

SUSTAINABLE TECHNOLOGY IN AGRICULTURE

Daniela Kuzmanović¹, Zoran Kuzmanović², Sava Smiljić³

¹University of Belgrade, Faculty of Agriculture, Belgrade, SERBIA

²Faculty of Business Studies and Law, University Union-Nikola Tesla, Belgrade, SERBIA, e-mail: zoran.kuzmanovic@fbsp.edu.rs

³Faculty for Strategic and Operational Management, University Union-Nikola Tesla, Belgrade, SERBIA, e-mail: sava.smiljic@fsom.edu.rs

Abstract: *Classical agriculture for many years resulted in continued degradation of land, and if this trend continues (and past practice leads to it) there will indeed be a permanent loss of land as the most important resource. Agricultural production is sustainable only if it is profitable, and it can be profitable either in economic or in environmental terms. In economic sense, it is useful i.e. profitable, for those to whom it provides adequate income and allows a certain quality of life, while preserving the environment as an ecological profitability of sustainable agriculture. The system of sustainable agriculture and the concept of good agricultural practice should eliminate the consequences caused by conventional farming. If to sustainable agriculture and good agricultural practice we add modern sustainable technologies to, we will have the most sustainable possible systems of agricultural production.*

Keywords: *sustainable agriculture, good agricultural practices, organic farming, green technology, economic benefit.*

1. CURRENT TRENDS IN POPULATION GROWTH AND REQUIREMENTS IN AGRICULTURE

The problem of environmental pollution, originally comes from the industrialization of manufacture production. At the same time the migration of the population in the former urban areas begins, as well as a sharp rise in the number of urban population. The report of the "Club of Rome" (1972, when the total population was 6 billion) predicted that in 20 years the total population would amount to 12 billion, and that 90% of population growth shall occur in poor and underdeveloped countries, and 90% of it will be in already overburdened urban areas. Of course, this did not happen, but that trend of population growth and migration still exists today and poses a serious threat to the entire population, environment, and agriculture.

The global problem of population growth consists of the following [1]:

- The exponential population growth in developing countries
- Permanent reduction of the population in developed countries
- Increasing permanent migration, legal and illegal, that leads to social pathology

Agriculture is one of the largest sources of pollution of all environmental media. Methods of conventional agriculture applied over the past decade have led to long-term pollution, not only of the soil but also water by resources artificial synthetic chemical substances. To ensure the production of sufficient quantities of food, not just for existing but also for future generations, it is necessary to change current agricultural practice - to modify it so that it becomes viable over a long period of time. [2] One of the biggest challenges that the modern world meets is to provide enough food for a growing world population, while ensuring sustainability and health safety of the food industry, trade and consumption.

It is absolutely necessary to change over to organic agriculture that will allow not only food that is safe for human health, but also the preservation of the natural environment. Methods of organic agriculture, which are already applied in many countries in the world, have shown excellent results in terms of not only the preservation of soil biodiversity, but also the purification of soil and water from pesticides and artificial synthetic fertilizers. Sustainable agriculture will allow the survival of not only the rural population, but also people in urban areas who are directly dependent on food production in our or urban, i.e. in rural areas.

According to data from 2009 (published at a conference in Rome on “How to Save the World in 2050” [3]) in the period from 2009 to 2050 world population is expected to increase by 1/3 (2.3 billion people) and then the total population of the world will amount to 9.1 billion inhabitants. Also, it is envisaged that the urban population will participate with up to 70% in the world’s population, while the agricultural population shall have a declining tendency. It is estimated that by 2050 the demand for animal products and cereals will increase from 2.1 billion tons, which is today at 3 billion tons. [4]

Population growth and the inevitable growth in production and consumption will cause a negative impact to the environment, and thus increase environmental input and the output of the crisis. [5] This brings us to the information that the arable land in developing countries will have to increase from less than 70 million hectares to 120 million hectares, i.e. by 7%, while in developed countries, arable land will decrease by 8% (50 million ha). Agriculture in developed countries has progressed, and thus contributed to the creation of richer rural areas with lower food prices.

According to the latest data of IFOAM¹ (International Federation of Organic Agriculture Movements) of the certified organic production on a world scale, there were 37.2 million ha of organic agricultural land (including areas in the period of conversion). Regions with the most arable land are Oceania (12.2 million hectares), Europe (9.3 million hectares) and South America (8.6 million hectares). The countries with the most organic agricultural land are Australia, Argentina and the United States. In 2009 (according to IFOAM) registered 1.8 million producers, representing an increase of 31% compared to 2008. Of the total 37.2 million hectares under organic production almost 2/3 of organic agricultural land was pasture and meadow (23 million ha).²

1 <http://www.iofam.co.uk/> (10.03.2014)

2 <http://www.agrovizija.rs/teme/organska.php?subaction=showfull&id=1338737235&ucat=18>

Despite these challenges, agricultural technology has had (and we indeed hope it shall continue to have) a central role in overcoming the challenges in food safety. 20th century was marked by a significant time investment in scientific research that contributed to a historic increase in the area of agriculture and food safety.³ Based on the assumption that human population growth shall not be limited, as a result there will be food shortages as the most important social values. In this way, the role of technology in sustainable agriculture is threefold:⁴

- Technology has increased and will increase agricultural production,
- Technological development has been and will be more sustainable
- Sustainable agriculture is based on a sustainable technology.

2. SUSTAINABLE AGRICULTURE

The term “sustainability” in ecology can best be described through the natural ecosystems where everything is based on the circulation of matter and energy (from the producer to the decomposers of organic matter) and that by using nothing but solar energy. Circulation takes place through the trophic levels where organic compounds (substances) of plants and animals translate to elementary, which as such re-enter the cycle of circulation and become available again. Only such systems can be considered sustainable because they require no human or chemical agent to keep the system functioning smoothly – that is why today both incredible knowledge and technological efforts are being invested in order to achieve these systems in agriculture. Therefore, sustainability in agriculture is based on the capacity of agro-ecosystems to predictably maintain production through time.

Agricultural sectors indeed have adequate guidelines for national and international action that will lead to the development of sustainable agricultural systems of production⁵. Therefore, the principles of good agricultural practices that apply globally had been defined - Global GAP [6] (Good Agricultural Practices), which form the basis for a more detailed instructions for each individual production systems within specific agro ecosystem. Global GAP (formerly known as the Euro GAP) has established a standard that is a key reference for Good Agricultural Practice in the global market, following the demands of consumers in agricultural production. Benefits from the application of good agricultural practices should apply to the following factors:⁶ farmers, consumers, economy in general and all of humanity.

HACCP [7] (Hazard Analysis and Critical Control Point) is being introduced based on the Global GAP certificate, and it represents a system of control of physical, chemical and biological dangers in food production, i.e. those are the key control points where contamination might occur. Sustainable agriculture and safe food is a way of producing food that can

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3 www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Global_Agriculture.pdf (09.03.2014)

4 <http://ipmworld.umn.edu/chapters/hutchins3.htm> (09.03.2014)

5 Dr. sc. Midhat Glavić „Kodeks dobre poljoprivredne prakse“, Program razvoja tržišne poljoprivrede (FARMA) Novembar, 2012.g.

6 http://www.google.rs/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCcQFjAA&url=http%3A%2F%2Fwww.ruralinfosrbia.rs%2Fpublikacije%2FPravila%2520dobre%2520poljo%2520privredne%2520prakse.pdf&ei=D98eU_D5HNOd0wXQooHYCw&usq=AFQjCNEsJoAVxtbIkJbJ5t_f3VtQhz_uw&sig2=4Au8fFoXenUvyM72YReC8g&bv=bv.62788935,d.Yms (02.03.2014)

be implemented also for future generations to come. The future of sustainable agriculture will be unable to do the following:⁷

- Understanding of human needs with safe, high-quality and health-safe produced food,
- Protecting natural resource base will prevent degradation of air, land and water,
- There will be a more efficient use of nonrenewable resources,
- we shall use natural biological cycles and biological control of pests and weeds,
- The economic survival of agriculture and the welfare of farmers, their families and communities shall prove to be safe
- There will be institutional incentives and funding to focus public and private research, education and technology development increased productivity and profitability of agriculture to environmental protection.

HACCP is a system of control relating to the physical, chemical and biological dangers in food production that manufacturer observes, controls over production, identifies and analyzes all potential hazards. This type of practice is applied in organizations, agricultural complexes and households to identify potential risks to health safety of food, and further in order to take key actions that need to reduce or eliminate danger for the occurrence of potential adverse consequences. Farmers need to know to properly handle and treat agricultural products and should also be energy-efficient. By this we mean that glasshouses / greenhouses are to be well insulated as well as barns, coops, etc. Further, they should use RES. What HACCP standard also prescribes are the conditions of transport, storage and packaging of food products.

3. ORGANIC AGRICULTURE

The development of agriculture has led to the mass production and use of mineral fertilizers that have positively influenced the increase of labor productivity in agriculture, but has caused significant negative consequences: the contamination of natural resources, water, air, land, and thus more arable land becomes unsuitable for organic agriculture and intensive land degradation and the use of illicit means to organic production.

The origins of organic farming is evidenced in a series of scientific experiments in mid-20th century to the present day - industry worth 55 billion US dollars, which can be attributed to the fact that consumers are willing to pay higher prices for organic production method that promotes agro ecosystem health without the use of chemical agents. [8] Organic agriculture has a role to play in achieving sustainable development, particularly in developing countries where there is this kind of production, and those primed exercise price (exporting to developed countries), but current offer can not meet the growing demand for this type of product. To make this happen, policy-makers, civil society and the private sector all need adequate databases that will help them make adequate decisions.

According to IFOAM organic agriculture is a production system that in a positive and ecological way preserves and maintains the health of agro ecosystems and people. Organic production is a system of sustainable agriculture which is based on high respect for natural

⁷ Technology for Sustainable Agriculture, Chet Townsend, Presented at a Forum on Sustainable Agriculture for Florida Gulf Coast University on April 7, 1998. (<http://www.ultimatecitrus.com/disc/sustainableag.html>) (10.03.2014)

processes through the rational use of resources and the use of renewable energy sources, and environmental protection. Organic production is a production with no synthetic materials and fertilizers, growth regulators, hormones, antibiotics and GMO, and thus represents the ultimate choice for every each state that cares about the health of the nation.

Organic production in Serbia is becoming more popular and economically important, all that thanks to the resources which are primarily reflected in the fragmented possession of the land that is not contaminated by harmful substances. Therefore, the organic production is set as one of the priorities of agricultural development and is an integral part of the strategy for rural and agricultural development of the Republic of Serbia. The Republic of Serbia has 5.11 million hectares of agricultural and 25.4 million hectares of arable land (800,000 ha and are completely unused). What concerns certified organic area in Serbia, it was 2,580 ha, and we see that it has much more potential. [9] “The Law of organsokoj agriculture” in the Republic of Serbia, adopted in 2006 (and rebuilt in 2010) defined the basic strategic directions and elements of organic production. Law [10] in 2010, regulates the production of agricultural products and other methods of organic production: processing, storage, transportation, marking, labeling and transport of organic products, certification and resertifikata for organic products, as well as other issues of importance to organic production. This law gives the possibility for identification, allocation and cancellation of environmental labeling and certification. Let thus enabling the expansion of organic production on the domestic market but encourages farmers to be placed on the international market as a win-win situation, both for the manufacturers themselves, but also for the state. The aim of this law is [11]: Officially approved for obtaining the products with the procedure of production, sustainable socio-economic rural development, consumer protection, marking that clearly indicate the manner and medode organic production, protection of resources from pollution, long-term maintenance and increasing soil fertility, conservation biodiversity.

4. IMPLEMENTATIN OF HCCP IN AGRICULTURE

Society is becoming increasingly concerned about the uncontrolled exploitation of natural resources and environmental degradation, and in recent decades there has been more and more noticeable increase in interest and caring society for the environment. To this end, the industry and the business recorded an increasing need and interest towards the implementation of green activities that will not jeopardize the state of the environment, all that in order to produce “green” products with “greener” processes.

The concept of design for the environment DfE (Design for Environment) as well s the instrumentsof life cycle analysis LCA (Life Cycle Assessment), together with extended producer responsibility EPR (Extended Producer Responsibility) are emerging as critical tools that advanced companies use to develop new and improve the performance of existing businesses. The purpose of “green design of products” is to identify, assess and minimize the environmental impacts of a particular product. This is achieved through a systematic review of product performance through impacts on the environment, health and safety of people during its entire life cycle, i.e. from the extraction of resources, production, product design, use of products to final disposal.

The concept of sustainable development is also applied in the production of agricultural products and called HACCP. HCCP standard combines the best technology and sustainable agriculture. HCCP standard control the following aspects:

1. Extraction of raw material - adoption of basic elements (Ca, Mg, P, etc) from the soil;
2. Processing and production - processing of fruit includes: cleaning and sorting by size, while manufacturing represents the conversion of fruit into a particular product;
3. Packaging and distribution - fruit or product is packed and transported in boxes and distributed to the markets or supermarkets;
4. Use - quality (nutritional value and food safety) of products consumed by buyers;
5. Waste disposal and recycling - this segment should be present in every part of the production cycle:

- From the remains of plants that are used as green manure, compost or for the production of biodiesel
- Use of recycled packaging and transport boxes
- All the way to households all biological waste should be disposed of in specific bags / boxes that are still deposited in the appropriate place where they're being taken in to compost-stations and serve for the production of compost or biodiesel.

Farmers need to know how to – according to the HACCP standard - properly treat and treat land and agricultural products.

HCCP standard [12] also regulates: packaging, transport conditions, packaging and storage of food products. Consumers of these products expect sorting and recycling of products and packaging.

5. CERTIFICATION OF ORGANIC FOOD

In developed countries, there is control of organic producers by governmental and non-governmental organizations and it is linked to the “Eco-label”. The standards for labeling are not harmonized throughout the world, but the ISO 14020 series of standards is considered an international solution for the “Eco-label”, i.e. standardization and certification of organic products. “Eco label” is a sign on the packaging that gives the validation that the product was produced in an environmentally friendly way, which enables consumers to make an informed, free choice. The main reasons for the introduction of eco-labels in agricultural production are as follows: [13]

- Promotion of products that positively affect the environment
- Stimulation of sustainable production and use of recycled materials in order to save resources
- Customers have reliable and complete information on the impact of a product or service on the environment.



Figure 1: The “Eco sign” in the Republic of Serbia [14]



Figure 2: The official logo for organic products in the Republic of Serbia [15]

All the products that are manufactured in the Republic of Serbia and meet the criteria laid down by the “Regulation on conditions and procedure for obtaining the right to use eco sign’ [16] can obtain the “Eco sign.”

“The draft law on organic farming and organic products” gives the ability to certify organic products and mark them with the label “organic product;” further, it can contain the code of the authorized organization and the national logo. The national sign is determined by the Minister of Agriculture.

The application of HACCP standards and sustainable agricultural technologies and practices in organic farming is the only way for us to have health certification of safe and environmentally friendly food and agriculture.

6. CONCLUSION

Agriculture is one of the largest sources of pollution of all environmental media. Methods of conventional agriculture, applied in previous decades led to long-term pollution by pesticides, herbicides and other synthetic chemical substances. It is not only pollution of soil, but also of water resources. In order to ensure sufficient food production for present and future generations, it is necessary to implement sustainable agricultural technology. Methods of organic agriculture, which is already applied in many countries in the world, have shown excellent results in terms of not only the preservation of soil biodiversity, but also the purification of soil and water from pesticides and artificial synthetic fertilizers. Biological pest control, the use of natural substances to control the disease, the use of fertilizer (manure and / or compost) to increase soil fertility, the measures are in accordance with the requirements of a healthy environment, and enable maintenance of ecological balance in nature.

Each environmentally friendly organic product must have a certificate of organic production (eco label) so that as such it enter the market, not only domestic but also international.

Therefore, as far as the modern (sustainable) technologies in sustainable agriculture are concerned, in addition to organic farming, which increases the quality of the environment, and conducts its purification, we also refer to the following: create sustainable systems of production, the use of compost, manure and green manure, application of renewable energy sources, and the use of fuel cells in the transport system products, but also in the systems

as such within the complex mechanization of agricultural producers. Without the entire modern – sustainable - process of agricultural production we could not have organic production and organic certified processes.

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