Industrial agriculture depends on expensive inputs from off the farm (e.g. pesticides and fertilizer), many of which generate wastes that harm the environment. It uses large quantities of nonrenewable fossil fuels and it tends toward concentration of production, driving out small producers and undermining rural communities. The following environmental and public health concerns are associated with the prevailing production methods: monocultures are eroding biodiversity among both plants and animals, synthetic chemical pesticides and fertilizers are polluting soil, water, and air, harming both the environment and human health, soil is eroding much faster than it can be replenished, water is consumed at unsustainable rates in many agricultural areas.

In that half-century of ascendance, industrial agriculture has substantially increased crop yields through high-yielding plant varieties, mechanization, and synthetic agrochemical inputs. Humans have practiced agriculture for more than 10.000 years, but only in the past 50 years or so have farmers become heavily dependent on synthetic chemical fertilizers and pesticides and fossil fuel-powered farm machinery. Fossil fuel energy is also a major input to industrial agriculture.

The grain raised to supply feedlots (cattle) and factory farms (chickens, hogs, veal calves) is grown in intensive monocultures that stretch over thousands of hectares, leading to more chemical use and exacerbating attendant problems (e.g., pesticide resistance in insects, and pollution of surface waters and aquifers by herbicides and insecticides). The use of growth-promoting antibiotics in animal agriculture is thought to be one of the factors driving the increase in antibiotic resistance in humans. In addition, the most prevalent foodborne pathogens are overwhelmingly associated with animal products, most of which come from factory farms and high-speed processing facilities. The crowded conditions in factory farms, as well as many of their production practices, raise ethical concerns about the inhumane treatment of animals.

Gases from animal manure at factory farms create potential human health risks for workers and residents living downwind, and manure runoff can damage local water quality by overloading it with nutrients, particularly phosphates.

Human exposure to pesticides can come through residues in food either on or within fruits and vegetables, or in the tissues of fish and animals we eat through contaminated drinking water, and through the air we breathe.

Industrial agriculture also endangers soil health because it depends on heavy machinery that compacts the soil, destroying soil structure and killing beneficial organisms in the soil.

Agriculture accounts for about two-thirds of all water use worldwide, far exceeding industrial and municipal use. Agriculture affects water resources in two ways: irrigating fields using surface waters or aquifers diverts water from other potential uses; and when farming practices pollute surface waters and aquifers, they reduce the amount of water that is suitable for other uses. In many parts of the world, irrigation is depleting underground aquifers faster than they can be recharged.

Agriculture is dependent on biodiversity for its existence and, at the same time, is a threat to biodiversity in its implementation. One way that agriculture depends on biodiversity is in developing new varieties of plants that keep pace with ever-evolving plant diseases. In order to find a resistance gene to improve a domestic variety, plant breeders sometimes cross-breed the variety with a wild relative. However, because they are under pressure to bring a product to market quickly, plant breeders usually search for a single gene that confers resistance. This practice is risky.

The practice of monocropping or monoculture planting the same crop over a large land area creates greater necessity for quick-cure plant breeding. Insect pests and plant diseases are both aided by monocropping if a crop variety that may be susceptible to a plant disease or insect pest is planted contiguously and in great volume.

Industrial agriculture erodes biodiversity not only because it favors monocultures but also because those monocultures replace diverse habitats. Another threat to biodiversity is the continued consolidation of the seed industry and the effect it is having on the availability of nonhybrid plant varieties. Large seed companies tend to rely on first-generation hybrids because they force growers to buy new seed every year. As the industry has consolidated, traditional varieties have been removed from seed catalogs at an alarming rate.

The dependence of industrial agriculture on synthetic chemicals has reduced biodiversity in the insect world, as well. Pesticides kill wild bees and other beneficial species that are nontarget victims.

The growth from 1.7 million hectares of biotech crops in 1996 to 148 million hectares in 2010 is an unprecedented 87-fold increase, making biotech crops the fastest adopted crop technology in the history of modern agriculture. (CLIVE 2010).

Main considerations of Genetically Modified Crops use for plant protection are possibilities of incorporation of resistance in protection from insects, viruses, with stress to the main problem of long-term resistance. Genetically Modified Crops have been defined as genetically engineered to contain traits from unrelated organisms. In traditional plant breeding, a desired trait must be obtained from a closely related species that will breed with that plant through natural mechanisms, but genetic engineers can search for the desired trait anywhere in the plant or animal kingdom. Introducing genes into crops in this novel way raises ethical, environmental, and health concerns.

POSSIBILITIES FOR ADAPTION CULTURAL PRACTICES IN CROP TECNOLOGY BASED ON SUSTAINABLE DEVELOPMENT CONCEPT

One of the goals of the sustainable agriculture movement is to create farming systems that mitigate or eliminate environmental harms associated with industrial agriculture. That aim can be realized only in flexible cultural practices in real agroecological conditions (different regional characteristics, soil types, adapted cultivars for low-input or organic production).

Greater adoption and refinement of low-external input (LEI) farming systems have been proposed as ways to ameliorate economic, environmental and health problems associated with Conventional Farming Systems (LEIBMAN and DAVIS, 2000, OLJACA *et.al.*, 2000). Agricultural producers invested their hopes in the development of sustainable agriculture, a concept that should rely on the breeding of low-input cultivars and cutbacks in production costs. As far as wheat is concerned, we have developed in Serbia several low-input cultivars of winter wheat. Research carried out by KOVACEVIC *et al.,* 2010 (Table 1) has shown that low-input cultivars according to previous experience (Pobeda, Francuska, Lasta, NS Rana 5) positively responded to reduces in tillage systems and different nitrogen amount in side-dressing. Growing practice with certain reduction of tillage, nitrogen fertilizer and weed control was more favourable for low-input cultivars which positively responded by their higher yield 3.24 ha^{-1} compared with two cultivars created for intensive high-input technology (Pesma, Rana niska) 3.04 t ha^{-1}. These results demonstrate potential new technologies comprehend higher flexibility of cultural practices (soil tillage, fertilization, integrated weed management, crop rotation) with proper choice of wheat cultivars adapted to these conditions.

Table 1. Effects of different inputs in winter wheat technology on grain yield some cultivars (t ha^{-1}).

Tillage systems (A)	Nitrogen amount (B)	Cultivars (C)						Average	
		Low-input			High-input				
		Pobeda	Lasta	Evropa	NS rana	Pesma	Rana	AB	A
Conventional tillage	control	2.52	2.46	2.69	2.54	2.56	2.57	2.56	4.03
	60 kg ha^{-1}	3.59	3.82	3.55	3.51	3.61	3.99	3.68	
	120 kg ha^{-1}	6.08	5.80	5.95	6.14	5.70	5.48	5.86	
Average	AC	4.06	4.03	4.06	4.06	3.96	4.01		
Mulch tillage	control	2.09	2.25	2.59	2.24	2.03	1.72	2.15	3.13
	60 kg ha^{-1}	3.03	2.90	2.75	2.71	2.82	2.50	2.78	
	120 kg ha^{-1}	4.30	4.04	4.66	4.46	4.44	4.88	4.46	
Average	AC	3.14	3.06	3.33	3.14	3.10	3.03		
No-tillage	control	1.79	1.48	1.59	1.50	1.49	1.41	1.54	2.37
	60 kg ha^{-1}	2.42	2.66	2.13	2.10	2.13	1.80	2.21	
	120 kg ha^{-1}	3.54	3.74	3.66	3.44	3.04	2.69	3.35	
Average	AC	2.58	2.63	2.46	2.35	2.22	1.97		
Average	BC	2.13	2.06	2.29	2.09	2.03	1.90	2.08	B
		3.01	3.13	2.81	2.77	2.85	2.76	2.89	
		4.64	4.53	4.76	4.68	4.39	4.35	4.56	
	C	3.26	3.24	3.29	3.18	3.09	3.00	3.18	
		3.24			3.04				

LSD	0.05	0.01		0.05	0.01		0.05	0.0
A	0.112	0.148	AB	0.275	0.364	ABC	0.476	0.63
B	0.112	0.148	AC	0.194	0.25			
C	0.159	0.210	BC	0.275	0.364			

ORGANIC AGRICULTURE

A need for healthier environment and numerous negativities caused by present conventional agriculture have led to the trends of the future development of agriculture based on the complete absence of chemistry, among which is the so-called organic agriculture. Organic production represents the holistic production management system of agricultural, food and other products, which combines a good agricultural practice, high degree of biological diversity (biodiversity), conservation of natural resources, application of high standards of animal welfare and production mode in accordance with the preferences of certain consumers for the products whose production uses natural substances.

Organic agriculture is popularly defined as agriculture which does not use mineral fertilisers and pesticides. However, it is essentially much more than that. According to the definition given by the Council Regulation (EC) No. 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing

Regulation (EEC) No. 2092/9, organic production represents a holistic production management system of agricultural, food and other products, which combines a good farming practice, high degree of biological diversity (biodiversity), conservation of natural resources, application of high standards of animal welfare and mode of production in accordance with the preferences of certain consumers for the products whose production uses natural substances.

The principle of precaution, prevention and responsibility are emphasised in organic farming as the key factors in the management and development of organic agriculture. Science is necessary to ensure the conditions that organic food is of high quality, safe and eco-friendly. Practical experience, accumulated knowledge and tradition as well as local knowledge offer acceptable solutions which are tested by time. Organic agriculture should avoid serious risks by accepting suitable technologies, and rejecting unpredictable ones such as, for example, genetic engineering (LAZIC and SEREMESIC, 2010b).

Today, it is absolutely certain that in Serbia as well as in the world organic agriculture is best developed at a small and medium-sized family farm and creates opportunities to most farmers, not only for the survival but for the development as well, generating economic and ecological profit. It is particularly evident within the multifunctional organic agriculture.

Organic agriculture as a model of sustainable agriculture contributes to:

- quality and safety of food,
- biodiversity conservation,
- greater energy efficiency,
- more prominent degree of multifunctionality.

Quality and safety of food. Organic food is a product of organic agriculture and according to its main biochemical characteristics it corresponds to the given species and cultivar. Nevertheless, the implementation of ecological agrotechnical measures contributes to a manifestation of more valuable food components particularly from the group of secondary matters. The right choice of the species and cultivar for the given region contributes to higher nutritional value of organic food. Organic fruits and vegetables of everyday meal, have a natural taste, smell and colour, characteristic of a species and cultivar, and higher dry matter content (around 25%), vitamin C content (around 28%), as well as beta carotene, then flavonoids (up to 70%) and other biological active matters - antioxidants. In vegetables, there is less than about 90% of nitrate very damaging to humans, particularly to children. In milk, the content of damaging metals, mycotoxins, pesticide residues and glycoalkaloids is reduced. In meat, there is a higher content of unsaturated fatty acids and omega 3 fatty acids. Plants contain more natural biotoxins, such as solanine in potato and tomatine in tomato, which increases their resistance to diseases and pests. Organic production achieves a higher yield in the dry years compared with conventional production, because plants are more resistant, and production methods allow the decrease of 20 to 40% in soil losses because of erosion. Food is without pesticide residues, heavy metals, without antibiotics, growth hormones and additives, and using of genetically modified cultivars, breeds and so forth is prohibited, which all together increases its nutritional and health value. Organic products are safe because they are subject to regular control of the production process. Certified production is transparent, traceable, and the documents and logo are a guarantee that it is organically produced food. Organic production takes care of animals, and they are grown in natural conditions, enabling the manifestation of their natural functions and behaviour, as well as higher quality products.

Biodiversity conservation. Biodiversity is a diversity of living organisms (plant species, animals, micro-organisms and ecosystems which is the basis of life on the planet. Biodiversity conservation in organic farming is enabled by encouraging biological cycles which include plants, animals, micro-organisms as well as flora and fauna of the soil. The management of biodiversity for agricultural intensification implies a more rationale use of this resource and improved conservation efforts. Because it is difficult to predict what parts of the broader biodiversity pool might provide a yield breakthrough in the future or a new biocontrol agent for reducing pest damage, a wise course is to safeguard as much biodiversity as possible in natural and cultural habitats. With the adoption od appropriate farming practices, crop and range land can be used in such a way that they minimize damage to wildlife, water supplies and nearby habitats.

Agricultural intensification could help alleviate destructive pressure on habitats by meeting agricultural production needs on existing farmland. KOVACEVIC *et a*l. (2004b, 2007, 2009) states that modifications of all cultural practices as well as adequate assortment are necessary for organic crop production.

When specifying the advantages in the system of organic farming it should be stated that the conservation of soil fertility is achieved by the resources of the farm alone, and in that sense, a great significance is attached to crop rotation and its phytosanitary role. In the system of organic farming and in the structure of crop rotation, forage and leguminous plants occupy 30 to 50% of fertile areas, which contributes to stronger connection between crop growing and animal husbandry.

Rational modes of soil cultivation, mostly conservational ones are implemented, which greatly saves energy. For the purpose of fertilising exclusively organic fertilisers are used: manure, different types of compost, green fertiliser, biological nitrogen - symbiotic and non-symbiotic nitrogen fixation. Regarding care measures, mechanical and biological ones are carried out, particularly to protect from weed and disease - biopreparations.

Crop rotation in this system is viewed from the standpoint of nitrogen balance, control of weeds, diseases and pests, providing fodder and along with soil cultivation in the stabilisation of active matters. The risks of environmental pollution are decreased. The dependence on chemical industry (mineral fertilisers and pesticides) is reduced. There is a greater possibility for a recycling of the secondary raw materials of agriculture. The mentioned elements are always considered as the advantages of this system. Biological balance with all its characteristics of local nature is maintained by natural modes of production and arranging of areas. A specific designing of field includes eco-corridors, floral belts inside the field, and around the field, along with a proper planting of the shrubs and trees as a habitat for insects and birds.

Organic production by growing a greater number of species, cultivars and breeds, especially old ones maintains genetic variability (LAZIC and MALESEVIC, 2004; 2006; LAZIC *et al.* 2009). Today in Europe, more than 30 new, that is, rarely grown species as well as some forgotten species are produced together with the development of new products (BAVEC, M. and BAVEC, M., 2007).

Organic agriculture is more energy efficient with smaller carbon footprint compared to conventional one (less harmful gases). It uses alternative energy sources very frequently. It produces 28% more carbon, and it is estimated that during one year it can fix, in this production type, 1000 kg of C per ha of soil.

Organic agriculture obtains its full value by multifunctionality - production of agricultural and non-agricultural products and services by preserving agricultural landscape. It creates conditions for better quality and richer touristic offer and contributes to integral rural development (JAMISKES and RADOVANOVIC, 2004; LAZIC and BABOVIC, 2008, LAZIC *et al.,* 2008; LAZIC, 2010).

It should be noted that some transient time is necessary for the transition from the conventional system to organic farming system.

The shortcomings of organic agriculture can be perceived as follows: lower yields, increased dependence on climatic conditions, deficiency in fodder, reduction of content of accessible phosphorus and potassium, decreased productivity, greater participation of manual labour and need for labour force, greater weed infestation, stronger pest attacks, diseases and so forth.

Livestock production is an integral part of organic agriculture and it should be balanced with other branches of agriculture, providing nutrients for crop production and organic matters for soil fertility. This helps ensure the balance between soil and crop production, crop production and livestock production as well as livestock production and soil. This balance is achieved by respecting and implementing principles and standards of organic animal husbandry. In addition, it should be taken into account that organic farm functions as one organism (hence the term "organic"), and studying and knowledge of such a system, as well as of any other organism are possible only if all its components are known. These components (soil, animals, facilities, food and so forth) mutually and individually assert their influence on health and welfare of animals, thus, first of all principles of organic animal husbandry, the primary goal is a conservation of health and welfare of animals.

BIODYNAMIC AGRICULTURE

The development of ecological awareness and the increase of widespread concern for the future of humankind have initiated the development of different schools and courses of alternative agriculture, with often very divergent philosophical definitions, from eastern (FUKUOKA, 2008), to anthroposophical STEINER teachings, sometimes even with occult, supernatural entries.

The concept of "biodynamic" agriculture was created by the successors of Rudolf Steiner (RAUPP and KÖNIG, 1996). The guiding idea for a conceiving of biodynamic agriculture is that the whole farm should be regarded as a single organism and therefore it should be a closed, self-sufficient system. The fertility of the whole farm is based on the strategies which emphasise a generating of the fertility from the biological processes on the farm itself. It is one of the models which supports the recovery of the ecosystem through reintroducing and increasing of biodiversity, establishing and enhancing soil fertility by natural mechanisms and ensures a complete cycle of circulation of matter and energy within one farm via integration of plant and animal production.

Biodynamic farm operates like organic one. However, there are some methods which are characteristic only for biodynamic farming practice. Given that biodynamic agriculture is based on a holistic concept, the influences of planetary rhythms on the development of plants and animals are considered as equally important segment of agriculture. Those characteristics imply a different method of preparing compost, as well as a use of astrological calendar when determining the date of sowing, nurturing and harvesting, that is, applying of lunar calendar. Biodynamic agriculture guarantees higher quality and more diverse diet.

CHALLENGES FOR PLANT BREEDERS

Many modern production systems promote the use of a single variety over large areas, often requiring heavy doses of pesticides or fertilizers. Modern varieties are understandably promoted in agricultural development project because they are generally higher yielding. New cultivars can give high yields in favorable conditions, but it can significantly reduce the lack of resources. Technologies for more sustainable production under reduces agrochemicals, desirable crop cultivar will complete effectively with weeds throughout the growing season. Within this spectrum of changes, breeders can design crop cultivar to fit anticipated changes in system. Plant breeder must attempt to foresee these changes and their breeding programs in such away that products will be adapted and productive under these more sustainable production systems (KOVACEVIC, 2000, BERENJI, 2009).

Wheat cultivars have different reaction in yield comparing two agricultural farming system (Table 2). The semidwarf cultivars Pobeda, Fundulea 4, Bezostay 1 and Siete Cerros show higher differences in yield while comparing tall cultivars Odeskay 51 and Flamnik. Reason for that is probably that in tall cultivars genetic potential for yield is generally low compared to semidwarf genotypes (KOVACEVIC *et al.,* 2004).

Cereals are inevitable plant species in organic production. Numerous species, subspecies, forms, types and varieties make their growing possible in the whole world and in almost all agricultural areas. In Serbia, there are valuable genetic collections of cereals which enable breeding of new genotypes intended for organic production, but they also give opportunity to revitalize old, authentic varieties. Number of organic producers and areas under certified organic production in Serbia are constantly increasing due to the growing market demands for healthy and safe food (KOVACEVIC *et al.* 2007; 2009; MALESEVIC *et al.,* 2010). The Republic of Serbia has significant heterogeneous natural resources and favourable conditions for agricultural production that can meet the basic requirements for the establishment of organic agricultural production, due to lower land and water pollution due to less application of pesticides and other chemicals. This production under conditions in Serbia is still modest due to the existing market restrictions.

Table 2. Effect of cultural practices in different farming systems on grain yield of different cultivars of winter wheat (t ha^{-1})

Farming systems (A)	Cultivars (B)						Average
	Pobeda (Serbia)	Fundulea 4 (Romania)	Bezostay 1 (Russia)	Siete Cerros (Mexico)	Odeskay 51 (Ukraina)	Flamnik (Lesotho)	
CFS	8.44	8.33	7.67	7.07	7.02	6.93	7.58
SA	3.18	2.19	2.40	1.49	2.19	2.09	2.26
Average	5.81	5.26	5.04	4.28	4.61	4.51	4.92

d 5.26 6.14 5.27 5.58 4.83 4.84 5.32

* d - differences between Conventional Farming System (CS) and Sustainable Agriculture (SA)

LSD	0.05	0.01		0.05	0.01
A	0.206	0.280	AxB	0.505	0.687
B	0.357	0.486			

The results of investigations by KOVACEVIC *et al.,* 2011 (Table 3) show that yield grain of wheat was higher in first year with better meteorological conditions. With different alternative wheat species, naked barley and naked oat were obtained lower yields compared with *Triticum aestivum* ssp. *vulgare* - commercial cultivar NS 40S. However, it is expected, but we emphasize that the good yields obtained and tested with alternative small grains that have other advantages when it comes to their specific purpose and quality. This results it could be usefull for organic growers. Alternative types of wheat yield the highest return given the species of *Triticum durum* (3.34 t ha^{-1}) which was significantly higher yield of the species *Triticum spelta* and *Triticum compactum*. In particular it highlights the winter wheat *Triticum durum* - cultivar Durumko. Organic field crop technology that includes a combination of basic fertilization with Bio-Humus and microbial fertilizer (Slavol) in recharge gives the highest yield. Statistically significantly lowest grain yield given with naked barley (2.67 t ha^{-1}) and naked oat (1.45 t ha^{-1}).

Tabe. 3. The effect of technology based on organic principles on grain yield different alternative small grain species (t ha^{-1})

Year (A)	Alternative small grains (B)	Fertilizers (C)			Average	
		Control (C_0)	Bio humus - (C_1)	Bio humus+ Slavol (C_2)	AB	A
2007/08.	*Triticum spelta* - Nirvana	3.75	4.51	4.84	4.37	3.97
	Triticum durum - Durumko	3.83	4.84	6.10	4.92	
	Triticum aestivum ssp. *compactum* - Bambi	3.49	3.97	5.22	4.23	
	Triticum aestivum ssp. *vulgare* – NS 40S	4.63	4.44	5.40	4.82	
	Hordeum vulgare L. - naked barley	2.92	3.93	4.41	3.75	
	Avena sativa L. - oat bran	1.27	1.51	2.35	1.71	
	AC	3.31	3.87	4.72		
2008/09.	*Triticum spelta*- Nirvana	1.43	1.84	2.11	1.79	1.78
	Triticum durum - Durumko	0.85	1.66	2.79	1.77	
	Triticum aestivum ssp. *compactum* - Bambi	1.33	1.85	1.88	1.69	
	Triticum aestivum ssp. *vulgare* – NS-40S	1.99	2.26	3.69	2.65	
	Hordeum vulgare L. naked barley	0.98	1.52	2.30	1.60	
	Avena sativa L. oat bran	0.97	1.15	1.44	1.19	
	AC	1.26	1.71	2.37		
Average	BC	2.59	3.17	3.47	3.08	B
		2.34	3.25	4.44	3.34	
		2.41	2.91	3.55	2.96	
		3.31	3.35	4.54	3.73	
		1.95	2.72	3.35	2.67	
		1.12	1.33	1.89	1.45	
	C	2.29	2.79	3.54		

LSD	0.05	0.01		0.05	0.01		0.05	0.01
A	0.047	0.063	AB	0.116	0.154	ABC	0.217	0.268
B	0.082	0.109	AC	0.082	0.109			
C	0.058	0.077	BC	0.142	0.268			

THE FUTURE OF AGRICULTURE

On the basis of the previous theoretical but also practical knowledge, some things can be listed, which will certainly provoke significant changes in the field of agriculture. First of all, global climatic changes will have their reflection on the territory of Serbia as well.

A higher degree of desertification can extend to the southern part of our country. Plant breeding along with an adequate agrotechnical measures (irrigation) may lead to the appropriate solutions to the given situation.

The lack of energy, that is oil, will require the solutions orienting toward other sources. The production of biodiesel and bioethanol is linked to agriculture where two crops of maize and oilseed rape are very important. An increased production of maize for those purposes, first in the world, will result in major changes in sowing structure, but also in animal husbandry where the lack of it will be felt. Apart from energy, preservation of water resources will be significant due to its huge spending in agriculture.

It is evident that the rise of human population will lead to a great need for food, which will be mostly satisfied from large areas under genetically modified crops.

Huge problems are expected in reducing arable areas per capita. Today it is at the level of about 0.33ha, and around 2050, it is expected to be double reduction. Genetically modified organisms will be increasingly present in conventional agriculture because the development of biotechnical sciences as well as nanotechnology will be dominant in XXI century. Apart from many positive sides, many negative aspects of this industrial crop growing will be increasingly noticeable.

These problems will be a constant reason for popularisation of all ecological trends in agriculture, that is, their divergence and expansion, but an occasional return to some classical technologies from time to time should not be excluded. Modern cities will have the need for using different ecological trends in architecture, touristic attractions, permaculture - modern landscape design, where the multifunctionality of agriculture will be seen in the best way.

ACKNOWLEDGMENTS

This work was suported by Ministry of Sciency and Techological Development R. Serbia. Project (TR-31066)

Received September 30th, 2011
Accepted February 23rd, 2012

REFERENCES

BAVEC, F. and M. BAVEC (2007): Organic Production and Use of Alternative Crops. Books in Soil, Plants and the Environment, CRC Press, Taylor and Francis Group, 1-116, 2007.

BERENJI, J. (2009): The role of cultivar and certified seed in organic agriculture. Scientific research on field and vegetable crops. Institute of Field and Vegetable Crops Research. Novi Sad. *46* (1): 11-16.

CLIVE, J. (2010): ISAAA Brief 42-2010: Executive Summary. Global Status of Commercialized Biotech/GM Crops: 2010. A global overview of biotech (GM) crops. http://www.isaaa.org/resources/publications/briefs/42/executivesummary/default.asp

FUKUOKA, M. (2008): One-straw revolution. (translate into Serbian) Arhit. Gornji Milanovac: 9-41.

JAMISKES, L. and R. O. RADOVANOVIC (2004): Organic Farming und Food Tourism in Vojvodina. Development in Relationships. 100 Years. American association of geographer. Philadelphia

KOVACEVIC, D., S. DENCIC, B. KOBILJSKI, S. OLJACA, N. MOMIROVIC (2000): Effect of cultural practices on soil physical properties and yield of winter wheat under different farming systems. Contemporary state and perspectives of the agronomical practicies after year 2000. Proceedings of ISTRO. 29 August-2 September. Brno. Czech Republic: 134-138.

KOVACEVIC, D. (2004a): Organic agriculture. The concept in environmental protection. Scientific research on field and vegetable crops. Institute of Field and Vegetable Crops Research. Novi Sad: *40:* 353-371.

KOVACEVIC, D. and N. MOMIROVIC (2004b): Weed management in organic agriculture. Acta biologica Yugoslavica. Serija G. Acta herbologica.Vol.*13*. No.2. Beograd: 261-276.

KOVACEVIC, D., S. DENCIC, B., KOBILJSKI, S. OLJACA, Z. DOLIJANOVIC (2004c): Effect of farming systems on soil compaction, weed synuzia and yield of winter wheat. Acta biologica Yugoslavica. Serija G. Acta herbologica.Vol.13. No. 2: 385-392. Beograd.

KOVACEVIC, D., S. OLJACA, S. DENCIC, B. KOBILJSKI, Z. DOLIJANOVIC (2007): Sustainable agriculture. Important of modification cultural practices in winter whet production. Journal for Scientific Agricultural Research. Vol. 68. No. 244: 39-51.

KOVACEVIC, D. (2008): Weeds in Arable Crops-Biology and Control. Monography. Ed. Faculty of agriculture-Zemun: 1-520.

KOVACEVIC, D., Z. DOLIJANOVIC, S. OLJACA, V. MILIC (2009): Yield of some alternative cultivars of winter wheat in organic field production. Journal for Scientific Agricultural Research. 2009/3 (5-62) Vol.*70*. No. 251: 17-25.

KOVACEVIC, D., S. OLJACA, Z. DOLIJANOVIC, M. SIMIC (2010): Sustainable Agriculture: Importance of Cultural Practices Adaptation in Winter Wheat Technology. Alps-Adria Scientific Workshop Špičák, Cheh Republic. DOI:10.1556/Novenyterm. 59. 2010. suppl. Hungary 1:1-4

KOVACEVIC, D., S. OLJACA, Z. DOLIJANOVIC (2011): Grain yields of alternative small grains in organic field production. Proceedings. 46th Croatian and 6th International Symposium on Agriculture. Opatija. Croatia:80-83.

LAZIC, B. and M. MALESEVIC (2004): The basic principles of organic agriculture. Scientific research on field and vegetable crops. Institute of Field and Vegetable Crops Research. Novi Sad. 40: 439-445.

LAZIC, B. and M. MALESEVIC (2006): Organic agriculture. Yes!, "My farm". Ed. Branka Lazic. Green Network of Vojvodina. Novi Sad: 97-113.

LAZIC, B., J. BABOVIC et al. (2008): Organic Agriculture I and II. Scientific Institute of Field and Vegetable Crops Research. Novi Sad: 1-686.

LAZIC, B., M. MILOSEVIC, S. DRAGIN (2009): The role of gene banks to conserve and use genetic resources. Managing genetic plants and animals resources in Serbia. Serbian Academy of Sciences and Arts. Belgrade. Book 3.

LAZIC, B. (2010): Multifunctional organic farming. Proceedings of the Rural development and organic agriculture. Fund Organic Serbia. Belgrade: 7-13.

LAZIC, B. and S. SEREMESIC (2010): Organic agriculture-today and tomorrow. Contemporary agriculture. Vol. *59*. No.5. Novi Sad: 522-529.

LEIBMAN, M. and A.S. DAVIS, (2000): Integration of soil, crop andweed management in low-external-input farming systems. Weed Research.Vol. *40*: 27-48.

MALESEVIC, M., J. BERENJI, F. BAVEC, G. JACIMOVIĆ, D. LATKOVIC, V. ACIN (2010): Organic cereal production – Opportunity for agriculture in Serbia. Contemporary agriculture. *59* (3-4). Novi Sad: 400-416.

MOMIROVIC, N., M. DJEVIC, Z. DUMANOVIC (1995): Conservation tillage systems in sustainable agriculture concept. Agricultural engineering. Belgrade. Vol. *3*. No. 5-6 : 49-53.

OLJACA, S., R. CVETKOVIC, D. KOVACEVIC, G. VASIC, N. MOMIROVIC (2000): Effect of plant arrangement pattern and irrigation on efficiency of maize (*Zea mays*) and bean (*Phaseolus vulgaris*) intercropping system. Journal of Agricultural Science. 135: 261-270. Cambridge. Cambridge University Press.

RAUPP, J. and U. J. KÖNIG (1996): Biodynamic preparations cause opposite yield effects depending upon yield levels. Biol. Agric. & Hort. *13*, 175-188.

***GLOBAL ORGANIC FARMING STATISTICS AND NEW, 2011 the World of Organic Agriculture, FiBL, IFOAM.

SAVREMENI PRAVCI RAZVOJA POLJOPRIVREDE I ZAHTEVI U OPLEMENJIVANJU BILJAKA I KORIŠĆENJU ZEMLJIŠTA

Dušan KOVAČEVIĆ[1,3] i Branka LAZIĆ[2,3]

[1]Poljoprivredni fakultet, Zemun
[2]Poljoprivredni fakultet, Novi Sad
[3]Akademija inženjerskih nauka Srbije

I z v o d

Budućnost poljoprivrednog razvoja u XXI veku podrazumeva održivu poljoprivredu kao alternativu sadašnjoj konvencionalnoj. Poljoprivreda je obično razvijena onoliko koliko i samo društvo u kome postoji kao privredna grana. Danas postoje različiti pravci na kojima je zasnovana poljoprivreda, od najviše zastupljene vrlo intenzivne konvencionalne poljoprivrede, do brojnih ekoloških pravaca zasnovanih na ekološkim principima.

Konvencionalna (industrijska) poljoprivreda ima zadatak da obezbedi maksimalnu proizvodnju u pogledu kvantiteta i kvaliteta. Za te svrhe koristimo brojne agrotehničke mere, koje ponekad, pored očekivanih pozitivnih, imaju mnoge negativne dugoročne efekte u agroekosistemima i u ekosistemu u celini.

Organska poljoprivreda je jedan od interesantnih aktuelnih pravaca zasnovan na ekološkim principima i na odsustvu primene agrohemikalija. Zahvaljući sveobuhvatnom pristupu organskom proizvodnjom dobija se bolji kvalitet proizvoda (bolji ukus, povećan sadržaj suve materije, vitamina i drugih antioksidantnih materija), zaštita prirodnih resursa (zemljište, voda) i povećanje biodiverziteta sa pažljivim izborom sorata za specifične namene.

Primljeno 30. IX. 2011.
Odobreno 23. II. 2012.